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Digital Divide and Operational Digital Literacy in Deaf and Hard-of-Hearing Students

Yulia Krasavina[*], Ekaterina Ponomarenko[**], Anastasia Shishkina[***], Andrey Gareyev[****]

Kalashnikov Izhevsk State Technical University, Faculty of Mathematics and Natural Sciences, Izhevsk, Russia

Introduction. The digital divide is a concept that has been explained as deficiencies in accessing and mastering new technologies caused by economic, social, or personal reasons. Overcoming the digital divide is a crucial social issue that implies focused research on digital literacy in the most vulnerable groups. *Objectives*. This study is aimed at assessing operational digital literacy in deaf and hard-of-hearing (DHH) university students and revealing potential grounds for hearing disability digital divide. *Methods*. The selection of study participants involved purposive sampling. Qualitative data on learning experiences in digital media were collected through verbal protocol sessions, diary entries, and semi-structured interviews with DHH university students. Grounded theory (open and axial coding) was used to analyse the data collected during interviews and verbal protocol sessions. Data collected from diary entries were analysed with Voyant Tools. *Results*. The main findings were categorised into: the use of the Internet and mobile applications, the digital divide, the use of text editors and spreadsheet programs, document creation and editing, and Internet search. The digital divide phenomenon in DHH students was described through the causal paradigm model. *Conclusions*. The study clarifies the difficulties that DHH participants faced in every stage of completing experimental tasks in the digital environment and provides arguments for proving that the grounds for the hearing disability digital divide are rooted in the lack of reading, writing, and written communication skills and not technical skills. The study also revealed the students' 'survival' strategies to overcome difficulties with poor reading skills and perceiving auditory information.

Keywords: deaf and hard-of-hearing students, digital literacy, digital divide, online learning

Correspodence: Yulia Krasavina, juliadamask@yandex.ru
* https://orcid.org/0000-0001-9250-7631
** https://orcid.org/0000-0002-8764-8998
*** https://orcid.org/0000-0002-0651-9079
**** http://orcid.org/0000-0002-4969-1012

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Introduction

The first extensive scientific research in digital literacy dates back to the late 20th century (Bawden, 2001; ICT Literacy Panel, 2002; Gilster, 1997). Since that time, this research area has been growing rapidly (Lowenthal et al., 2021). These two decades were marked by significant events that shaped the modern way of life: the global spread of mobile phones, the emergence of social networks, the massive transition to remote communications during COVID-2019, the rise of artificial intelligence, etc. These emerging technologies have already changed the world and the way people communicate, study, and work, and continue to change it in many ways. Living in two worlds, real and virtual, is already a reality, and it is vital to understand clearly that digital literacy today is as important as reading and writing skills.

The capacity for life-long learning and the skills to quickly find information and use technologies to solve problems are crucial for a successful career and personal development. Therefore, an in-depth analysis of the necessary digital literacy skills is important when providing university education, as it will allow graduates to adapt well to the digital world and its changes. At the moment, many researchers are studying the use of technology in education to analyse how it affects the development of digital literacy (Handley, 2018). A challenging area in the field is digital literacy skills in people with disabilities. A recent review of the literature on this topic (Lowenthal et al., 2021) shows that along with the opportunities that technology offers to people with disabilities, there are also certain risks, which are referred to as the "digital divide" problem (Lythreatis et al., 2022). It means that having a phone or a computer does not mean equal access to the Internet or other digital technologies and the opportunities they offer. To solve this problem, it is crucial to study and identify ways to develop high-level digital literacy skills for each type of disability. This paper is aimed at assessing operational digital literacy in deaf and hard-of-hearing (DHH) university students and revealing potential grounds for hearing disability digital divide.

Literature Review

Numerous attempts have been made in the recent past to define the concept of digital literacy and outline the framework for measuring it. The earliest papers already suggest that digital literacy is not limited only to the possession of technical skills but addresses the meta-level nature of literacy (Gilster, 1997) and can even be considered social practices and concepts related to information which is produced, received, distributed, exchanged etc., digitally (Knobel & Lankshear, 2006). Today, most studies consider it a concept that includes several components, such as cognition, critical thinking, communication, etc., referring to ideas introduced in fundamental studies in this field (Bawden, 2008;

Burniske, 2008). At the same time, generally accepted definitions of digital literacy are associated with three main aspects: they consider digital literacy as a skill, confine it to roles concerned with information, and finally, they assume epistemic engagement with information (Knobel & Lankshear, 2006). In his review, Bawden (2008) identified digital literacy or digital information literacy as a concept strongly related to information literacy and later described four generally agreed components of digital literacy, introducing computer literacy, information literacy, operational component, and a component related to attitudes.

