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TECHNOLOGY LITERACY AMONG PRIMARY SCHOOL TEACHERS FOR ENHANCING NUMERACY AND LITERACY SKILLS OF EARLY-GRADE PUPILS WITH HEARING IMPAIRMENTS IN TANZANIA

Abstract. Information Communication Technologies (ICTs) have significantly transformed the educational landscape, and offer substantial benefits for learners with special needs including those with hearing impairments. The primary purpose of this research was to determine the technological literacy level among primary school teachers in using ICTs to support literacy and numeracy skills among learners with hearing impairments and compare them based on demographic information. A quantitative analysis approach was used, involving 121 teachers from the deaf unit primary school who completed a self-rating questionnaire based on the Technology Literacy Assessment Scale developed by UNESCO. Both mean scores, the Mann-Whitney U test, and the Kruskal-Walli's test were used to compare teachers' technological literacy using ICTs. The results indicated that teachers' demographic information is significantly related to technological literacy at the p=0.05 level. The results found that female teachers had higher technological literacy than male teachers. Also, teachers with lower education levels were found to have higher technological literacy than those with higher levels of education. Among the teacher characteristics, working experience and age were found to have no significant difference with technology literacy as they had p-values of 0.313 and 0.212 respectively. Interestingly, teachers who specialized in special needs education were found to have higher technological literacy than those who didn't specialize in special needs education.
The findings revealed that technology literacy among primary teachers who teach pupils with hearing impairments was high, which signifies confidence in basic ICT skills for enhancing literacy and numeracy skills among learners with hearing impairments. However, incompetence levels were found in integrating ICT in organization and administration, especially in managing individual variation among pupils with hearing impairments, and curriculum and assessment had lower mean scores than other elements of the UNESCO ICT-CFT areas. These findings suggest that adaptive and personalized learning systems are essential, and comprehensive training regarding ICT integration specifically tailored for teaching pupils with hearing impairments is needed for effective classroom usage.

Keywords: technology literacy; ICT; adaptive and personalized learning; literacy skills; numeracy skills; hearing impairments.

1. INTRODUCTION

Information Communication Technology (ICT) has revolutionized government services and made a profound impact on all sectors of Tanzania's economy including education, as in other countries [1]. It has received considerable attention from schools, parents, and teachers as a tool to assist learners with special needs by promoting personal independence, remediating

learning problems, strengthening communication, and reinforcing the development of skills [2]. Learners with special needs encompass those with physical and intellectual disability, autism, language and communication disorders, visual impairments, and hearing impairments, as well as multiple disabilities. The necessity for learning resources for learners with hearing impairments is rising which is leading to a significant increase in the use of various technologies such as educational software and devices [4]. Utilizing these technologies can help learners with disabilities who have trouble with grade-level content areas such as reading, and writing problems enhance their reading and numeracy skills [5]. Article 9 of the Convention on the Rights of Persons with Disabilities, emphasizes and promotes access to ICTs for persons with special needs. The use of technology can provide immediate assistance to students, foster collaboration, and offer relevant resources specific to their learning needs [6]. Even though learners with hearing impairments in Tanzania have a right to a better education, their academic performance is negatively impacted by the poor learning environments that prevent them from attaining basic reading and numeracy skills [7].

Poor ICT knowledge among teachers is one of the challenges that hinders the effective use of digital materials for teaching learners with hearing impairment in Oyo State, Nigeria [8]. Moreover, limited training for teachers has been identified by UNICEF as one of the main barriers preventing children with disabilities from accessing education in Vietnam [9]. Teachers are under pressure to deliver the best educational services possible due to the growing number of students with special needs attending special primary schools. They are encouraged to pursue a variety of learning opportunities to acquire technology literacy to manage students with special needs in their classrooms. Technology is promising in overcoming this challenge by providing personalized learning for a larger number of students in the class.

The problem statement. The Tanzania National ICT policy of 2024 indicates that the digital transformation era requires the development of knowledgeable and skilled ICT experts who can use the rapidly advancing digital technologies for social and economic progress [10]. However, access to high-quality education remains a barrier for children with disabilities including hearing impairments when compared to children without disabilities [11]. Despite similar studies being done, previous research has examined technology literacy among university lecturers in various universities, and tutors in teaching colleges [12], [13], while some research has focused on primary or secondary schools for non-disability learners[14]–[17], and there have been few studies that have assessed the use or role of technology in supporting learners with and without disabilities [18], [19]. However, very little is known about technology literacy among primary teachers specifically in the enhancement of literacy and numeracy skills for pupils with hearing impairments, particularly in Tanzania.

