European Journal of Contemporary Education
E-ISSN 2305-6746
2022. 11(2): 388-407
DOI: 10.13187/ejced.2022.2.388
https://ejce.cherkasgu.press




# Enhancement of Digital Literacy of Students with Disabilities

Aibek Ibraimkulov [a, c, *], Kulira Khalikova [b], Aigerim Yerimbetova [c, d], Konrad Gromaszek [e]

[a] Al-Farabi Kazakh National University, Almaty, Kazakhstan
[b] Abai Kazakh National Pedagogical University, Almaty, Kazakhstan
[c] Institute of Information and Computational Technologies CS MES RK, Almaty, Kazakhstan
[d] Satbayev University, Almaty, Kazakhstan
[e] Lublin University of Technology, Lublin, Poland

**Abstract**

Digitalization has affected all spheres of life, including education. Modern didactics and methods of digital education are designed to solve problems related to the use of digital technologies, tools and resources in the education, upbringing and development of children with disabilities. The aim of the study was to develop a model of the components of digital literacy and in practice to assess the level of development of digital literacy of students with hearing impairment. The process of forming and improving the components of digital literacy of hearing impaired students was carried out on the basis of the scientific substantiation of the content of the special course in addition to computer science. The study was conducted in Kazakhstan between the years 2019 and 2021 among 127 students of special (correctional) schools. We have proposed the author's two-component model of digital literacy of hearing impaired students: (1) digital user component and (2) digital correction-intellectual component. In the first component students with hearing impairments will able to know the basic Engineering training. For example, installing, starting, removing and updating software; installing the operating system; increasing the speed of a computer; working with drivers, peripheral devices and etc. On the basis of the collected data, we have noticed the following: digital user component of digital literacy is an important for hearing impaired students because the respondents possess the lowest level of knowledge in the area of engineering training and have the ability to create digital content. This led to create the second component as Digital correction-intellectual component. According to this component, students will be able to improve their cognitive, logical, critical, creative, systems thinking, memory, attention, speech, communication skills through learning adopted additional course. Thus,

* Corresponding author
E-mail addresses: aibek_ibraimkulov@mail.ru (A. Ibraimkulov), aigerian@mail.ru (A. Yerimbetova)

facilitating the development of Digital literacy of students with hearing impairments has become one of the key challenges faced by special (correctional) schools today.

**Keywords:** digital literacy, students with hearing impairments, components of digital literacy of students with hearing impairments, computer science, additional course.

## 1. Introduction

The problem of adaptation of schoolchildren with disabilities in society, creating conditions for them to receive a quality education, increasing their creative abilities, integration into society as a full-fledged member of society can be considered one of the most important issues that is currently being intensively carried out in many countries of the world. In the era of digital technology development, improving the digital literacy of schoolchildren with disabilities is the aim of today's school curriculum especially in the computer science course.

Modern educational practices and pedagogical systems of developed and developing countries are undergoing changes necessary for society, making the transition to new educational concepts and technologies. International organizations recommend inclusive education as a priority direction for the development of the educational system, aimed at realizing the right of citizens to receive quality education and social integration. Let's give an example on the International legal framework for teaching, upbringing and education of children with disabilities, such as:

Universal Declaration of Human Rights (1948) – Adopted by the UN General Assembly on 10.12.1948. Article 26.2: "Education should be directed to the full development of the human personality and to increase respect for human rights and fundamental freedoms (UDHR, 2015). Education should promote mutual understanding, tolerance and friendship among all peoples, racial and religious groups, and should contribute to the activities of the United Nations in maintaining peace."

The UN Convention on the Rights of the Child (1989) – Adopted by UN General Assembly resolution 45/25 of 20.11.1989 – The UN Convention on the Rights of the Child enshrines the right of all children to receive education without discrimination on any basis, the right of the child to respect for his dignity, living in a family, the right of disabled children to social integration (UN CRC, 1989).

World Declaration on Education for All (1990) – The World Declaration on Education for All was adopted by the participants of the World Conference "Education for All" in Jomtien, Thailand, on March 5-9, 1990, with the aim of meeting the basic educational needs of all people. Article 3 – the so-called "making access to education universal and promoting equality" states that the educational needs of persons with disabilities deserve special attention. It is necessary to take measures to ensure equal access to education for all categories of persons with disabilities as an integral part of the educational system (UDHR, 1990).

The Standard Rules on the Equalization of Opportunities for Persons with Disabilities (1993) – the objectives and content of the Standard Rules on the Equalization of Opportunities for Persons with Disabilities: the Standard Rules on the Equalization of Opportunities for Persons with Disabilities were developed based on the experience gained during the United Nations Decade of Persons with Disabilities (1983–1992). States should recognize the principle of equal opportunities in primary, secondary and higher education for children, youth and adults with disabilities in integrated structures. They should ensure that the education of persons with disabilities is an integral part of the general educational system (UN SREOPD, 1993).

The Salamanca Declaration: on Principles, Policy and Practical Activities in the field of education of Persons with special needs (1994) – On principles, policy and practical activities in the field of education of persons with special needs: 'persons with special educational needs should have access to education in ordinary schools, which should create conditions for them on the basis of pedagogical methods focused primarily on children in order to meet these needs' (UNESCO SDPPPA, 1994).

As well as UNICEF, which carries out activities to protect the rights of children with disabilities throughout Europe and Central Asia: from spreading the best possible ways of caring for such children to supporting their education and participation in local life (Children with disabilities, UNICEF).

Based on the above-mentioned International legal framework, it can be concluded that every child has a fundamental right to education and should be able to receive and maintain an

acceptable level of knowledge, each child has unique characteristics, interests, abilities and educational needs, despite their disability.

In order to give the students the opportunity to receive and maintain an acceptable level of knowledge, it is necessary to use digital technologies in their educational process.

Digitalization is transforming societies, providing new opportunities to improve education in the classroom, enhance the management of education systems, but also to consider innovative models of delivery (OECD, 2021). One of the main elements of the digitalization of education is digital literacy. Digital literacy is the main priority of modern education, it is the ability to design and use the content using digital technologies such as computer programming, graphic visualization techniques, computer graphics, multimedia development of online courses, etc., search and exchange of information and communication with other learners (Petrov, Bondareva, 2019).

Digital literacy is an important learning area for all learners who can participate in learning, recreation and work in the 21st century (OECD, 2015). This could enable students with disabilities to use modern digital technology as a creative learning tool. The term digital literacy has been given much attention in various sectors of the sphere, including in education, problems from the digitalization of education to the formation and development of digital literacy of teachers and students have been studied, but limited attention has been paid to teaching students with disabilities and various educational needs. Digital literacy opens up opportunities for all students, especially those with disabilities. For example, the use of a number of assistive tools such as a web application as an online Internet tool in the classroom provides students with disabilities with new ways to interact with educational content, perceive the material and express their understanding of this content.

### 1.1. Digital literacy capability

Digital literacy capability is important for students with disabilities, as it can enable access to learning and to self-improvement. Difficulties in understanding what this ability means for students with disabilities and how their learning in this area is progressing have created difficulties for teachers in developing digital literacy for students with disabilities. To solve this problem, this study attempted to define the concept of digital literacy development for students with hearing impairments in order to form and develop the components of digital literacy. The school computer science course is responsible for the formation of a wide range of meta-subject educational results in the field of information and communication technologies that meet the realities of the time and are constantly changing in accordance with these requirements. But, unfortunately, if we talk about the formation of digital literacy of a student with hearing impairments, the existing educational and methodological complexes in computer science are not adapted to fully reflect all its components.

Digital literacy occupies the most important place in the list of basic skills that are in demand in the XXI century in almost any position.

## 2. Materials and methods

### 2.1. Research goal, implementation and the methodological basis

Digitalization has affected all spheres of life, including education. Modern didactics and methods of digital education are designed to solve problems related to the use of digital technologies, tools and resources in the education, upbringing and development of children with disabilities.