At the beginning of the twenty-first century, attempts to measure digital literacy in a more formal way resulted in several international initiatives, including the European Computer Driving Licence (ECDL or currently ICDL) certification programme (Leahy & Dolan, 2010), which has become recognized in more than 150 countries by 2020. This certification programme originally concentrated on evaluating computer skills rather than information skills, and the assessment tasks were presented mostly as tests. Another framework suggested by the International ICT Literacy Panel focused on the importance of using technology in a knowledge-based society and stated that ICT literacy includes digital skills a person needs in order to access, manage, integrate, evaluate, and create information (ICT Literacy Panel, 2002). Consistently, they developed comprehensive scenario-based assessment tasks and scales that measured skills related to getting access, management, integration, evaluation and creation of information. Subsequent international and European initiatives such as The Digital Competence Framework for Citizens (Vuorikari et al., 2016) and UNESCO Global Framework of Reference on Digital Literacy Skills (Law et al., 2018) adopted the approach suggested by the ICT Literacy Panel (2002) and presented conceptual reference models that included various modules covering such areas as information literacy, communication, problem-solving, etc. Extended digital literacy scales (Amin et al., 2022) include multicultural aspects and are based on Chen's comprehensive approach, "9 C's of Digital Literacy", which incorporates nine components: communication, collaboration, critical thinking, creativity, citizenship, character, curation, copyright, and connectedness. In search of more practical frameworks, Spires (2019) suggests a digital literacy model that includes such components as searching, using, creating, and communicating in digital media.

Apart from everything else, attempts to develop comprehensible and practical frameworks for measuring digital literacy were aimed at overcoming the digital divide, a concept explained as deficiencies in accessing and mastering new technologies (ICT Literacy Panel, 2002). Digital divides can be caused by various reasons: economic, social, personal, etc. In this article, we focus on exploring the disability digital divide, particularly the hearing disability digital divide.

Analysis of studies exploring disability digital divide showed that it is a pressing issue for current research in the field of digital literacy (Cabero-Almenara et al., 2023; Ibraimkulov et al., 2022; Lowenthal et al., 2021). Cabero-Almenara et al. (2023) conclude that digital literacy skills in people with disabilities are lower than in people without disabilities. Yang and Lee (2022) mention similar results for older adults. The same conclusion was reached in studies on digital literacy in DHH students (Blom et al., 2019; Kritzer et al., 2020; Krasavina et al., 2023) outline cognitive challenges in DHH students when working in digital media, while Blom et al. (2019) report on lower networked hypertext comprehension of DHH students and students with language disabilities compared to hearing students.

Some studies focus on educational practices aimed at developing digital literacy in DHH students. Ibraimkulov et al. (2022) proposed an original two-component curriculum for teaching digital literacy to DHH students, including a digital user component and a digital correction-intellectual component. Several studies describe positive experiences of using computer and mobile applications to develop literacy skills, including digital literacy skills in DHH children and teenagers (Abdullina & Zolotovitskaya, 2023; DeForte et al., 2020). Kurniawati et al. (2022) suggested a nine-step technique for developing digital tools for DHH people and claimed that it should be preceded by a digital literacy assessment.

To conclude this section, the literature identifies disability digital divide as a crucial research issue, but the characteristics of digital literacy and digital divide in DHH students remain understudied. The aim of this study is to assess operational digital literacy and reveal potential grounds for the digital divide among DHH university students. In this research, the assessment of digital literacy is based on the study by Gareyev (2023), where the structure and content of epistemic competence in digital media in DHH students were defined by means of expert assessment. The resulting structure of the competence has been approved to consist of four components based on motivation, cognition, operation, and communication. The study also presents the methodology of evaluating students according to these criteria for all components of epistemic digital competence. Our study is based on the suggested structure, focusing on its operational component. According to the study (Gareyev et al., 2023), the operational component includes the following aspects: working with text editors (Word, etc.), spreadsheets (Excel, etc.), software for creating presentations (PowerPoint, etc.); using tools for copying, duplicating or moving data or information between folders, devices (via email, messengers, USB, via cable) or to the cloud; creating files (documents, images, videos) using various elements (text, images, tables, graphs, animations, sounds, etc.); using advanced search engine functions; using special tools intended for DHH people (online translators, Sign Language dictionaries, etc.).