Analysis of recent studies and publications. Lawrence [20] examined the perceived technology literacy levels among Nigerian University lecturers using the UNESCO competency framework. This research employed the technology literacy component of the UNESCO framework to determine lecturers' ICT usage for instruction. The study found that over 70% of the lecturers had a positive perception of technology literacy in their instruction and concluded that ICT use is essential for creating new knowledge. The study recommended that the government should increase the provision of training and new technologies to lecturers. Also Foulger *et al.* [12] conducted research on technology competency among teacher educators in Delphi, India. The study emphasized the importance of technology integration during teacher preparation. It is concluded that all teacher educators are needed to prepare student teachers with skills in integrating ICT for teaching and learning.

Konan [14] conducted a study to determine computer literacy levels among teachers in Malatya, Tukey. The study revealed a significant difference between demographic variations among teachers and their technological literacy levels and suggested that teachers are required to obtain a European Computer Driving License to increase their computer literacy levels.

Lubuva and Ndibalema [13] assessed the ICT competency level of tutors in Teachers' Colleges in Tanzania. The study adopted the UNESCO competence framework for teachers and involved 78 tutors for data collection. It was found that most tutors possessed higher knowledge-acquisition skills compared to knowledge deepening and creation. The study recommended that more practice and hands-on experience in ICT usage are needed in classrooms.

Neneng *et al.* [21] addressed the teacher's information literacy for inclusive education to provide literacy and numeracy for special needs children in Indonesia. The study found that teachers who are information literate on special needs children who have special needs can support play-based activities that help them gain literacy and numeracy skills. Teachers can use information literacy in managing learning from identifying the learning needs, to designing, implementing, and evaluating learning programs. Therefore, teachers must undergo the required training to enhance their information literacy, particularly for effectively managing classroom instruction for learners with special needs. Also, Zhang [16] in China investigated the technological literacy of English language teachers and the role of contextual factors in their literacy development. The study found that teachers' digital literacy is not affected by their contextual factors. Also, observed that teachers' digital literacy may be greatly impacted by their attitude, access, and skills toward technology use.

Korkmaz and Akçay [17] examined the perception of digital literacy levels among primary school teachers in Turkey. The findings demonstrated the high competency primary school teachers believe they possess in various domains of digital literacy and their mastery of these domains. The study found that teachers' levels of digital literacy varied significantly depending on their demographic variables. Kalinga and Ndibalema [22] conducted a study on technological competence among secondary teachers in Tanzania. The study found that most teachers had higher technology literacy on the knowledge acquisition level. Moreover, no significant differences in terms of demographic variables such as experience, age, and technological literacy were found. The study recommended several ICT trainings are needed to uplift their knowledge to a higher knowledge level.

The research goal. The study aimed to examine the technology literacy among primary school teachers in using ICT for enhancing numeracy and literacy skills among the early grade pupils with hearing impairments using various technologies. Quantitative methods were employed to address the following research questions:

1. What is the level of teachers' technological literacy in utilizing ICT to enhance literacy and numeracy skills among learners with hearing impairments?
2. Is there a relationship between participants' demographic information and their technological literacy?