There is a problem of developing digital literacy based on the creation of additional educational content, learning technologies necessary for the formation of digital literacy of students with disabilities.

In this paper, two major problems are considered.

Firstly, it is necessary to replenish and improve the methodological support of the educational process, focusing on the development of educational and cognitive sections of adapted programs, to increase the digital literacy of students with disabilities. Secondly, it is necessary to develop additional training courses in computer science, for correction and in the development and effective socialization of students with disabilities.

The purpose of the study is to create an additional educational course in computer science aimed at improving the level and formation of digital literacy of students with hearing impairment, taking into account the trend of creating and applying a digital resources in pedagogical practice, scientific development of teaching methods and description of its application in practice.

The implementation of this goal involves solving the following tasks:

- to formulate a definition of the concept of "digital literacy of students with disabilities, namely with hearing impairments";
- to determine the components and build a model of digital literacy of students with hearing impairments;
- to develop an additional educational course for the formation and development of digital literacy of students with hearing impairments in addition to the main course of school informatics;
- to substantiate the results obtained and check the effectiveness in practice.

The methodological basis of the authors' research was formed by the ideas of a personality-oriented approach of students with hearing impairments. The main research methods were chosen theoretical analysis of educational and methodological, scientific literature and Internet resource on the formation of digital literacy of students with disabilities, generalization of practical experience in the formation and development of digital literacy, questionnaires to identify the dynamics of the formation of digital literacy of students with hearing impairments.

### 2.2. Review of digital literacy sources for students with disabilities

A review of numerous scientific sources on digital literacy has shown that digital literacy is defined as the ability to correctly use information and communication technologies to search, evaluate, create, retrieve and transmit information, content that requires both cognitive and technical skills not only in the professional sphere, but also in everyday life.

Various researchers have presented definitions of digital literacy and conducted a number of studies on this issue (e.g., see Gilster, 1997; Neumann et al., 2017; Porat et al., 2018; Lankshear, Knobel, 2008; Bawden, 2001) and research on digital literacy skills for students through improved pedagogical methods (e.g., see Sahu, 2019; Kuznekoff et al., 2019). After analyzing digital literacy, the authors noted the use of digital technologies that have great pedagogical potential, students will be able to confidently use them in their studies and in life. According to Martin (2008), Digital Literacy: "is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process". At the beginning of the 21st century, Eshet-Alkalai, (2004) in his research telling that "Digital literacy includes a wide range of complex cognitive, motor, sociological and emotional skills that users need to function effectively in a digital environment" proposed a new conceptual system for the concept of digital literacy, joining five types of education: (a) photovisual literacy; (b) reproduction literacy; (c) information literacy; (d) branching literacy; and (e) socio-emotional literacy. According to the authors, these types of digital literacy cover most of the cognitive skills used when using the digital environment. As a result, this conceptual framework can improve understanding of how users perform tasks that require the use of different types of digital skills.

The study by the researcher, Professor P Hagel (2015) showed that 'digital lııteracy' integrates three literacies: information literacy, media literacy, and information and communication technologies (ICT) literacy. These literacies have become "legacy" perspectives that continue to influence conceptions of digital literacy (see in Table 1). In addition to this concept, research by Martin, Grudziecki, 2006 – *Martin, A., Grudziecki,* (2006) distinguish other "digital literacies": Technological literacy; Visual literacy; Communication literacy (see in Table 1). According to the authors these "literacies of the digital" mostly from the pre-digital era, but presented as a way of understanding phenomena that have become more important or even transformed in the digital context.

**Table 1.** A brief overview of the contribution to digital literacy, according to P Hagel (2015) and Martin, Grudziecki, 2006 – *Martin, A., Grudziecki,* (2006)

| Hagel, Pauline (2015) | Allan Martin and Jan Grudziecki (2006) |
|---|---|
| Information literacy:<br>skills of independent search, analysis, critical understanding of information data; | Computer, IT or ICT literacy:<br>Computer literacy concepts are divided into three phases:<br>- Mastery phase: Obtaining special knowledge |

| | |
|---|---|
| | and skills for mastering the computer. "Computer Basics", whatever they are called, consists of how a computer works and how to program it i.e. using whatever languages were in use at the time.<br>- Application Phase: In this phase, the computer is considered as a tool that can be applied in education, work, leisure and home. The use of software applications has become a major focus of literacy activities, and the definition of computer or IT literacy focuses on practical skills rather than specialized knowledge.<br>- Reflective phase: In the Reflective phase IT could be a vehicle in pedagogy focused on students. |
| Media literacy relates to the creation, production, reading, communication and critical evaluation of media and texts. | Technological literacy:<br>Technological literacy has emerged as a response to a variety of concerns: increasing awareness of the enormous potential danger of technological development to the environment and humanity; and the growing fear that a lack of understanding about technological developments will cause the workforce. |
| The ICT Literacy Panel (cited in Mackey, Jacobson, 2011: 65) defined this literacy as: "...using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information to function in a knowledge society". | Information literacy includes knowledge of information problems and needs and the ability to identify, retrieve, evaluate, organize, and effectively create, use and communicate information to solve current problems or problems. It is a prerequisite for effective participation in the information society and is part of a fundamental human right to lifelong learning. |
| | Media literacy focuses more on the characteristics of different media genres and how messages are constructed and interpreted. From this perspective, the characteristics of the author/sender and recipient are important to understanding the meaning and content of the message. Information literacy tends to focus on how to access information and evaluate content. |
| | Visual literacy originated in art criticism and art education and was originally concerned with cognition and how artists and designers use perspective, proportion, light, color, and other methods of visual communication. |
| | Communication literacy, in fact, emphasizes the importance of communication as a human activity as the basis of social interaction and is regarded as a primary personal attribute, whether verbal or digital. |

In the studies of Berman (2017) it is noted that the concept of "digital literacy" includes three components: digital competencies, digital consumption and digital security. And also Digital literacy includes the personal, technical and intellectual skills that are necessary in order to live in a digital world. As digital technologies become mainstream in society, the understanding of digital competence has expanded from technical aspects to a broader understanding of the application of

digital technologies. For example, digital competencies include: proficiency in Internet search technologies. Digital consumption reflects the level of availability of various digital technologies, both hardware and software. Digital security includes the possession of skills for safe working in the network, both technical and socio-psychological.

We agree with the opinion of Hobbs et al., 2018 – *Hobbs, R., Coiro, J.* (2018) that digital literacy is an extended concept of literacy that responds to the current changes in information and communication technologies that are part of everyday life.

Describing the state of digital literacy and emerging articulations, Connolly et al., 2018 – *Connolly, N., McGuinness, C.* (2018) note that they are more focused on the contextual and social aspects of this term, pointing out the need for models that would be immersive, meaningful and related to the life experience of young people. And the state of digital literacy can be seen through participation in digital culture, social responsibility, ethical consciousness and digital citizenship.

When forming digital literacy among students, Potupchik, 2017 – *Potupchik, E.G.* (2017) pays special attention to network security and ethics of working on the Internet. According to the author, "remote network interaction in distributed groups within the same school contributes to the formation of personal and meta-subject educational results in younger schoolchildren, ensuring the further development of elements of their digital literacy".

### 2.3. Analysis of the development of digital literacy for students with hearing impairments

Various researchers have conducted numerous studies on the formation of digital literacy among students with disabilities (e.g., see Park, Nam, 2014; Lowenthal et al., 2020; Conley et al., 2019).

A changing perspective on education for hearing impairment students in the 21st century must incorporate a focus on digital literacy. Digital literacy refers to the skills required to digitally work with information to use Internet-based tools and to present information clearly. To be competitive in the workplace, students with hearing impairments should know not only basic computer skills, but also how to use and care for personal assistance products and hearing aids. Learning to deal with digital technologies and using them for learning can be seen as an aspect of digital literacies. The combination of teaching students with disabilities and especially digital literacy training is difficult for many teachers, as it requires the provision of additional support and methods.