Objective

This study is aimed at assessing operational digital literacy in DHH university students and revealing potential grounds for the hearing disability digital divide.

Materials and Methods

Study Design

This research was designed as a part of a larger study on the learning experiences of deaf and hard-of-hearing students in digital media. The study employed an inductive design using verbal protocols, semi-structured interviews, and diary records analysis. The selection of study participants involved purposive sampling. For that purpose, 17 technical university DHH students majoring in Mechanical Engineering were asked to complete the survey questionnaires. All the participants were bilingual, with sign language being their primary language, and were graduates of different state schools for DDH children. The survey included questions on the intensity of learning interests (independence, initiative, the use of additional sources for research, emotional attitude, etc.) and learning styles (students' learning routines, practices and habits). Along with the students' academic performance, the survey results were used to select respondents for interviews and individual sessions using verbal protocols. The inclusion criteria were high academic performance (average grade not less than 70%), high or medium intensity of cognitive interests, and universal or regular learning style. According to the survey results, the universal learning style characterizes students who were ranked as highly disciplined and active, and the regular learning style characterizes students who perceive learning as a stressful activity but achieve good results by regular studying and distributing the efforts evenly throughout the semester. Thus, five participants were selected for the main experimental part of the research. Table 1 presents the main participants' demographic characteristics and survey results.

Table 1

Participants' demographic and academic characteristics

Students	Characteristics				
	Age	Gender	Degree of hearing loss	Academic performance	Survey results (learning style/ intensity of learning interests)
R1	24	Female	profound	high	Universal / High
R2	23	Female	severe	high	Regular / High
R3	21	Female	moderate	high	Regular / Moderate
R4	22	Female	profound	high	Universal / High
R5	20	Female	moderate	high	Regular / High

Data Collection

Data were collected by the authors through verbal protocol sessions, semi-structured interviews, and diary records during the spring and autumn terms in 2023 at Kalashnikov Izhevsk State Technical University.

Verbal Protocols

The qualitative research included designing experimental tasks and conducting individual sessions using verbal protocols, implying the participants comment on their actions or "think aloud" while performing experimental tasks in the presence of a researcher (Ericsson & Simon, 1980). The verbal protocol method is recommended when performing tasks of a practical rather than hypothetical nature (Russo et al., 1989). A sign language interpreter was present during the sessions and voiced the participants' comments. The sessions were recorded on video; all participants signed a written consent to participate in the research.

Experimental Process

The materials for the verbal protocols study included two tasks based on a predefined scenario in different contexts. A scenario of performing the experimental tasks required the use of cognitive and metacognitive strategies (performing information search, information evaluation and understanding, analysis and synthesis, and finally, creation of a document containing a short presentation on the topic given or answer to the question). Each task was given 30 minutes to complete.

The sample task (in the context of the Psychology course) was presented as follows: "You have to prepare a short presentation on Behaviourism theory. You need to find several reliable sources where you can take information for the presentation and write a script for the presentation (1 page in Word)." The second task (in the context of the ESL course) was formulated in a similar way but additionally required stating the participant's opinion and justifying it based on the arguments from the Internet.

The tasks performed by the participants were evaluated using the following criteria: subject definition, language accessibility, logical structure, text originality, the use of multiple sources, document design, and text length. Additional criteria for the second task included clarity of answer to the question, availability of arguments, and availability of reference sources.

Semi-structured interviews

The second phase of the research involved semi-structured interviews aimed at identifying challenges related to learning in digital media in DHH students. The interview questions focused on four aspects: motivation (interests and perseverance in problem-solving), cognition (awareness of main strategies for Internet search), operation (technical aspects), and communication when learning in a digital environment. The

interviews were conducted in the presence of a sign language interpreter. On average, the interviews lasted between 45 minutes and one hour.