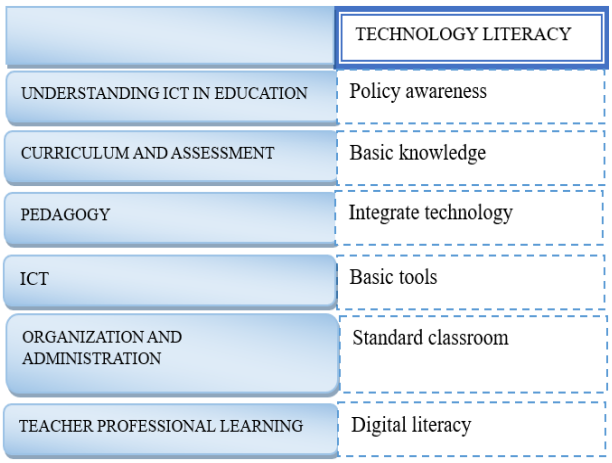
2. THE THEORETICAL BACKGROUNDS

This study was guided by the UNESCO ICT Competence Framework for Teachers (ICT CFT), which identifies 23 specific technological literacy items organized in six areas including, understanding ICT in education, curriculum and assessment, pedagogy, ICT, organization and administration, and teacher professional learning, as shown in Figure 1. The ICT-CFT framework focuses on educators in both primary and secondary schools; however, it may also apply to other areas, including vocational and tertiary education, as well as to on-the-job learning and continuing education [23]. It emphasizes that educators/teachers are required to have ICT literacy so that they may be able to teach their students.

The framework is arranged in three successive stages of teacher development: the first is technology literacy which is the basic knowledge of ICT utilization for supporting teaching and learning activities, the second is knowledge deepening, which is the knowledge required for solving complex problems, and the knowledge creation, which is the knowledge required for

developing new knowledge such as the development of various programs [23]. In the context of teaching and learning, technology literacy means knowing what can be done with the use of technology, how to use it, and deciding on the type of technology and the appropriate time for usage. In Area 1, teachers are involved in understanding the basic principles of using ICT in teaching. In Area 2, teachers must be able to integrate ICT into the curriculum and formative assessment. In Area 3, teachers must know how to use ICT for classroom activities. Area 4, teachers must know basic ICT tools and their operations. In Area 5, teachers must be able to use ICT to manage student groups and individual activities. In Area 6, teachers must have ICT knowledge to support their professional learning.

This framework was selected to guide this study because it emphasizes important aspects to be considered when measuring teachers' technological literacy in ICT utilization for teaching and learning. In this study, primary school teachers acted as educators, therefore, the researcher prepared tools to measure teachers' technological literacy as identified by this framework. This has given the researcher a picture of teachers' technological literacy to integrate ICT-enhanced literacy and numeracy skills among pupils with hearing impairments.



(Source: UNESCO [23]*)*

Figure 1. UNESCO ICT-CFT Technology Literacy Domains

3. RESEARCH METHODS

3.1 Research approaches and design

The quantitative approach was employed in this research. Both descriptive quantitative research design and correlational research design were used. Descriptive quantitative research was used to describe a sample population and provide insight into the sample characteristics as well as the technological literacy skills possessed by the teachers. The correlational Research design explored the relationship between technology literacy and participants' demographic information.

3.2. Research instruments and measures

A 5-point Likert scale questionnaire was used in this study. The questionnaire had 23 items organized into six main categories, as shown in Figure 1 above. This study used close-ended questions with a five-point Likert scale, ranging from 1 (strongly agree) to 5 (strongly disagree). The mean score was computed from those 23 questions. Those respondents who scored more than 3 were considered to have low technological literacy levels, while those who scored 1 or 2 were regarded to have higher technological literacy. The independent variables of

this study were the participants' demographic characteristics which include age in years, gender of the respondents, working experience, levels of education, and name of educational qualification or specialization. The overall technology literacy was obtained by calculating the mean value of all the items using the formula:$mean = q1 + q2 + q3 + q4 + \cdots + qn/n$. The average mean scale used was 4.21-5.0=Strongly Disagree, 3.41-4.20 =Disagree, 2.61-3.40= Neutral 1.81-2.60=Agree, 1.0-1.80=Strongly Agree.

3.3. Population and Sampling

The research was conducted in special or deaf unit primary schools for pupils with hearing impairments in eight regions of Tanzania, including Njombe, Dar es Salaam, Iringa, Ruvuma, Arusha, Kilimanjaro, Dodoma, and Manyara. Convenience sampling was used to sample the teachers engaged in a survey. Due to the limited number of special primary schools in the eight regions, only one primary school was selected from seven regions excluding the Kilimanjaro region. This research involved a total of 121 primary teachers who served in special primary schools with hearing-impaired learners. Table 1 presents the distribution of respondents in the eight regions. These primary schools were selected due to the larger number of learners with hearing impairment in the particular council.