Thanks to digital literacy skills, students could show how intellectually developed they are through various means. Students with disabilities often lack the skills that create a transitional bridge for access to the general education program and successful study at school.

Students with hearing impairments, unlike students without hearing impairments, have a number of features that create difficulties in mastering educational content, therefore, when organizing the educational process, the content, pedagogical methods, teaching forms and means of teaching should be adapted depending on the degree of hearing impairment.

The peculiarities of the psyche of a child with impaired hearing develop differently in comparison with hearing children (there is a disparity in the development of visual-figurative and verbal-logical thinking; written speech in all forms-impressive (reading) and expressive (writing) acquires a greater role compared to oral; the impressive form of speech prevails over expressive. This feature should be taken into account when organizing the education and training of children with hearing disorders.

According to the World Health Organization over 5 % of the world's population – or 430 million people – require rehabilitation to address their 'disabling' hearing loss where 34 million are children. (WHO, 2021). Various studies have been carried out with various authors on the intelligence of students with hearing impairments (e.g., see Ebrahim, 2006; Bogdanova, 2009; Topal, 2017).

According to M. Marshak (1997), the intellect and speech development of children with hearing impairments are not completely independent of each other. We also agree with the opinion of Emad E. Abdallah and Ebaa Fayyoumi that: "some people think that intelligence of deaf and dumb people are less than normal people, but this idea is not true. Deaf and dumb people have sharp intelligence that makes them equal with normal people".

Children with hearing problems initially have an intersection of the lines of development of thinking and sign language. This has a beneficial effect on the formation of visual-figurative

thinking, since the main feature of this type of speech is its visual and expressive nature. For the transition to the next stage – conceptual thinking – a higher level of generalization and abstraction is required, which only sign speech, without verbal speech, cannot provide. When deaf children of this group are taught verbal speech in all its forms (oral, written, dactyl), it begins to influence both sign speech and the development of the cognitive sphere as a whole.

### 2.4. Formation of digital literacy components for hearing impaired students

Before forming the components of digital literacy, the pedagogical and psychological features of students with hearing impairments were identified in this research. Let's consider the features of the hearing impaired that affect their educational activities in educational processes:

(i) The main burden of information processing falls on the visual analyzer. Visual perception is the main tool for communication and knowledge acquisition. The main basis of information perception is visualization. Constant concentration of the facial expressions and gestures of the speaking person requires a strain of attention, which in turn leads to fatigue and loss of stability of attention. Therefore, hearing-impaired children have difficulties communicating and switching attention. This, in turn, leads to a decrease in the performance of any tasks in the educational process.

(ii) Reduced ability to receive information, as well as its storage, i.e., problems with memorizing, processing and using information;

(iii) Slowing down the process of forming concepts;

(iv) Children with hearing impairments have a slower recognition of objects compared to hearing children;

(v) Complex phrases are very difficult to perceive, distorts the grammatical structure of the sentence during speech, lack of vocabulary;

(vi) It takes more time to highlight the informative features of the subject.

The intellectual sphere of the hearing-impaired, as a delayed development of mental operations, in particular the operations of analysis, synthesis, abstraction, they have difficulties in identifying and understanding the goal. In the process of working and mastering professional skills, they strive to get a result as soon as possible, i.e. get there. However, they have a lack of concentration, the ability to correlate the image of the future result with the resulting product and analyze the causes of difficulties. Problems in mastering professional skills are usually associated with the fact that students, in an effort to get results faster, neglect important labor operations. In addition, people with hearing impairments tend to be unaware of the imperative to achieve their goals. Thus, in addition to the task of teaching, teachers are faced with the task of educating the hearing impaired with a positive attitude to work and the formation of appropriate motivation for them.

In order to form and develop digital literacy of children with hearing impairments, we should determine the components of digital literacy, by taking into account their psychological, pedagogical and physiological abilities.

We have analyzed various components of digital literacy. There are different criteria in the components of digital literacy development. In research Doug Belshaw, 2014; Jenkins, 2006; Łukasz, 2020; Sharpe, Benfield, 2012; Sharikov, 2016 different components of digital literacy are offered. As shown in Table 2, most of the authors proposed components for working with digital technologies and security components.

**Table 2.** Comparison Table of Digital Literacy Components

| D. Belshaw (2014) | Henry Jenkins (2006) | Łukasz Tomczyk (2012) | R. Sharpe, G. Benfield (2012) | A.V. Sharikov (2016) | T.A. Boronenko, et al. (2019) |
|---|---|---|---|---|---|
| 1. Cultural | 1. Skills of working with a computer and other devices | 1. Ergonomics of using ICT | 1. Increasing digital competence | 1. Technical and technological capabilities | 1. Technical aspect |
| 2. Cognitive | 2. Skills of working with programs | 2. Assess the reliability of information | 2. Use of digital media | 2. Content and communication opportunities | 2. Information on the Internet |

| | | | | | |
|---|---|---|---|---|---|
| 3. Constructive | 3. Skills in working with digital technologies | 3. Safe online communication | 3. Digital transformation | 3. Technical and technological threats | 3. Communication on the Internet |
| 4. Communicative | | 4. Anonymity in the digital world | | 4. Sociopsychological threats | 4. Digital consumption |
| 5. Confident | | 5. Secure access to the system | | | |
| 6. Creative | | 6. Intellectual property | | | |
| 7. Critical | | | | | |
| 8. Civic | | | | | |

Renowned media scientist Henry Jenkins (2006) believes that digital literacy includes the ability to work with a computer as "hardware", understanding the characteristics of the device and distribution of digital information, understanding the structure of the network community and the characteristics of social media. And also H. Jenkins et al. they believe that digital literacy depends on the formation of the following skills:

- skills in interacting with a computer and any other electronic devices;
- skills of interaction with software;
- skills in working with digital technologies.

Further in the research of the famous scientist in the field of education and digital literacy researcher Doug Belshaw (2014) in his research, which testifies to the presence of various models of this digital literacy and made eight components (see in Table 3) as the basis for the qualitative interaction of a person with the digital world:

**Table 3.** Components of digital literacy by D. Belshaw, 2014

| Components of digital literacy | Definition |
|---|---|
| Cultural | «...the Cultural element of digital literacies is best acquired by being immersed in a range of digital environments. These environments should include those where different issues, norms and habits of mind are present. This ensures individuals have to modify their approach. Development can therefore be seen by the extent to which individuals can move increasingly quickly and seamlessly between these different digital environments.» |
| Cognitive | «...the Cognitive element of digital literacies is developed by encouraging sound 'habits of mind'. Exposure to various ways of conceptualizing digital spaces and ways of interacting within them certainly helps. Additionally, reading around such practices helps crystallize understanding». |
| Constructive | «...developing the constructive element of digital literacies involves knowing how and for what purposes content can be appropriated, reused and remixed. It is as much about knowing how to put together other people's work in new and interesting ways as it is about understanding the difference between the digital and physical worlds». |
| Communicative | «...the Communicative element of digital literacies is always closely aligned to the Constructive element as it involves making something — a thing some may term a social object. Having the knowledge, skills and understanding to do this constitutes the nuts and bolts of literacies in digital networked environments.» |

| | |
|---|---|
| Confident | «…Developing the Confident element of digital literacies involves solving problems and managing one's own learning in digital environments. This can be encouraged by the kind of practices that work well in all kinds of learning experiences. Namely, self-review focusing on chievement and areas of development, paired with mentoring.» |
| Creative | «…the creative element of digital literacies is about doing new things in new ways that somehow add value. It is about using digital technologies and techniques to create or achieve things previously impossible — or at least out-of-reach to most people.» |
| Critical | «…becoming more advanced in the Critical element of digital literacies involves thinking about your own literacy practices. It involves reflecting on how they have come about, what has influenced you, and how your actions affect others.» |
| Civic | «…if literacies are always for a particular purpose, if they're always about reading and writing something, then, to my mind, the Civic element is that 'something' that is being read and written. Preparing both ourselves and others to participate fully in society should, to my mind, be the goal of literacies.» |

The authors of different concepts of digital literacy agree on only one understanding of how digital reality works, which can teach a person to control the information environment and make interact with digital technologies.