Diaries records

As an additional research method, DHH students were asked to keep periodic diaries on their learning experience in the electronic environment. For two weeks, students were asked to send daily entries describing their experience by answering 10 questions related to the websites and applications they used during the day, their activities on the Internet, and digital communication.

Data analysis

Video and audio recordings from the verbal protocols sessions and interviews were transcribed and translated into text. Then, the data were analysed using grounded theory (Strauss & Corbin, 1990), implying open coding to identify the main categories related to the digital divide, strategies, and challenges that participants face when working in the electronic environment. Later, we used axial coding to present the results in the framework of the causal paradigm.

The information obtained from the diary entries was analysed with Voyant Tools (https://voyant-tools.org) in order to discover the relative frequency of words in the entries and identify DHH students' priorities in using the Internet and mobile applications.

Results

Use of the Internet and Mobile Applications

The main findings related to the use of Internet and mobile applications are presented in Table 2. Only eight entries were analysed from each student instead of fourteen, as not all of them sent their reports daily.

All participants used at least two devices with Internet access (a phone and a computer). Students' diary entries confirmed that they all used various digital services for study, self-development and communication on a daily basis. With rare exceptions, university course assignments required daily Internet access.

Table 2

Relative frequency of words in diary entries related to the use of Internet and mobile applications

Students	Research method	
	Analysis of diary entries (the most frequently used words in the entries), from https://voyant-tools.org	
	Actions on the Internet	Daily communication
R1	watched (12); searched (5); communicated (4); news (4): friends (4)	relatives (7); friends (7): group mates (4); teachers (3); Sign language translator (2)
R2	watched (10); read (9); series (6); news (5); books (2)	relatives (7)
R3	read (9); tests (7); took (7); searched (8); answers (6)	relatives (7); friends (7): acquaintances (4); teachers (2)
R4	watched (12); video (9); read (6); photo (6); news (6)	Sign language translator (7); relatives (7); friend (7)
R5	read (10); video (8); information (8); searched (6); solved (5)	relatives (7); friends (7); group mates (4); Sign language translator (5); teachers (4)
General	read (4); watched (3); searched (3); news (3); video (2)	relatives (5); Sign Language translator (3); teachers (3); friends (3); group mates (1)

The analysis of the websites visited daily showed that each participant has formed a personal list of websites and services to satisfy their learning interests. Suggested that this list includes websites that have been logged in more than 3 times in 2 weeks, it will count up from 6 to 10 websites. For all participants, this list included popular search engines, social networks, popular video hosting websites, and the university's e-learning system website. For three participants, this list also included websites related to their studies at the university (lecture notes, information on State standards, websites for technical computing). Websites directly related to the deaf community (materials designed for deaf people) are regularly visited by only one respondent whose interests include sign singing (R1). In two weeks, none of the participants visited websites related to sign language (online translators, sign dictionaries). In addition to websites, all participants used popular messengers on a daily basis, both for communication and entertainment (watching the news).

Digital Divide

Applying grounded theory (Strauss & Corbin, 1990), open coding was used to identify categories, parameters, and scales for the digital divide phenomenon based on the comments obtained during the interviews. Then, we

described the digital divide concept through the triangle diagram and the causal paradigm model. Table 3 shows the identified categories, assigned parameters, and scales (measurements) for the digital divide phenomenon, as well as a short fragment from the corpus of comments obtained during the interviews.

Table 3

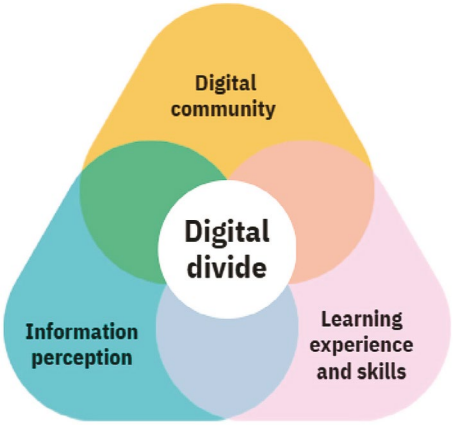
Application of open coding procedures to analyse qualitative data on digital divide