Table 1

Distribution of respondents in eight regions in Tanzania

Region	**Council**	**Number of Teachers**
Kilimanjaro	Moshi Municipal a. School A	9
Kilimanjaro	Mwanga District council b. School B	10
Njombe	Njombe Town Council c. School C	9
Ruvuma	Songea Municipal Council d. School D	10
Dodoma	Dodoma City Council e. School E	15
Iringa	Iringa Municipal Council f. School F	19
Dar es Salaam	Ilala Municipal Council g. School G	20
Manyara	Mbulu District Council h. School H	11
Tabora	Tabora Municipal Council i. School I	18

(Source: author's representation)

3.4. Data Collection and Analysis Method

Data were collected through the use of questionnaires among 121 primary teachers. The design of the questionnaire was based on adopting some constructs and aspects from the UNESCO ICT Competency Framework for Teachers. The data collection was undertaken between March to May 2024.

Data were analyzed through quantitative data analysis where numerical values were assigned to the data for analysis using descriptive and inferential statistics. Descriptive statistics were utilized to determine frequencies, percentages, and measures of central tendency. Additionally, inferential statistics were employed to assess correlations between variables, utilizing the Mann-Whitney U Test (Wilcoxon Rank-Sum Test) and the Kruskal-Wallis Test, conducted using IBM SPSS software version 23 and R studio version R-4.4.0. This analysis aimed to demonstrate teachers' technological literacy in using ICT to enhance numeracy and literacy skills among pupils with hearing impairments.

3.5. Reliability and Validity

The reliability of the research instrument was calculated using Cronbach's alpha. Based on the results from SPSS for the 23-item test, the Cronbach alpha coefficient was 913. Table 2 indicates that the Cronbach alpha value was higher than the recommended value which 0.07, therefore, the research instrument used was reliable. The researcher pre-tested the research instrument with four experts (two from the NM-AIST and two from the University of Dodoma) to ensure its validity. Since the research instrument contained items from previous surveys, the questionnaire as a whole was considered valid.

Table 2

Reliability Statistics

Cronbach's Alpha	Number of Items
.913	23

3.6. Ethical Consideration

A research permit was obtained from the Nelson Mandela African Institution of Science and Technology (NM-AIST). The institutional letter introduced the researcher to The President's Office, Regional Administration, and Local Government (PO-RALG). Study permits were then obtained from the Regional Administrative Secretary (RAS) of eight regions. Permissions were sought from the office of the Executive Director of various councils where the special or deaf unit primary schools are located, followed by the Education Officer of the Department of Primary Education of the councils, who provided a permit to the heads of school to allow the research to be conducted in primary schools.

4. THE RESULTS AND DISCUSSION

4.1. Demography

4.1.1. Respondent's demographic information.

Table 3 shows the respondent's demographic information, where 121 respondents were recruited for this study. The results, as shown in Table 3, indicate that the majority of the respondents were female (57%). Regarding the level of education, most teachers had lower levels of education, diplomas (32.2%) and certificates (25.6%), followed by a bachelor's degree (39.7%), and then a master's degree (2.5%). More than 50% of the respondents were aged less than 40. Moreover, it was found that the majority of the teachers had over 16 years of working experience (26.4%). The results also indicate that most teachers had specialized in special needs education (57%). These findings indicate that almost all the teachers owned an ICT device (95%).

Table 3

Participants' Demographic information

Variable/Category		Frequency (N)	Percentage (%)
Gender of respondents	Male	52	43.0%
	Female	69	57.0%
Age	Below 25	10	8.3%
	25-29	22	18.2%
	30-39	36	29.8%
	40-49	30	24.8%
	50-59	22	18.22%
	60-more	1	0.8%
Level of education	Certificate	31	25.6%
	Diploma	39	32.2%
	Bachelor	48	39.7%
	PGDE	0	0%
	Masters	3	2.5%
Working experience in years	0 to 4	28	23.1%
	4 to 8	26	21.5%
	8-12	18	14.9%
	12-16	17	14.0%
	16-more	32	26.4%
Name of education qualification	Special needs based education	69	57.0%
	Nonspecial need-based education	52	43.0%
ICT own Device	No	5	5%
	Yes	115	95%

(Source: author's representation based on the demography analysis)

4.1.2. Possession of ICT Devices, internet and computer Access

In this study, the possession of individual ICT devices depended on teachers' priorities and personal needs. Table 4 shows various ICT devices that were owned and used by teachers for both school and non-school activities. The results revealed that 1.8% of the respondents owned a normal mobile phone, 28.8% possessed tablets, 90.7% possessed laptops, 5.3% had desktop computers, and 47.3% owned smartphones. This implies that teachers were ready to use such ICT tools in teaching and learning if they were directed on how best to use it.