In addition to the researchers, we consider the components of digital literacy from the point of view of world organizations in the field of education (see in Table 3).

**Table 4.** Comparison of the components of digital literacy according to the different World Organizations

| JISC (2014) – Joint Information Systems Committee | UNESCO (2011) – United Nations Educational, Scientific and Cultural Organization | AECT (2014) – Association for Educational Communications and Technology |
|---|---|---|
| 1. Media literacy | 1. Access to information | 1. Search |
| 2. Communication and collaboration | 2. Information management | 2. Placement |
| 3. Career and personality management | 3. Evaluation of information | 3. Accessibility |
| 4. ICT literacy | 4. Integration | 4. Management |
| 5. Reading skills | 5. Formation of new knowledge | 5. Integration |
| 6. Digital learning experience | 6. Communication | 6. Evaluation |
| 7. Information literacy | | 7. Analysis |
| | | 8. Synthesis |

JISC – (Joint Information Systems Committee) has identified that Digital literacy: "is the capabilities that fit an individual for living, learning and working in a digital society. Digital literacy looks beyond functional IT skills to describe a richer set of digital behaviours', practices and identities. What it means to be digitally literate changes over time and across contexts, so digital literacies are essentially a set of academic and professional situated practices supported by diverse and changing technologies" (JISC, 2014).

UNESCO – According to the working definition, agreed at the UNESCO June 2003 Expert Meeting in Paris, "literacy is the ability to identify, understand, interpret, create, communicate, compute and use printed and written materials associated with varying contexts. Literacy involves

a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society." (UNESCO, 2011).

AECT (2014) – Association for Educational Communications and Technology – has identified that: "Digital literacy is the use of high technology in everyday life. A digitally literate person may use specific hardware such as a computer, a cell phone, or other digital resource in combination with communication software, such as the Internet, to interact with society at large, thus becoming a digital citizen or e-citizen and improving social and economic opportunities".

Summing up this section, we can give the following definition of digital literacy of students with hearing impairments: Digital literacy: "is a set of knowledge and skills necessary for the effective use of digital technologies in everyday and professional activities, regardless of their psychophysical characteristics".

## 3. Results

### 3.1. Two-Component Model of Digital Literacy of students with hearing impairments

In the course of the study, taking into account the author's recommendations of various scientists on the components of digital literacy, we formulated our two-component model of digital literacy of students with hearing impairments to improve digital literacy in an additional computer science course (see Figure 1):

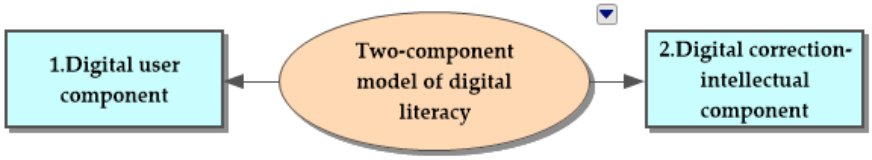
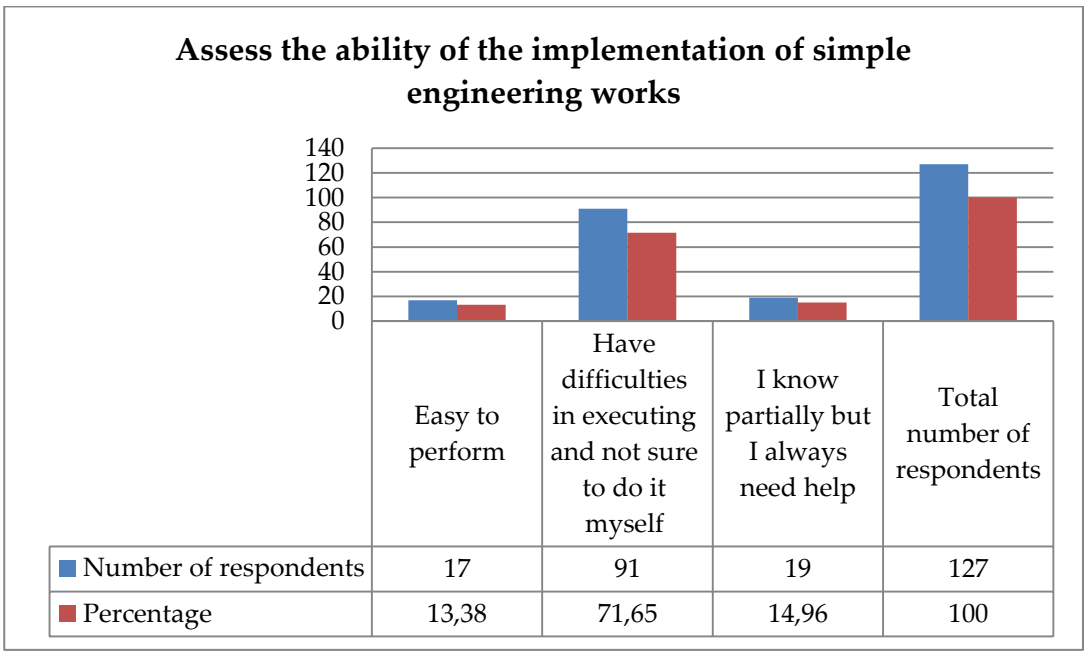



**Fig. 1.** Two-component model of digital literacy of students with hearing impairments



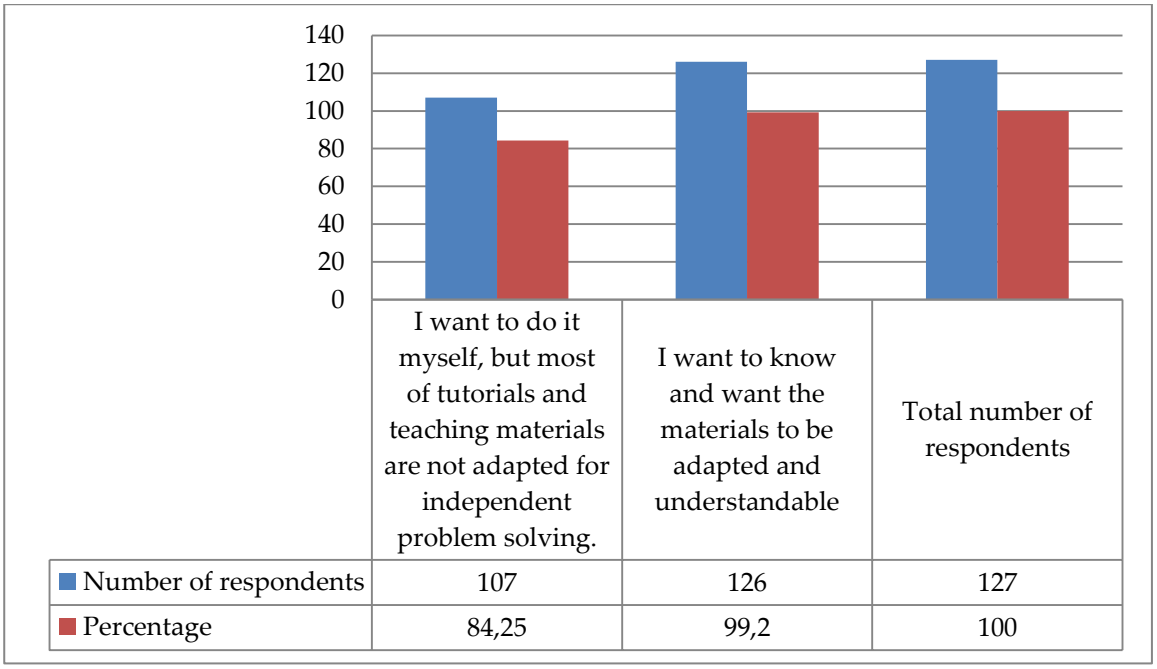

| | Easy to perform | Have difficulties in executing and not sure to do it myself | I know partially but I always need help | Total number of respondents |
|---|---|---|---|---|
| Number of respondents | 17 | 91 | 19 | 127 |
| Percentage | 13,38 | 71,65 | 14,96 | 100 |

