Supporting the development of digital literacy skills for students with disabilities

Aigerim Yerimbetova†‡, Aibek Ibraimkulov†*, Kulira Khalikova# & Gulmira Skabayeva§

Institute of Information and Computational Technologies, Almaty, Kazakhstan†
Satbayev University, Almaty, Kazakhstan‡
Al-Farabi Kazakh National University, Almaty, Kazakhstan*
Abai Kazakh National Pedagogical University, Almaty, Kazakhstan#
Kazakh National Agrarian Research University, Almaty, Kazakhstan§

ABSTRACT: In this article, the authors analyse the features of the development of digital literacy of students with hearing impairments. The inclusion and successful use of digital resources in teaching and learning contributes to the intellectual development of students with disabilities and helps in the formation of capabilities, such as cognitive, creative, etc, positively impacting the students' overall engagement in activities. The primary purpose of this study was to create an additional modified training course in computer science for students with hearing impairments in special needs schools in Kazakhstan. The primary aim was to develop and improve the level of digital literacy of those students. In the course compiled by the authors, students work with computer graphics and 3D software, develop mobile applications and are engaged in research activities, thereby improving their engineering and technical skills and developing creative abilities.

INTRODUCTION

Currently, digital literacy is high on the list of basic skills in demand in the 21st Century for almost any job. Digital literacy is an essential life skill that affects all areas of modern life and professional activity in any economy. Digital literacy has a beneficial effect on the development of other basic skills and competencies of students; for example, the ability to learn and self-study, creative thinking skills, productivity skills, etc. Digital literacy covers a wide range of competencies, such as personal data management skills, database and personal cybersecurity on the Internet. It relates to developing creative, critical thinking that allows to analyse and verify the accuracy of information on Web sites, and the ability to create media content.

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. The need to include children with disabilities in the educational process has been repeatedly noted at the world level, including: the Universal Declaration of Human Rights, 1948; the UN Convention on the Rights of the Child, 1989; the World Declaration on Education for All, 1990; and the Salamanca Statement on Principles, Policy and Practice in Special Needs Education and a Framework for Action, 1994. International organisations recommend inclusive education as a top priority for educational development, with the goal of realising citizens' right to high-quality education and social integration. According to UNESCO 2008, inclusive education is:

> *…the process of responding to the diversity of children through enhancing participation in classrooms and reducing exclusion from education* [1].

The concept of inclusive education arose from long-standing traditions in the field of special education for children with disabilities. Many concepts and words linked with the education of children with special needs have been used in the field of education throughout the previous few decades [2]. With the growing demand for computer scientists, it is important that students with disabilities be included in digital literacy courses.

The main mission of this current study is to create an opportunity to improve the quality and accessibility of modern education for students with disabilities, to increase their digital literacy, to provide an opportunity for the development of their professional skills, successful socialisation and work in modern society. This will be facilitated by the creation of additional training courses in school computer science. One needs to teach computer science to different groups of children, including students with disabilities if one wants future software applications to meet different requirements. Not only is this possible, but it is already being done. Therefore, the problem of the development and formation of digital literacy for students with disabilities is very relevant.

An inclusive learning process helps to more widely implement the educational activities of students with disabilities. It assumes that students, due to their capabilities and abilities, fully participate in school life and educational activities.

All students with disabilities have the right to education, participation in public life and work. Each student with disabilities has their own characteristics, needs and interests. Therefore, it is very important in the informatics lesson to develop digital literacy using active methods, hands-on training and practical tasks. A course in computer science specifically created for the development of digital literacy, enables students to successfully develop skills, such as attention and focus on the task at hand, imagination, cognitive and creative activity, outside-the-box thinking, etc.

All tasks in the course of the formation of digital literacy should be appropriate for the age, characteristics and abilities of students. The authors have selected students with hearing impairments from special needs schools for the development of digital literacy. It is recommended to teach students with hearing impairments through the implementation of the following pedagogical principles: openness, accessibility, visibility, individualisation, intensity and communication based on the use of information technology in the course.