Table 4

Teacher's possession of ICT devices

		Responses		Percent of Cases
		N	Percent	
Possession of ICT devices	Smartphones	107	47.3%	90.7%
	Laptop	38	16.8%	32.2%
	Desktop computer	12	5.3%	10.2%
	Tablets	65	28.8%	55.1%
	other	4	1.8%	3.4%
Total		226	100.0%	191.5%

(Source: author's representation)

4.1.3. Teachers' Access to Computer and Internet

The majority of teachers (76.2%) had access to the Internet at home, 74% at schools, and 61.4% had access to computers as shown in Table 5. This implies that many teachers were using computers for teaching pupils with hearing impairments. However, most of the schools had fewer than 10 computers in their laboratories which is not enough compared to the number of students at each school (see Table 6). Most teachers accessed the internet using their devices and internet packages.

Table 5

Teachers' access to computers and the Internet

		Responses		Percent of Cases
		N	(%)	
Access to computer and internet	Internet access at home	77	36.0%	76.2%
	Use of computer at school	62	29.0%	61.4%
	Internet access at school	75	35.0%	74.3%

(Source: author's representation)

4.1.4. Availability of Computers at Schools

Table 6 presents the summary statistics for the number of computers present in the selected primary schools is small compared to the total number of students in each school Although the computers at the primary school are not sufficient, most teachers used their own ICT devices to enhance numeracy and literacy skills among pupils with hearing impairments.

Table 6

Number of available computers at the schools

S/N	School	Number of students	Number of computers
1	School A	86	20
2	School B	103	13
3	School C	129	1
4	School D	160	5
5	School E	92	7
6	School F	118	6
7	School G	212	10
8	School H	154	0
9	School I	108	5

(Source: author's representation)

4.1.5. Teachers' ICT Policy Awareness

The findings indicated that most of the teachers were aware of the ICT policy. This implies that the teachers know the government is supporting and emphasizing the use of ICT for teaching and learning due to the availability of the ICT policy. When teachers were asked to rate the level at which the ICT policy originated, over 60% of teachers said it was at the national level (see Figure 2).