**Fig. 2.** A survey of students conducted before the start of training on the implementation of engineering activities

As shown in Figure 1, the first component is called digital user component. In this component students will able to know the Engineering training. For example, installing software, uninstalling, updating, cleaning, etc. This is due to the fact that without the full development of engineering skills, students will not be able to achieve full digital literacy, and during the investigation, we noticed that the

basic school computer science course in the Republic of Kazakhstan did not fully reflect the exact Engineering skills. In addition, the results of the questionnaire survey of students conducted before the study on the implementation of engineering activities served as the basis for the compilation of this component (see Figure 2). The survey was taken from schools where hearing-impaired students study.

As shown in Figure 2, only 17 out of 127 respondents have the ability to independently solve the engineering problems. About 72 % of respondents have difficulty performing simple in engineering. After evaluating the possibility of performing engineering work, we received another survey of students with hearing impairments about their needs in the area of engineering (see Figure 3).




| | I want to do it myself, but most of tutorials and teaching materials are not adapted for independent problem solving. | I want to know and want the materials to be adapted and understandable | Total number of respondents |
|---|---|---|---|
| Number of respondents | 107 | 126 | 127 |
| Percentage | 84,25 | 99,2 | 100 |

**Fig. 3.** A survey of students with hearing impairments about their needs in the field of engineering

According to the survey results which are shown in Figure 3, we see that almost all respondents want to get some knowledge about engineering activities through an additional course in school computer science.

The second component is digital correction-intellectual component. In this component students will be able to improve their cognitive, logical, critical, creative, systems thinking, memory, imagination, attention, speech, communication skills through learning adopted additional course.

Our approach to the formation and improvement of digital literacy of students with hearing impairments is based on correctional cognitive pathways. Based on the proposed two components, we have developed the adapted the curriculum of the course. This course is designed for 34 hours per year for students in grades 9-10. During the course, students can experiment with digital platforms, tools and learn about research and program development in digital literacy. In developing the program, we have focused on the interaction the two components. The course program consists of 4 modules. As shown in Table 5, the first component consists of 1 module and the second component consists of 3 modules.

**Table 5.** Course module

| Component | Module |
|---|---|
| Digital user component | Engineering and technical training |
| Digital correction-intellectual component | Computer graphics and 3D modeling |
| | Creating a mobile application |
| | Digital research project |

When developing the course, new educational methods and technologies were used:
- Information and Communication Technologies;
- Design Technologies;
- Technologies for the Development of Critical Thinking.

We will discuss the course module in the Discussion and conclusion section.

## 4. Discussion

### 4.1. The importance and general characteristics of the course

The strategy for the formation of digital literacy of students with disabilities should include to work to reduce inequality in access to digital technologies by developing an additional educational course. In the school course, the task of forming and developing digital literacy of students was considered as part of the subject Informatics. The educational process, organized in informatics classes, should ensure the formation of students' readiness for creative self-development and the acquisition of new knowledge. For the development of digital literacy in the subject of computer science, it is important to organize additional courses. Therefore, the authors have compiled curriculum of the additional courses on Computer Science with educational materials that cover all of the above components of digital literacy. As part of the additional course in computer science, special attention is paid to the development of "hearing and speech skills" as well as their creative, cognitive-visual skills, for example, related to computer graphics, creating a 3D model, developing mobile applications, creating projects in the MS Project environment, as well as the configuration and settings of a computer, work in different applications, work with information resources of the network, application Internet services. So, our course was developed on the basis of modular technologies and is divided into four main modules (see Table 6).

**Table 6.** Course description and teaching methods

| Module | Description | Teaching methods |
|---|---|---|
| 1. Engineering and technical training | Installing, starting, removing, updating programs. Installing the operating system. Increasing the speed of a computer. Working with drivers and peripheral devices. Remote computer control | Method for solving engineering and design problems |
| 2. Computer graphics and 3D modeling | Explanation of the concept of computer graphics. Types. Areas of application. Significance. Software for working with computer graphics. Description of 3D modeling. Examples. | Creation and design of objects |
| 3. Creating a mobile application | Origin, history, interesting facts about mobile technologies and applications. Ways to create mobile applications. | Method of projects |
| 4. Digital research project | Students use computer programs on a variety of topics and develop projects using different methods. | Individual, group work |

Let's describe the learning elements of each module. For example, in the first module there are 5 learning elements: (1) Installing, starting, shutting down, and updating programs. Installing the operating system. (2) Increasing the speed of a computer. (3) Working with the control panel. (4) Working with drivers and peripherals. (5) Computer remote control. The method of solving engineering and design problems is used as a method of teaching how to perform tasks. The first

module is specially designed so that (a) students have the opportunity to independently solve problems with computers and other digital devices (b) deepen their appreciation for the joint solution of technical problems; and (c) focus on how the students achieved expected results.

The second module provides an excellent opportunity to improve the visual and graphic skills of students. In this module, students are introduced in detail to the concept, types, significance of computer graphics and types of programs for processing computer graphics. In addition, in order to increase the creative abilities of students, they will work with 3D modeling, which is considered the most important type of computer graphics. In particular, in Sweet Home 3D they will create projects of a house and a buildings. The methods used in this module include: the design method, methods for creating and designing objects. In Sweet Home 3D, students experience collaborative inquiry as they collaborate and discuss, create and take action, and analyze and reflect. By working with a partner in Sweet Home 3D, students spend a lot of time talking about the decisions they make as designers.

In the third module, students will develop a mobile application. To develop the application, we chose the Thunkable platform for developing native mobile applications for Android and iOS. Using this constructor, students will be able to learn how to create a convenient mobile interface and develop their own mobile applications for Android and iOS. This module uses the project method to develop a mobile application. Upon completion of this module, students will gain practical skills in creating applications and will effectively use the capabilities of the platform and resources. Through the development of mobile programming, students develop computational thinking. Computational thinking helps students develop problem solving skills, creative thinking, learning, and teamwork skills.

The fourth module is called the Digital Research Project. This allows students to develop cognitive interest, independence, culture of educational work, systematize, generalize and deepen knowledge in the research area and apply it in practice. Preparing students for research involves several stages:

(a) Choosing a research problem: Discussion of possible research topics. Research topics can be any topic, for example, methods of information protection, the construction of intelligent systems, automated control systems, etc.

(b) The study of scientific literature: Compiling a bibliography on the topic; different types of reading, highlighting the main idea, taking notes; discussion of the scientific papers read.

(c) Formation of research skills: Consulting on the formulation of the research topic, hypothesis, understanding of the goals and objectives of the work.

(d) Collection and processing of the received material: Planning and conducting an experiment, collecting material and systematizing and summarizing the results of the work

(e) Presentation of the results of the work: presentation of the results in the form of tables, diagrams, etc. Analysis of the work done, discussion of long-term plans.

Moving from stage to stage, students learn:

- See the problem;
- Ask questions;
- Plan and implement verification of the expected result;
- Analyze the results of the study;
- Give definitions
- Develop and conduct an experiment;
- Draw conclusions;
- Structure the material;
- Prove and defend your ideas and research results;
- Work with digital technologies.
- Learn project management in MS Project.
- Can compile Deming Cycle, PERT, SWOT, PEST analyzes and Gantt diagrams for the management and design of IT projects
- Know how to work with Agile, Scrum, Kanban techniques

After performing each task in the classroom, each student will report on its work to improve their speaking skills. The skill of speaking in front of the group increases.