Categories	Parameters	Scales (measurements)	Examples of comments
C1. Digital community	P 1.1 Opinion leaders	Following only deaf bloggers – following all bloggers	*"Just because they [DHH people] watch deaf bloggers doesn't mean they don't watch others* [C1.P1.1]. *But they watch their bloggers more"* (R2). *"I watch deaf people* [C1.P1.1] *who speak Sign language* [C2.P2.3]. *The text is not entirely clear* [C2.P2.1]. *I like signs more when they explain"* (R4) [C2.P2.3]. *"I might be insulted [C1.P1.3], something like: you are deaf and stupid as well"* (R1) [C1.P1.2]. *"It's difficult for me to trust hearing people* (R1)*"* [C1.P1.2]. *"I won't watch videos without subtitles"* (R2) [C2.P2.2]. *"[Popular video hosting] is deceiving. Captions, there are words that don't match"* (R2) (R2) [C2.P2.2]. *"The reasons are different. Someone was bullied as a child, and fear appeared."* (R3) [C3.P3.1]. *"DHH people don't read much* [C3.P3.2*].... Lack of vocabulary"* (R3) [C3.P3.3]. *"I never comment on posts* [C3.P3.3] *because I can't write correctly"* (R4) [C3.P3.2].
	P 1.2 Attitudes	No trust in hearing community – Trust in hearing community Assuming negative beliefs – Assuming tolerance	
	P 1.3 Expectation of negative feedback	Insult – Positive feedback	
C2. Information Perception	P 2.1Text	Not clear – Clear Time-consuming – Not time consuming	
	P 2.2 Captions	Not available – Available Incorrect – Correct	
	P 2.3 Sign Language	Not clear – Clear Negative attitude – Positive attitude	
C3. Learning experience, skills and behaviour	P 3.1 Consequences form negative past experience	Fear – No fear Shame – No shame	
	P 3.2 Reading and writing skills	Poor vocabulary – Rich vocabulary Poor writing skills – Good writing skills	
	P 3.3. Behaviour	Passive user – Active content creator	

Based on the results of qualitative data analysis, the digital divide phenomenon through the eyes of DHH people can be described as a concept triggered by factors related to three categories: divide in the digital community, divide in information perception, and divide in learning experience and skills. Figure 1 shows the triangle diagram presenting the concept.

Figure 1

Concept of the hearing disability digital divide



A divide in the digital community is expressed through social network preferences and subscriptions to groups in messengers. All participants follow deaf bloggers, although hearing bloggers are also present in their subscriptions. Loyalty to deaf bloggers is often associated with the clarity of information presented with sign language. The participants demonstrated no trust in the digital community of hearing people and would expect negative feedback in case they made a mistake while posting or writing comments.

Concerning information perception, all participants concluded that not all information on the Internet was available to DHH people. They confirmed that audio and video materials without subtitles are not available for students with hearing impairment. In addition, participants repeatedly pointed out that subtitles are often incorrect and do not match the video sequence, which hinders understanding. In addition to video and audio materials without subtitles, complex texts also present difficulties in learning online.

When asked about being active content creators, writing posts on social networks, and commenting on posts, all participants responded negatively. Most participants explained that their reluctance to practice written communication on social networks was caused by previous negative experiences in communicating with their hearing peers and fear of being bullied for the wrong language. Poor reading and writing skills were also mentioned as a cause that prevents DHH students from writing anything on social media.

Use of text editors and spreadsheet programs

Data received on the use of text editors and spreadsheet programs are presented in Table 4.

Table 4

DHH students' competence in the use of text editors and spreadsheet programs

Students	Research method		
	Verbal protocols (observation protocols)	Interviews (students' answers)	
	Text editor	Spreadsheet program	Presentation software
R1	Confident in opening files, editing, saving, and copying information, formatting the document	Confident user	Confident user
R2	Confident in opening files, editing, saving, and copying information, formatting the document	Confident user	Confident user
R3	Confident in opening files, editing, saving, and copying information, formatting the document	Confident user	Confident user
R4	Confident in opening files, editing, saving, and copying information, formatting the document	Confident user	Confident user
R5	Confident in opening files, editing, saving, and copying information, formatting the document	Confident user	Confident user

Documents creation and editing

When performing an experimental task during a verbal protocol session, students had to create a report/answer a question in a Word file. The study showed that all participants have good skills in creating files (documents, images) using different elements (text, images, tables, graphs) and using a copy-paste tool. However, all participants practically did not edit the contents of the document, limiting themselves to simple copying and pasting. At best, the document included fragments from various websites copied under different headings. None of the participants paraphrased or summarized the information they had found in their own words. The comments received during the interview confirmed the results of the observation.