METHODS AND MATERIALS

Research Goal, Implementation and the Methodological Basis

The goal of this study was to create an additional modified training course in computer science, aimed at developing and improving the level of digital literacy of students of special needs schools for children with hearing impairments. Achieving this goal involved the following tasks:

1) literature search on the importance of improving the digital literacy of hearing-impaired school children;
2) developing a modified course for the development of digital literacy of students with hearing impairments in addition to the basic computer science in schools;
3) methodological recommendations and testing the developed course.

To achieve this goal, the authors relied on pedagogical research methods. For example, theoretical research methods were used to identify the problem, formulate hypotheses and evaluate the collected data. Practical methods of scientific research were also involved: empirical method - a study of relevant literature, various documents and results of activities, observation, survey, questionnaire, etc. As a methodological component of the study, the authors used modular learning technology systems.

As planned, the authors developed an additional course in computer science adapted to special needs. This course was a 34-week intensive course aimed at improving the level of digital literacy. This course focused on improving the communication skills of students with hearing impairments that is, improving the skills of effective public speaking and presentation, self-regulation, creativity, critical thinking, co-operation and communication, and was based on the principles of the project method. In this study, the authors chose special needs schools for children with hearing impairments in grades 9-10 in Kazakhstan. The education of students with disabilities is one of the priorities of the education system of Kazakhstan. Currently, Kazakhstan is actively undergoing the process of improving the education and science system, whereby new projects, standards and regulations are being created.

Review of Digital Literacy Sources

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 that requires both cognitive and technical skills not only in the professional sphere, but also in everyday life. Digital literacy as a 21th Century skill for disabled students enables the use of technology to access learning activities. The authors of this article agree with the opinion of White et al that learning to use digital technologies and using them for learning can be seen as aspects of digital literacy [3]. More specifically, White et al have defined the concept of digital literacy as:

> *…the ability to interpret and use the symbols, text/graphics and tools of digital technologies and networks, and to do so in a culturally appropriate way* [3].

Digital literacy has become more important in the age of ubiquitous computing for success in any educational discipline or vocation. Many educators and companies take critical information technology competencies for granted, thus putting students and workers who lack the necessary computing and Internet skills at a distinct disadvantage [4].

Various researchers have presented definitions of digital literacy and conducted a number of studies on this issue, including Gilster [5]; Neumann et al [6]; Porat et al [7]; Lankshear and Knobel [8]. In 2015, Lankshear and Knobel divided the definitions of digital literacy into two types: conceptual definitions and standardised sets of operations [9]. As a conceptual definition of digital literacy, they pointed out that:

> *…Digital literacy allows us to match the media we use with the type of information we present and the audience we present it to* [9].

The second type of digital literacy definition referred to as *standardised* attempts to define what it means to be *digitally literate* in terms of specific actions [10], activities, defined demonstration of skills, etc. According to Martin, 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 [11].

It is very important to increase the technical and technological abilities of students in the formation of digital literacy, which in turn allows students to fully master digital technologies [12][13]. In the opinion of many teachers the importance of teaching digital literacy to students with disabilities has been fully demonstrated, and its beneficial effect is also supported by research [14]. In increasing the digital literacy of hearing-impaired students, actions should also be taken to improve their hearing. Hearing-impaired students require a special programme and development of special teaching methods. In the process of teaching children with hearing impairments, it is necessary to take into account the individual characteristics in the development of their thinking, that is, the development of all mental operations: analysis, synthesis, comparison and generalisation.

Improving digital literacy in computer science in special needs schools involves not only the development and formation of digital literacy, but also the remedial and developmental orientation of the educational process, which could help these students to socialise in the future. The course should pay special attention to the development of speech, creativity and intelligence of students with hearing impairment. Work in this direction involves the accumulation and comprehension of the relevant vocabulary; for example, as a glossary that includes terms specific to digital technologies, as well as technical phrases and phrases that contribute to the effective development of educational material.