Preparing and conducting a lesson

Each lesson has a specific place in our investigation. Accordingly, its organization is determined by the tasks of the entire topic and a specific stage in the study of the topic. The general patterns of building a lesson are as follows:

(i) Initial stage:

- Organizational stage: characterizing the psychological readiness of students for the lesson; repetition of previous material.
- Corrective stage: improvement of speech and hearing skills; working with words according to the topic of the new lesson.

(ii) Main stage:

- Setting the goal of the lesson for students;
- Explanation of the lesson;
- Initial check of comprehension and giving tasks.

(iii) Final stage:

- Control over the results of educational activities, carried out by the teacher and the student, knowledge assessment;
- Reflection and self-assessment of students.

For inclusion in the educational process of each student with hearing impairment, we have generalized the methods of correctional work (see Table 7). The methods described in the Table 7, the use of each method, contributes to the implementation of the didactic principle of visibility, practicality, cognition, intellectuality in teaching, adds diversity teaching methods, increases the efficiency and productivity of the lesson, develops observation in children, visual-figurative thinking, cognitive-intellectual thinking, visual memory and attention.

**Table 7.** Methods of correctional work

| Training method | Method in correction | Directions | Description |
|---|---|---|---|
| Perceptive | Verbal-communicative methods | Conversation, narration, discussion, etc. | Development of speech and hearing: "what do you think about this program?...", "Difficulties in completing the task...", "How did you do it, explain the algorithm...» |
| | Visual methods | Illustrations, demonstrations, etc. | Multimedia presentations, video tutorials made by screencast, infographic instructions with an exact algorithm |
| | Experimental methods | Exercises, project activities, tasks, etc. | Preparation of practical exercises on each topic with a pre-compiled algorithm |
| Logical | Cognitive methods | Independent search, replenishment of knowledge, correction of errors, effective organization of activities, analysis, comparison | Search, study, differentiate, correct, and compare errors that are necessary for completing the task. |
| Creative | Intellectual | Creating your own products | Production and assembly of products according to the given task. |

When explaining the lesson, didactic materials for students are used, i.e. presentations, video explanations, handouts. Classes are conducted using the "minimum theory, maximum practice" approach to make the lesson interesting. To improve the communicative abilities of students, they will be given group tasks, and at the end of the lesson they will defend the tasks that they

performed in a small group. To improve the leadership skills of each student, group leaders are replaced at each lesson. The task of the group leaders is to highlight the task given by the teacher to each member of the group, follow the process of completing the work, discuss, and at the end show the completed task as a mini-presentation. Thus, the division of students into groups allows to increase the speech abilities of each student, the ability to communicate with each other.

As for the assessment of the tasks completed by the students, the teacher never gives an assessment of the student's work. Instead, the student evaluates himself, looks critically, analyzes and compares each work performed. To improve speech development, at the end of the lesson, students are asked several questions, for example, "what did you learn in today's lesson?", "what was difficult, what did you do to solve it?", "evaluate your work yourself", "conduct a comparative analysis of the previous work done", etc. In addition, during reflection, students will get used to asking questions to each other not only to the teacher, but also to the students.

The most common difficulty for in children with disabilities is the lack of understanding of the educational material by the student, which is connected, first of all, with the insufficiently adapted material of any school disciplineIn the modern educational field, in order to increase the digital literacy of hard-of-hearing students in computer science lessons, along with the main one, it is necessary to conduct additional classes. This is due to the fact that teaching digital resources, which are widely used at present, makes it necessary to create an additional course separately from the main computer science lesson.

In our research work, in order to increase the digital literacy of students with hearing impairments, we should prove this in an experiment by creating an adaptive training course and focusing on their features. We received a positive result during the correctional work.

In the course of studying all the topics covered by the additional curriculum, we interviewed students and found that as a result, students' digital literacy increased, their speaking skills, hearing, comprehension, communication skills and cognitive thinking improved using the correction methods used during the lesson.

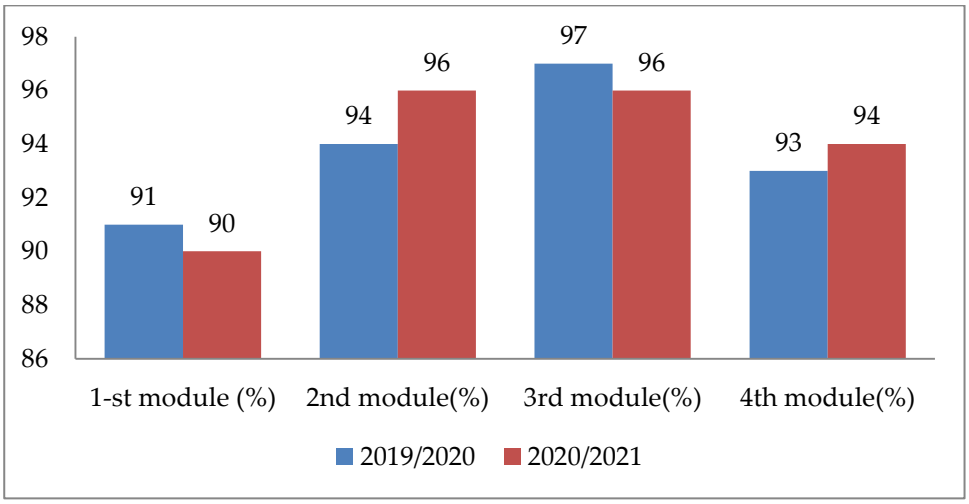



**Fig. 4.** Evaluation of the course by modules

Considering that the topics we have proposed have never been mastered by students before, the level of mastering of the curriculum we have proposed by them at the end of the course in the 2019–2020 academic year, for example: the average for the first module is 91 %, for the second module 94 %, for the third module 97 %, for the fourth module 93 %. And in 2020–2021, 90 % were shown on average for the first module, 96 % for the second module, 96 % for the third module, and 94 % for the fourth module. Our study was conducted by 127 students of grades 9-10 studying in special correctional schools. We made these calculations by obtaining an average calculation of the results of indicators given by students between 0-100 %. That is, each student showed a certain percentage of understanding of the program for each module. For example, here 0-49 % is not clear, 50-74 % is moderately clear, 75-89 % is clear, 90-100 % is completely clear.

In order to evaluate the effectiveness of the research and improve digital literacy, as a result of student feedback, we received answers to the following questions. Students had to answer each of the 9 questions asked with numbers from 1 to 5. Where 1 is – «strongly disagree»; 2 – «disagree»; 3 – «quite agree»; 4 – «agree»; 5 – «strongly agree». As a result, as can be seen from Table 8, the average response rate of each of the 127 students who took part in the study showed a level of 4.6.

**Table 8.** Average rating

| No | Questions | Average rating |
|---|---|---|
| 1 | The course was interesting for me | 4,9 |
| 2 | I can use the digital resources from the course in my daily life and in the future | 4,9 |
| 3 | During the course, engineering and technical skills were developed | 4,5 |
| 4 | I was able to create digital content in the course | 4,6 |
| 5 | During the course, my creativity has increased. | 4,8 |
| 6 | My thinking skills have increased in the course | 4,2 |
| 7 | After completing the course, I was able to create a mobile application on my own | 4,7 |
| 8 | The course has improved the skills of project development and research | 4,8 |
| 9 | During the course, I improved my hearing, speech, and communication skills | 4,5 |
| Average value | | 4,6 |

To indicate statistically significant difference in our experiment the Wilcoxon test was used. We accepted two hypotheses: So, $H_0$ states that the learning outcomes of the proposed course and level of digital literacy of students do not statistically differ from the results obtained before the course. $H_1$ states that the learning outcomes of the proposed course and the level of digital literacy of students are higher than the results obtained before the start of the course.