R2: *"I can't do it in my own words."*

Interviewer*: "Why?"*

R2: *"It's difficult for me. I don't know how to explain it. I have an idea, but I do not know how to explain, how to tell it."*

R5: *"The guys [group mates] copy and paste everything because they have a limited vocabulary, they can't write in a beautiful manner. Since their ears do not hear, they communicate by gestures, and one gesture has many meanings, so they do not remember all of them. ...The guys know about their problem".*

Internet search: challenges and strategies

The study participants used popular search engines to perform Internet searches. However, none demonstrated the skills of 'advanced search', such as using search formulas, including search modifiers, e.g. quotation marks, and operators 'AND', 'OR', etc.

However, major challenges in retrieving information were related to wording and correcting the search query. Based on observations and comments analysis (open coding) during verbal protocol sessions, we identified major categories of challenges related to query generation: identifying keywords/ all the keywords; identifying relevant auxiliary keywords; combining main and auxiliary keywords in one query; use of multiple-word queries; no further query correction. The observation protocol results concerning challenges are presented in Table 5.

Table 5

Challenges faced by DHH students when generating queries for Internet search

Students	Categories of challenges identified by grounded theory (open coding) and observation protocols				
	Identifying keywords/ all the keywords	Identifying relevant auxiliary keywords	Combining main and auxiliary keywords in one query	Use of multiple-word queries	No further query correction
R1	N/N	N	C	N	N
R2	C/C	C	C	C	C
R3	N/ C	N	N	N	N
R4	N/ C	C	C	N	N
R5	N/ C	C	C	N	C

Key: C – area of challenge; N – presents no challenge

At the same time, observation protocols and comments analysis allowed us to identify strategies that help DHH students, native speakers of sign language, to compensate for the inability to perceive audible information and difficulties with the perception of complex texts when working in a digital environment. The following strategies were identified: preferred video format (preceded by

checking if the captions are provided); use of images as a source providing simplified visual textual information; use of blogs and social networks as sources providing simplified textual information; use of the Internet to search for unknown words. Table 6 shows the observation protocol results.

Table 6

Strategies used by DHH students to cope with the problems of information perception recorded in observation protocols

Students	Strategies identified by observation protocols			
	Referring to sources providing simplified information			Use of the Internet to search for unknown words
	Videos	Images	Blogs and social network	
R1	U	N	U	Confirmed
R2	N	U	U	Confirmed
R3	U	U	U	Confirmed
R4	U	U	U	Confirmed
R5	U	U	N	Confirmed

Key: U – the use of the strategy was recorded during verbal protocols session; N – the use of strategy was not recorded