RESULTS AND DISCUSSION

Organisation of Educational Processes

The authors have compiled a programme for a modified course on the development of digital literacy. They used modular training technology in this course. Modular learning is a way of organising the educational process based on a block-modular presentation of educational materials. The advantage of modular learning in this particular case is that it includes blocks that consist of information, correctional material, application blocks, leading to the formation of independent learning skills, the development of students' cognitive abilities, the creation of an adaptive developmental space for students, the formation of creative thinking. This modified course consists of four modules, and the development of the material is done sequentially. Each module describes definitions and teaching methods. The modules consist of learning elements that are based on practical tasks. Each module contains theoretical and practical information, and tasks to perform. The general scheme for presenting materials for the study is presented in Table 1.

Table 1: Course description.

Modules	Learning elements/topics included	Description	Teaching methods
1. Engineering and technical training	a) Installing, starting, shutting down, and updating software. Installing the operating system; b) Increasing the speed of a computer; c) Working with the control panel; d) Working with drivers and peripherals; e) Computer remote control.	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 modelling	a) Characteristics of the concept of computer graphics and 3D modelling; b) Introduction to Sweet Home 3D and creating projects; c) Working with new 3D objects; d) Creating a project.	Explanation of the concept of computer graphics. Types. Areas of application. Significance. Description of 3D modelling. Examples.	Creation and design of objects
3. Creating a mobile application	a) Mobile technologies and mobile applications; b) Getting to know the Thunkable mobile app creation environment and creating apps; c) Working with Thunkable components; d) Creating a project	Origin, history, interesting facts about mobile technologies and applications. Ways to create mobile applications.	Method of projects
4. Digital research project	a) Working in the TurboSite program environment; b) Working in the Microsoft Publisher environment; c) Working in the Microsoft Visio environment; d) Creating a project.	Students use computer programs on a variety of topics and develop projects using different methods.	Individual, group work

The potential of the modified course in the special needs training system can be described as follows. This course is aimed at organising independent work of students in grades 9-10 of special needs schools in Kazakhstan for students with hearing impairments and is an addition to the basic computer science course. The course is focused on practical work and contains a large number of didactic materials and illustrations that facilitate the absorption of the material. The materials presented include a selection of examples that reveal both general and particular principles of working with digital resources. All course materials were added to the educational information system: video tutorials, presentations, lesson plans, documentation, methodological recommendations, etc.

For the development of cognitive abilities, intelligence, creativity and logical thinking, technical and engineering skills of students with hearing impairments, a *minimum of theory and a maximum of practice* approach is adopted in the lessons. The course consists of 90% practical tasks. For example, to develop engineering skills, students get the opportunity to configure computer software and hardware: installing, starting, removing and updating software; installing the operating system; increasing the speed of a computer; working with drivers and peripheral devices; remote computer control. Working with computer graphics, designers for creating electronic textbooks, Web sites and mobile applications form such qualities of a student as independence, attentiveness, self-confidence, accuracy, and also creative and intellectual ability is formed.

The preparatory stage of creative activity is the fulfilment of tasks for mastering the basic methods of work; for example, in the TurboSite environment. The practical part is performed at the computer using the learned basic methods of work. In conclusion, students demonstrate their work, justifying the choice of methods and forms for implementing the project tasks. For example, the task of creating electronic textbooks is aimed at increasing motivation for learning activities and enhancing the student's personal position in the educational process (Figure 1 and Figure 2).