The level of students who completed adapted course using modular technologies in order to improve digital literacy was compared with the level of their knowledge and skills before studying the course.

Students independently assessed the effectiveness of the proposed course through a questionnaire. The questionnaire contained four sections, so that each participant in the study answered them with one of the options on a scale from 2 to 5 points in accordance with the following distribution:

5 points – I know very well, I can do it completely and I have experience;

4 points – I know partially, I can do it and I have enough experience;

3 points – I do not know much, I can't do it well and I don't have enough experience;

2 points – I do not know, I can't do it and I don't have experience.

The questions were related to the learning elements of the course module. For example:

First section: Skills in the field of Engineering. Installing, starting, removing, updating software. Installing the operating system. Increasing the speed of a computer. Working with drivers and peripheral devices. Remote computer control.

Second section: Computer graphics and 3D modeling skills. Working with computer graphics software. 3D Model Creation.

Third section: Knowledge and skills in mobile application development.

Fourth section: Digital research project skills. Efficient literature searching, data management and data analysis tools (for example Deming Cycle, PERT, SWOT, PEST analyzes and Gantt diagrams), communication and collaboration skills, and the ability to learn and reflect using digital tools (for example, Agile, Scrum, Kanban techniques).

An example of students' responses before and after the experiment is presented in Table 9.

**Table 9.** Students' responses before and after the experiment

| Student No. | Questions (sections) | Before experiment | After Experiment |
|---|---|---|---|
| Student 1 | First section | 2 | 4 |
| | Second section | 3 | 5 |
| | Third section | 2 | 4 |
| | Fourth section | 2 | 4 |
| Student 2 | First section | 3 | 5 |
| | Second section | 3 | 5 |
| | Third section | 2 | 4 |
| | Fourth section | 2 | 5 |
| Student 3 | First section | 2 | 4 |
| | Second section | 4 | 5 |
| | Third section | 3 | 5 |
| | Fourth section | 2 | 4 |
| Student 4 | First section | 2 | 3 |
| | Second section | 3 | 5 |
| | Third section | 3 | 5 |
| | Fourth section | 2 | 4 |
| Student 5 | First section | 4 | 5 |
| | Second section | 3 | 5 |
| | Third section | 3 | 5 |
| | Fourth section | 2 | 4 |
| .... | | | |
| Student 127 | First section | 3 | 5 |
| | Second section | 4 | 5 |
| | Third section | 3 | 5 |
| | Fourth section | 2 | 4 |
| **Statistical test values and significance level (p)** | | | |
| | VAR00002 – VAR00001 | | |
| Z | -10,34254007 | | |
| Asymptotic Significance | 4,52382E-25 | | |
| a | Based on negative rank | | |
| b | Wilcoxon Signed Ranks | | |
| p-value (p value) | p < 0,001 | | |

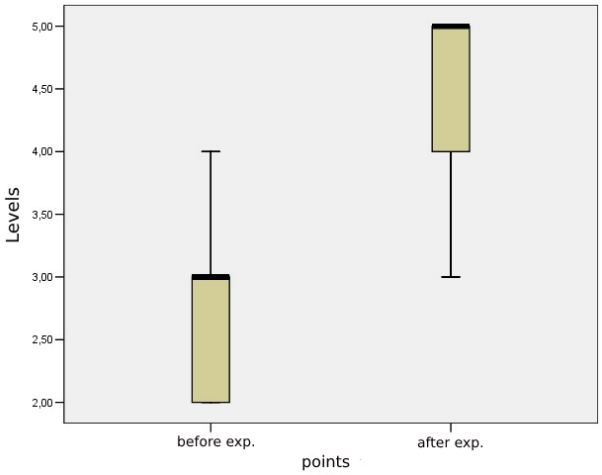



**Fig. 5.** Indicators at the beginning and at the end of the experiment

The calculation of the Wilcoxon criterion was made using the SPSS program. From the results, we can conclude that in our case, p < 0,001, that is, the criterion is significant, which means that we remain within the $H_1$ hypothesis. A box plot chart was constructed to visualize the results. See Figure 5.

The graph clearly shows that the results after the end of the course have a higher average value than the results before the start of the course (see Figure 5).

## 5. Conclusion

Upon completion of the specialty course, students will be interested in professions such as computer designer, IT manager, IT engineer, architect, and software developer. This means that, despite the peculiarities of students, in the future they will be able to become specialists, find their place in society and develop the socio-economic situation. The use of research results in practice is possible with the improvement of adapted training programs, the exchange of international experiences and further research in the field of digital and inclusive education.

## 6. Acknowledgments

This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09057872).

## References

Abdallah, Fayyoumi, 2016 –*Abdallah, E.E., Fayyoumi, E.* (2016). Assistive Technology for Deaf People Based on Android Platform. *Procedia Computer Science*. 94: 295-301. DOI: https://doi.org/ 10.1016/j.procs.2016.08.044

Alsalem, 2016 – *Alsalem, M.A.* (2016). Redefining literacy: The realities of digital literacy for students with disabilities in K-12. *Journal of Education and Practice*. 7(32): 205-215.

Bawden, 2001 – *Bawden, D.* (2001). Information and digital literacies: A review of concepts. *Journal of Documentation*. 57(2): 218-259.

Berman, 2017 – *Berman, N.D.* (2017). On the issue of digital literacy. *Russian Journal of Education and Psychology*. 8(6-2): 35-38.

Bogdanova, 2009 – *Bogdanova, T.G.* (2009). The structure of the intelligence of persons with hearing impairments. *Bulletin of the University of the Russian Academy of Education*. (2): 78-83.

Boronenko et al., 2019 – *Boronenko, T.A., Kaisina, A.V., Fedotova V.S.* (2019). Development of digital literacy of schoolchildren in the context of creating a digital educational environment. *Prospects for Science and Education*. 2(38): 167-193.

Children with disabilities, UNICEF – Programme Children with disabilities. UNICEF, 2020. [Electronic resource]. URL: https://www.unicef.org/eca/children-disabilities

Conley et al., 2019 – *Conley, Q., Scheufler, J., Persichini, G., Lowenthal, P., Humphrey, M.* (2019). Digital Citizenship for All. *Empowering Young Learners With Disabilities to Become Digitally Literate*. DOI: 10.4018/978-1-5225-8356-1.ch042

Connolly et al., 2018 – *Connolly, N., McGuinness, C.* (2018). Towards digital literacy for the active participation and engagement of young people in a digital world. In Council of Europe, Perspectives on Youth: Issue 4. Young People in a Digitalised World. Strasbourg: Council of Europe. Pp. 77-92.

Dragon Naturally Speaking – Dragon Naturally Speaking. [Electronic resource]. URL: https://www.nuance.com/dragon.html

Ebrahim, 2006 – *Ebrahim, F.* (2006). Comparing creative thinking abilities and reasoning ability of deaf and hearing children. *Roeper Rev*. 28: 140-147.

Eshet-Alkalai, 2004 – *Eshet-Alkalai, Y.* (2004). Digital literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and Hypermedia*. 13: 93-106.

Gilster, 1997 – *Gilster, P.* (1997). Digital literacy. New York: Wiley.

Hagel, 2015 - *Hagel, P.* (2015). Towards an understanding of 'Digital Literacy(ies)'. discourse: Deakin University Library research and practice. DOI: 10.21153/dsc2015no1art1

Harish, 2019 – *Harish Kumar Sahu* (2019). Digital Literacy Skills: A Study. *Res. J. Humanities and Social Sciences*. 10(2): 311-313. DOI: 10.5958/2321-5828.2019.00055.X

Hilton, 2013 - *Hilton, J.* (2013). Pedagogy for digital literacy: Advancing "hyperreading" skills in the classroom. *Pennsylvania Teacher Educator*. 12: 37-43.