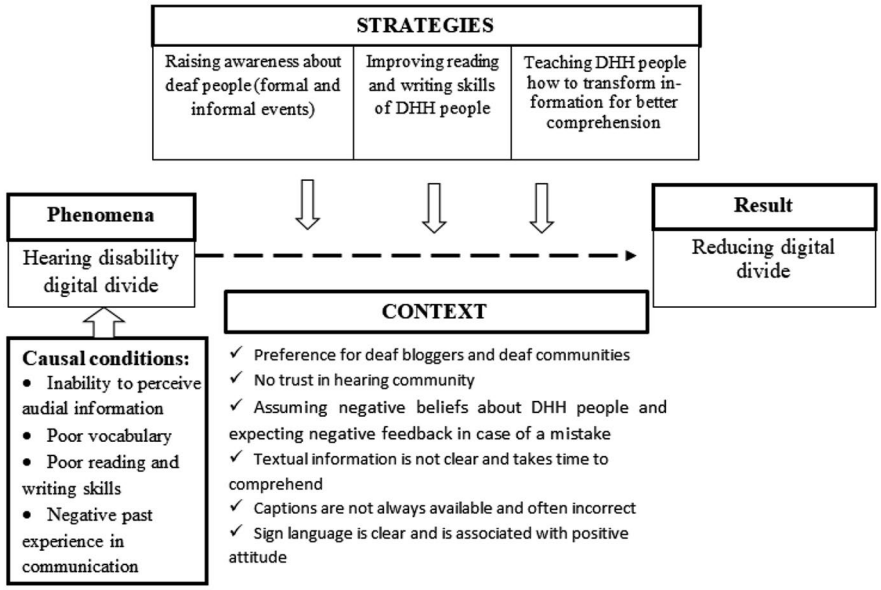
Discussion

The study showed that DHH students are active users of the Internet and mobile applications. The participants are technical university students who use the Internet and social networks for study, entertainment and self-development. The study allowed us to assess technical or operational skills in using ICT and the Internet; results showed that the respondents claimed no problems when working with text editors and spreadsheet programs and demonstrated excellent skills in creating and editing files in various formats.

However, our study revealed several significant challenges that allowed us to describe the complex phenomenon of the hearing disability digital divide as a multifaceted concept encompassing such elements as a divide in the digital community, information perception, and learning experience and skills. These categories were subjected to axial coding to model a causal paradigm for the concept and define the strategies needed to be implemented to reduce the divide. Figure 2 presents a simplified model for the causal paradigm for the hearing disability digital divide phenomenon.

Figure 2

Model of causal paradigm for the hearing disability digital divide phenomenon



The strategies to reduce the digital divide include raising awareness about deaf people, both with formal initiatives (official programs and campaigns) and informal initiatives (cooperation of deaf and hearing bloggers communities). DHH participants do not practice regular posting and commenting on social media. At the same time, a fear of negative feedback when creating textual content or commenting on social network posts was confirmed by all DHH participants of the study. Although a higher fear of negative evaluation is associated with more problematic Internet and social networks in people with no hearing problems (Naidu et al., 2023), the underlying reason for DHH individuals is that they tend to relate this fear to negative experiences from offline communication with hearing people.

Another strategy that follows from the analysis of the challenges is the improvement of DHH students' reading and writing skills. Apart from preventing DHH students from being active content creators, poor reading and writing skills have a detrimental effect on their whole learning experience in digital media. The typical online learning scenario includes information search, analysis, and synthesis. Our study clearly demonstrated that the lack of reading comprehension and text analysis skills mentioned by previous studies (Kuntze et al., 2023; Marschark & Knoors, 2012) for classroom learning is also critical for learning in digital media. At first, DHH students were challenged to understand the task and set the learning goal; then, they had to select key and auxiliary terms

(information decoding) and form an initial search query (coding). Later, they had to correct the query to retrieve information and choose relevant websites based on the abstracts provided. As the search results rely heavily on the correct combination of key terms and additional words and further query correction, poor text analysis skills prevent DHH students from retrieving the required information promptly and efficiently. Later, when selecting websites for learning and reading, when challenged with a complex scientific text, they would rather close it and try another one than make a conscious effort to understand the main idea or search for the required information. Thus, when choosing the source of information for learning, the criteria of linguistic accessibility is of priority for DHH students with poor reading skills. To conclude, in order to effectively learn and work on the Internet, users must apply higher-order thinking skills related to text analysis at every stage of their learning experience, which is the main challenge DHH students face.

Thus, our study provides additional support for proving that the grounds for the hearing disability digital divide are rooted in the lack of reading and writing skills and not technical skills. This confirms previous findings (Cabero-Almenara et al., 2023), which showed that students with disabilities are competent ICT users but are not very competent in forming new knowledge through ICTs. At the same time, it is fundamental to note that DHH students are aware of this problem and use the Internet to expand their vocabulary, as all participants in the experiment indicated in their diaries that they used the Internet to search for unfamiliar words.

In our study, we also identified several strategies that DHH students used to overcome difficulties with the perception of textual and auditory information. Most of the 'survival' strategies were related to finding simplified information: watching videos (with generated captions), turning to the 'images' tab as this option often provides structured and short texts on the topic being searched, and addressing reputed bloggers in search for answers to complicated questions. The latter identified strategy of targeting social media as a reliable information source is consistent with the trend highlighted by (Kožuh et al., 2014; Sommer, 2020) of focusing on social networks as a reliable source of learning. In order to expand the list of strategies that could assist DHH students in comprehending auditory information or complex texts, they could be taught how to transform them into accessible forms. Artificial intelligence tools that generate video content and abstracts of long texts could accelerate information search and facilitate the learning process in digital media.