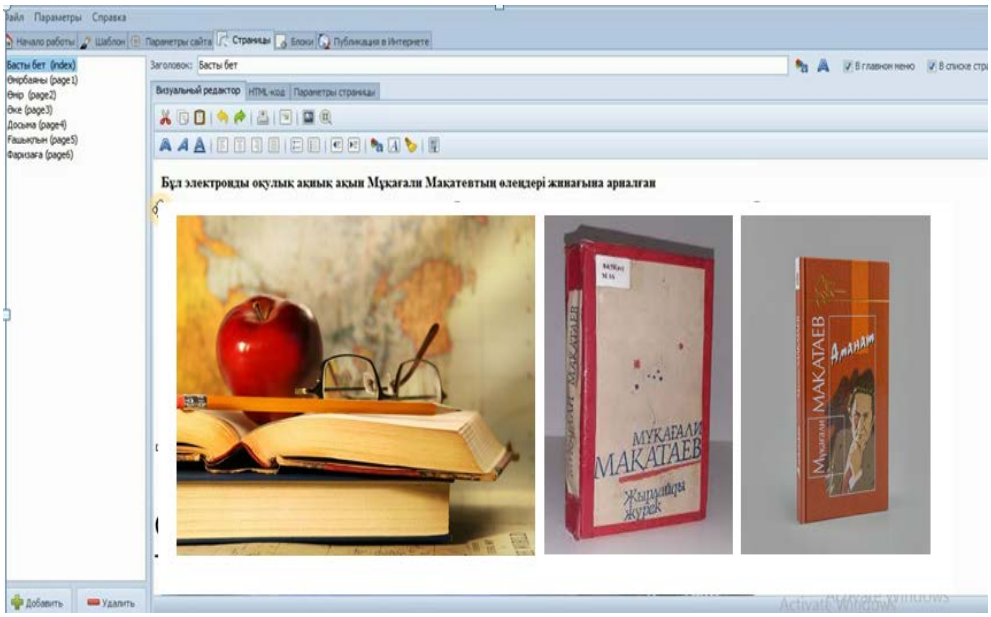

Figure 1: Samples of creative works of students.

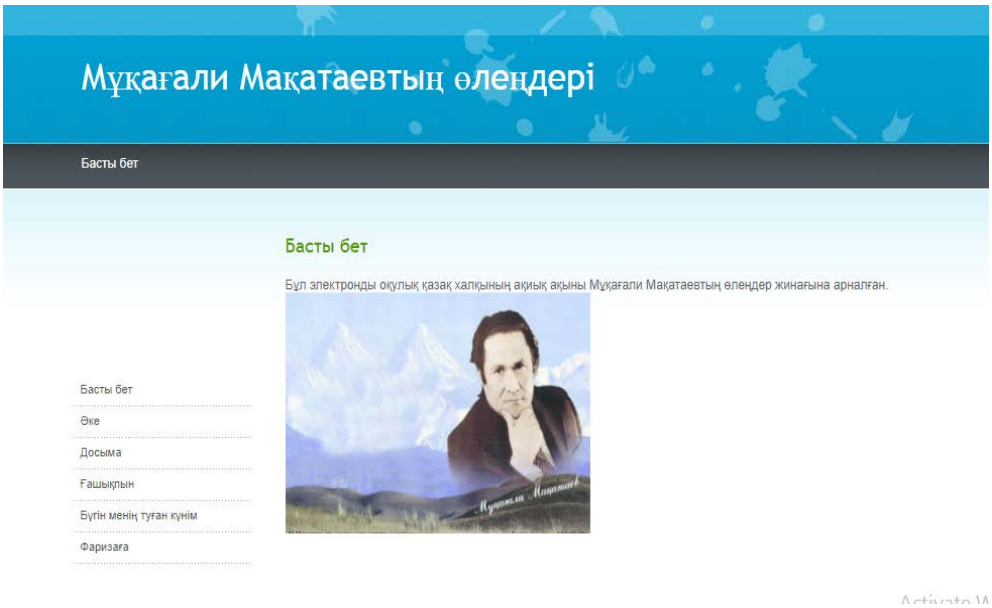

Figure 2: Samples creative works of students.

To reiterate, the purpose of the course is to develop the level of digital literacy of students in special needs schools for children with hearing impairment, expand their understanding of the capabilities of digital resources, lifestyle and features of the digital world, develop cognitive skills, develop their ability to think creatively, especially when working with digital resources, thus fulfilling the personal potential of each student.