Hobbs et al., 2018 – *Hobbs, R., Coiro, J.* (2018). Design features of a professional development program in digital literacy. *Journal of Adolescent and Adult Literacy*. DOI: 10.1002/jaal.907 Inspiration. [Electronic resource]. URL: https://www.inspiration-at.com/inspiration/

Jenkins, 2006 – *Jenkins, H.* (2006). Core Media Literacy Skills. [Electronic resource]. URL: http://henryjenkins.org/2006/10/confronting_the_challenges_of_6.html

JISC, 2014 – JISC. Developing digital literacies. 2014. [Electronic resource]. URL: https:// www.jisc.ac.uk/guides/developing-digital-literacies

Kritzer et al., 2020 –*Kritzer K.L., Smith, C.E.* (2020). Changing Perspectives for the 21st Century: Digital Literacy and Computational Thinking for Deaf/Hard-of-Hearing Learners. *The Oxford Handbook of Deaf Studies in Learning and Cognition*. DOI: 10.1093/oxfordhb/ 9780190054045.013.22

Kurzweil 3000 – Kurzweil 3000. [Electronic resource]. URL: https://www.kurzweiledu.com/ default.html

Kuznekoff et al., 2019 – *Kuznekoff, J., Munz, S., Titsworth, S.* (2019). Digital Inequality and Digital Literacy Skills. DOI: 10.4324/9780429355097-4

Lankshear, 2008 – *Lankshear, C., Knobel, M. (Eds.).* (2008). Digital literacies: Concepts, policies and practices. Vol. 30. Peter Lang.

Lowenthal et al., 2020 – *Lowenthal, P., Persichini, G., Conley, Q., Humphrey, M., Scheufler, J.* (2020). Digital Literacy in Special Education: Preparing Students for College and the Workplace. In book: Examining the Roles of Teachers and Students in Mastering New Technologies. Pp. 150-163. DOI: 10.4018/978-1-7998-2104-5.ch007

Luft, 2009 – *Luft, P., Bonello, M., Zirzow, N.K.* (2009). Technology skills assessment for deaf and hard of hearing students in secondary school. *American annals of the deaf*. 154(4): 389-399. DOI: https://doi.org/10.1353/aad.0.0106

Łukasz, 2012 – *Łukasz, T.* (2012). Skills in the area of digital safety as a key component of digital literacy among teachers. *Education and Information Technologies*. 25(3). DOI: 10.1007/s10639-019-09980-6

Mackey et al., 2011 – *Mackey, T.P., Jacobson, T.E.* (2011). Reframing information literacy as a metaliteracy. *College & Research Libraries*. 72(1): 62-78.

Marshark, 1997 – *Marshark, M.* (1997). Psychosocial Development of Deaf Children. N.Y, Oxford.

Martin, 2008 – *Martin, A.* (2008). Digital literacy and the "digital society". In C. Lankshear and M. Knoebel (2019). Digital literacy: Concepts, policies and practices (pp. 151–176). New York, NY: Peter. Google Scholar.

Martin, Grudziecki, 2006 – *Martin, A., Grudziecki, J.* (2006). DigEuLit: Concepts and Tools for Digital Literacy Development. *Innovation in Teaching and Learning in Information and Computer Sciences*. 5: 4: 249-267. DOI: 10.11120/ital.2006.05040249

Neumann et al., 2017 – *Neumann, M.M., Finger, G., Neumann, D.L.* (2017). A conceptual framework for emergent digital literacy. *Early Childhood Education Journal*. 45(4): 471-479. DOI: 10.100710643-016-0792-z

OECD, 2021 – Digital education for a strong recovery: A forward look, 2021. [Electronic resource]. URL: https://oecd-events.org/digital-education

Park et al., 2014 – *Park, E.-Y., Nam, S.-J.* (2014). An analysis of the digital literacy of people with disabilities in Korea: Verification of a moderating effect of gender, education and age. *International Journal of Consumer Studies*. 38(4): 404-411. DOI: 10.1111/ijcs.12107

Petrov et al., 2019 – *Petrov, N.P., Bondareva, G.A.* (2019). Digitalization and digital technologies in education. *World of science, culture, education*. 5(78): 353-355.

Phuapan, 2015 – *Phuapan, P.* (2015). Elements of Digital Literacy Skill. *Proceeding of 13th International Conference DRLE 2015*. 13: 12-4.

Porat et al., 2018 – *Porat, E., Blau I., Barak, A.* (2018). Measuring digital literacies: Junior high-school students' perceived competencies versus actual performance. *Computers & Education*. 126: 23-36. DOI: https://doi.org/10.1016/j.compedu.2018.06.030

Potupchik, 2017 – *Potupchik, E.G.* (2017). Networking as a condition for the formation of digital literacy in junior schoolchildren in computer science lessons. *Bulletin of the Krasnoyarsk State Pedagogical University. V.P. Astafieva*. 4(42): 178-185.

Sharikov, 2016 – *Sharikov, A.V.,* (2016). On the four-component model of digital literacy. *Journal of Social Policy Research*. 14(1): 87-98.

Sharpe et al., 2012 – *Sharpe, R., Benfield, G.* (2012). Internet-based methods. *Res. methods Methodol. Educ.* Pp. 193-201.

Shvaykovskaya, 2015 – *Shvaykovskaya, G.D.* (2015). Ispol'zovanie informatsionno-komp'yuternykh tekhnologii v protsesse razvitiya poznavatel'noi deyatel'nosti detei s narusheniyami slukha [Information and the use of computer technologies in the development of cognitive activity of children with hearing disorders]. *Molodoi uchenyi.* 16(96): 436-440. [in Russian]

Solntseva et al., 2012 – *Solntseva, V.A., Belova, T.V.* (2012). Psychological characteristics of persons with hearing impairments (hearing impaired). Handbook on organizing and conducting career guidance work. Moscow: Center for New Technologies. Pp. 89-92.

Topal et al., 2017 – *Topal, A.D., Budak, E.Ç., Geçer, A.K.* (2017). The effect of algorithm teaching on the problem-solving skills of deaf-hard hearing students. *Program*. 51: 354-372.

UDHR, 2015 – Universal Declaration of Human Rights (UDHR): United Nations, 2015. [Electronic resource]. URL: https://www.un.org/en/udhrbook/pdf/udhr_booklet_en_web.pdf

UN CRC, 1989 – Convention on the Rights of the Child (UN CRC). [Electronic resource]. URL: https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

UN SREOPD, 1993 – Standard Rules on the Equalization of Opportunities for Persons with Disabilities (SREOPD). [Electronic resource]. URL: https://www.un.org/development/desa/ disabilities/ standard-rules-on-the-equalization-of-opportunities-for-persons-with-disabilities.html

UNESCO SDPPPA, 1994 – The Salamanca Declaration: on Principles, Policy and Practical Activities in the field of education of Persons with special needs [SDPPPA] (1994). [Electronic resource]. URL: https://www.right-to-education.org/sites/right-to-education.org/files/resource-atta chments/Salamanca _St atement_1994.pdf

UNESCO, 2011 – UNESCO. Digital Literacy in Education. 2011. [Electronic resource]. URL: https://gdc.unicef.org/resource/digital-literacy-education

WDEA, 1990 – World Declaration on Education for All (WDEA). Published by UNESCO, Jomtien, Thailand. 1990. [Electronic resource]. URL: https://unesdoc.unesco.org/ark:/48223/ pf0000127583

White et al., 2017 – *White, E.H., Woods K., Poed, S.* (2017). The assessment and development of digital literacy in students with vision impairment and additional learning needs: Preliminary findings from a current PhD study. *9th ICEVI European Conference: Empowered by Dialogue (2-7 July 2017, Bruges, Belgium).*

WHO, 2021 – World Health Organization, 2021. Deafness and hearing loss. [Electronic resource]. URL: https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss

WordQ – WordQ. [Electronic resource]. URL: https://www.quillsoft.ca/wordq-desktop