Conclusion

The problem of improving the quality of inclusive learning in the digital environment for DHH people is a pressing issue that needs further research. Our study allowed us to draw several important conclusions that can be used further. The assessment results of operational digital literacy showed that the main difficulties that DHH students faced when learning in digital media are cognitive and closely associated with poor reading and writing skills. However, when searching for solutions to narrow the digital divide, these results must be interpreted with caution. For universities, possible solutions could involve additional courses on developing reading and writing skills and teaching cognitive and metacognitive strategies for Internet search to DHH people within their training programs. For digital content developers, possible solutions involve the development of a deaf-centred e-learning environment with adapted text and prevailing visual presentation of information. Although many educators could question the development of such an artificial environment, some takeaways for developing digital content are explicit: it is necessary to take into account the problem of generating incorrect captions, design digital texts with the highlighting of key ideas and more illustrations, and provide some tools to transform information into several formats. The problem of attitudes in digital communities should also be taken into consideration.

The present study has some limitations regarding the sample size and the sampling methodology. It could be regarded as an exploratory study offering the basis for designing more empirical studies involving DHH students from different universities and educational backgrounds in the future. It will allow us to clarify and generalize conclusions for the population of deaf and hard-of-hearing university degree holders who communicate predominantly/exclusively in sign language. Future research studies should also identify best educational practices for developing all aspects of digital literacy in DHH students, raising their confidence, and accepting the idea that they could become not only advanced digital content consumers but creators as well.

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Digitalna barijera i operativna digitalna pismenost kod gluvih i nagluvih učenika

Yulia Krasavina, Ekaterina Ponomarenko, Anastasia Shishkina, Andrey Gareyev

Kalašnjikov Iževski državni tehnički univerzitet, Prirodno-matematički fakultet, Iževsk, Rusija

Uvod: Digitalna barijera je pojam koji je objašnjen kao nedostatak pristupa i ovladavanja novim tehnologijama, koji je uzrokovan brojnim razlozima: ekonomskim, društvenim ili ličnim. Prevazilaženje digitalne barijere je ključno društveno pitanje koje podrazumeva fokusirano istraživanje digitalne pismenosti u najugroženijim grupama. *Cilj*: Ova studija ima za cilj procenu operativne digitalne pismenosti kod gluvih i nagluvih (DHH) studenata univerziteta i otkrivanje potencijalnih osnova za digitalnu barijeru kod oštećenja sluha. *Metode*: Odabir pojedinaca za studiju uključio je ciljane učesnike. Kvalitativni podaci o iskustvu učenja u digitalnim medijima prikupljeni su kroz verbalne protokolarne sesije, beleške u dnevniku i polustrukturirane intervjue sa DHH univerzitetskim studentima. Utemeljena teorija (otvoreno i aksijalno kodiranje) korišćena je za analizu podataka prikupljenih tokom intervjua i sesija verbalnih protokola. Podaci prikupljeni iz zapisa u dnevnicima analizirani su pomoću Voiant Toolsa. *Rezultati*: Glavni nalazi podeljeni su u sledeće kategorije: korišćenje interneta i mobilnih aplikacija, digitalna barijera, korišćenje uređivača teksta, programa za tabelarne proračune, za kreiranje i uređivanje dokumenata i pretraživanje interneta. Fenomen digitalne podele kod DHH studenata opisan je kroz model povremene paradigme. *Zaključak*: Studija pojašnjava poteškoće sa kojima su se DHH učesnici suočavali u svakoj fazi izvršavanja eksperimentalnog zadatka u digitalnom okruženju i pruža argumente za dokazivanje da osnove za digitalnu podelu sa oštećenjem sluha proizilaze iz nedostatka veština čitanja, pisanja i pismene komunikacije, a ne tehničkih veština. Studija je takođe otkrila strategije „preživljavanja" koje su učenici koristili da bi prevazišli teškoće sa lošim veštinom čitanja i percepcijom audio-informacija.

Ključne reči: gluvi i nagluvi učenici, digitalna pismenost, digitalna barijera, onlajn učenje

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