The course objectives are as follows:

1. To form the skills of gathering and processing information, and methods of using information and digital resources in school children with hearing impairments.
2. Formation of digital skills necessary for life and work in the digital economy.
3. Development of cognitive abilities, intelligence, creativity and logical thinking of students with hearing impairments in solving problems.
4. Improving knowledge of software for working with digital content.

At the learning stage, a student with hearing impairments should be provided with an adapted for special needs instruction containing a step-by-step description of the sequence of necessary actions. Screencast technology is used to explain the course material at all stages of the course: when presenting new material, in practical work, as a means of monitoring the results of independent work and project activities of students.

After completing each module of the course, students are given the task to create a group-based project to assess the students' knowledge. The implementation of the final project constitutes the summative assessment of their knowledge. Most of the students with disabilities have reduced independence and working capacity, and demonstrate a low level of cognitive activity for learning activities. Consequently, the search and use of active forms, methods and means of teaching are one of the most important and complex processes. To implement the course content process, which ensures the most effective achievement of the set goals, a teaching technology was formulated (Figure 3).

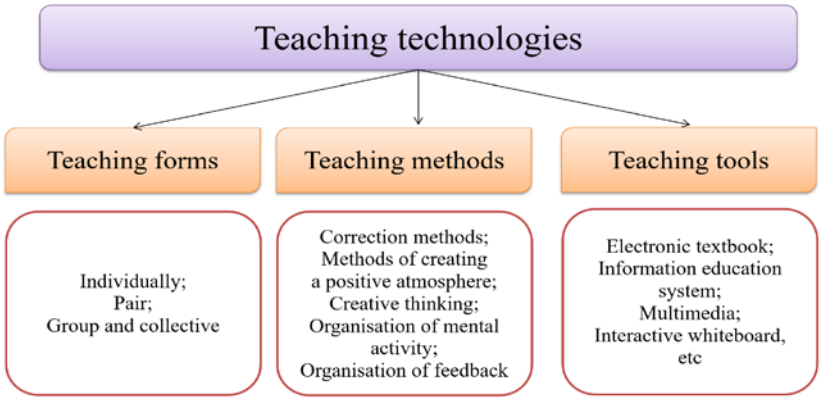

Figure 3: Teaching technologies.

As a form of education, the authors have chosen forms, such as extracurricular, individual, paired, group and collective. Within the individual form of training, the student performs tasks independently, but at the same time directly or indirectly using the help of the teacher. The technology of pair learning is one of the types of pedagogical technologies in which two people solve problems together and they will also be able to learn from each other. The group form of teaching consists of dividing the class into several groups of three to six students in accordance with the given task. The method of collective learning is a form of education that is described as group learning in all its forms; group lessons or communication in dynamic pairs.

To achieve the goals, such methods as correction-oriented methods, creating a positive atmosphere, stimulation of creative thinking and organisation of mental activity, and organisation of feedback were used. In addition, innovative pedagogical technologies were used in the course: interactive learning technology, design technologies and educational training. It is extremely important that all the lessons in the course take place in an interesting and entertaining way, so that the students are convinced of their capabilities every time. Students with disabilities have a weak motivation for learning; therefore, in order to achieve an intermediate goal, public praise by the teacher creates a situation of success, and hence positive emotions.

During the study, the authors involved a number of research methods, such as a questionnaire survey and in-depth interviews. In particular, before and after completing the course, students (N = 68) were asked to answer a short questionnaire: self-diagnosis of digital competencies, assessment of self-engineering skills, ability to create 3D models and usage of digital data analysis tools. During the last lesson, students again completed the questionnaire to evaluate the course curriculum, and analyse the effectiveness of the educational process and its role in the development of digital literacy. An additional research method was an in-depth interview with students to clarify a number of positions, analyse the interests, motives of the student community regarding the digitalisation of the educational environment and resources for the development of digital literacy. According to the results of the interview, N = 68 respondents positively assessed the effectiveness of the course (Table 2).

Table 2: Students' attitude to the course.

Attitude to the course	Distribution of answers to the following statement: *This course helped me improve my digital literacy skills*
Agree	49
Partially	14
Disagree	5
Total	68

The high interest in the course confirms the demand for such extra-curricular learning to be introduced into special needs school programmes in computer science to increase students' digital literacy.

CONCLUSIONS

The present study showed that the problem of increasing the digital literacy of students with hearing impairment is very relevant. At present, additional computer science courses are not enough for hearing-impaired students to address this problem, and there is a need to organise courses adapted to special needs to improve digital literacy. Hence, the aim of the study was to create an additional modified training course in informatics aimed at developing and improving the level of digital literacy of students in special needs schools for children with hearing impairments. Accordingly, a modified course was created with materials for the formation of digital literacy for students with hearing impairment, based on various innovative pedagogical technologies.

In the course compiled by the authors, students improve engineering and technical skills, work with computer graphics and 3D software, develop mobile applications, are involved in research and develop their creative abilities. Studies on creative abilities in children with hearing impairments is of particular importance since hearing loss in the development of cognitive processes: thinking, memory and imagination, creates certain difficulties in using digital technologies. In the developed course, students not only independently create digital content, but also increase their ability to talk, hear, communicate and memorise. After all, in each lesson, students get used to an oral explanation of the work they have done, an assessment of each other's project.

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

1. UNESCO. Global Monitoring Report 2008: Education for All by 2015. Will We Make It. Paris: United Nations Education, Science and Cultural Organization (2007).
2. Singh, B. and Prajapati, A.K., Inclusive education in India: what, why and how? *Inter. J. of Research in Economics and Social Sciences*, 11, **3**, 111-139 (2021).
3. White, E.H., Woods, K. and Poed, S., The assessment and development of digital literacy in students with vision impairment and additional learning needs: preliminary findings from a current PhD study. *Proc. 9th Inter. Council on the Educ. of People with Vision Impairment European Conf.* Bruges, Belgium (2017).
4. Murray, M.C. and Pérez, J., Unraveling the digital literacy paradox: how higher education fails at the fourth literacy. *Issues in Informing Science and Infor. Technol.*, 11, 85-100 (2014).
5. Gilster, P., *Digital Literacy*. New York: Wiley Computer Pub. (1997).
6. Neumann, M.M., Finger, G. and Neumann, D.L., A conceptual framework for emergent digital literacy. *Early Childhood Educ. J.*, 45, **4**, 471-479 (2007).
7. Porat, E., Blau, I. and Barak, A., Measuring digital literacies: junior high-school students' perceived competencies versus actual performance. *Computers & Educ.*, 126, 23-36 (2018).
8. Lankshear, C. and Knobel, M. (Eds.), *Digital Literacies: Concepts, Policies, and Practices*. New York, N.Y: Peter Lang, 30 (2008).
9. Lankshear, C. and Knobel, M., Digital literacy and digital literacies: policy, pedagogy and research considerations for education. *Nordic J. of Digital Literacy*, 8-20 (2015).
10. Lanham, R., Digital Literacy. *Scientific America*, 273, **3**, 160-161 (1995).
11. Martin, A., *Digital Literacy and the* Digital Society. In: Lankshear, C. and Knoebel, M. (Eds), Digital Literacies: Concepts, Policies, and Practices. New York, NY: Peter Lang, 151-176 (2008).
12. Hadromi, A model for a vocational school-corporate/industry partnership to improve students' technical skills. *World Trans. on Engng. and Technol. Educ.*, 16, **1**, 89-94 (2018).
13. Šuligoj, V. and Ferk Savec, V., The relationship of students' attitudes to technology and their creative ability. *World Trans. on Engng. and Technol. Educ.*, 16, **3**, 243-248 (2018).
14. White, E.H., Pavlovic, M. and Poed, S., *Understanding and Mapping Digital Literacy for Students with Disability*. In: Griffin, P. and Woods, K. (Eds), Understanding Students with Additional Needs (2020).