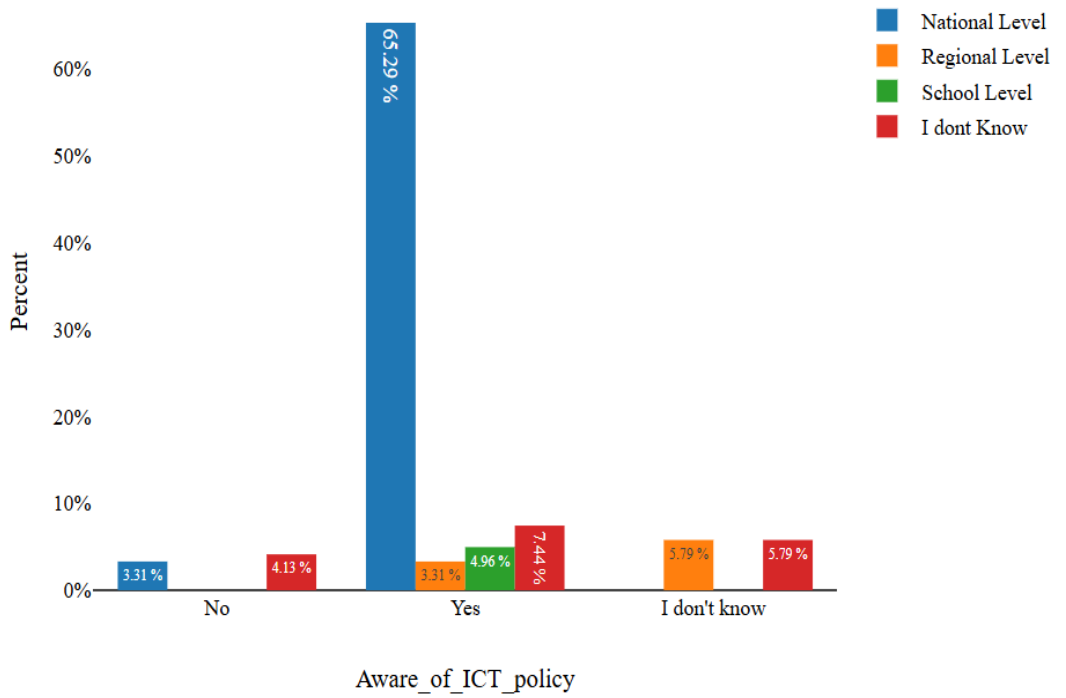


Figure 2: ICT policy awareness

When teachers were asked to rate how they could describe the implementation of the ICT policy, more than half of the participants (55.40%) agreed that they could do so (see Figure 3).

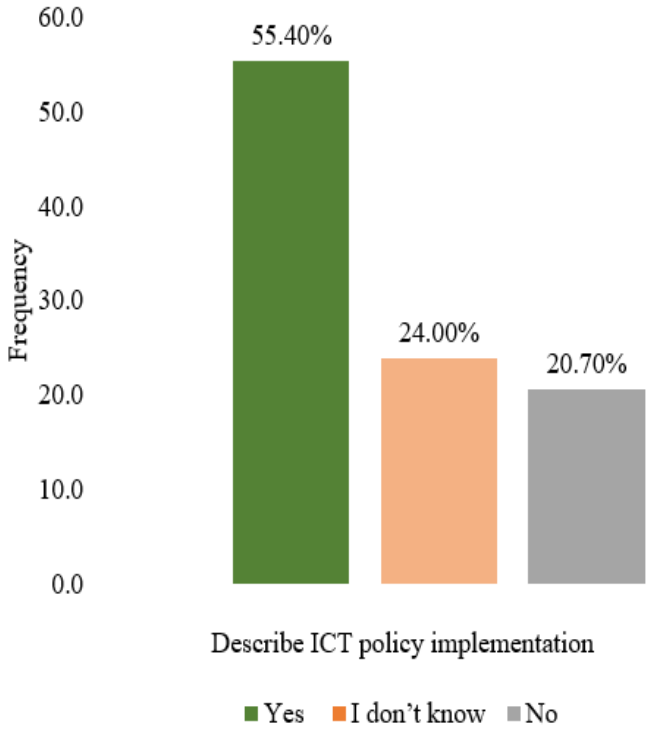


Figure 3. Teacher's ability to describe ICT policy implementation

Moreover, when asked if they could explain the strengths and weaknesses of the ICT policy, 50.40% agreed that they could do so (see Figure 4). The findings indicated that the majority of the teachers were aware of the ICT policy issues.

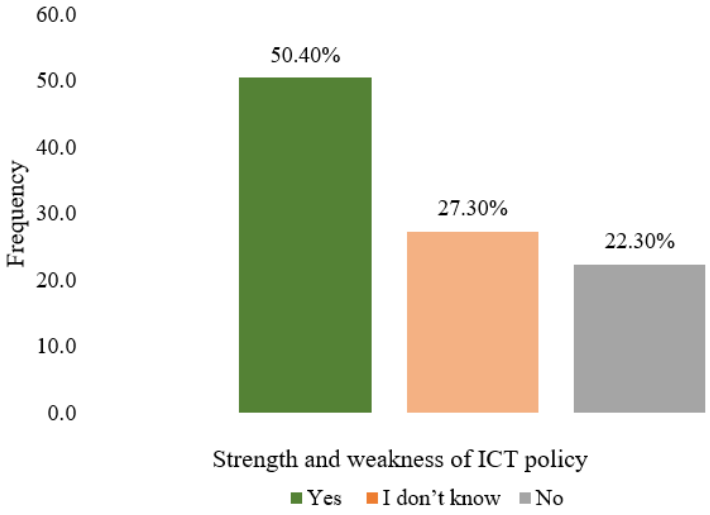


Figure 4. Teachers' ability strengths and weaknesses of the ICT policy

4.2. Teachers' technology literacy among primary teachers

The study examined the technology literacy among primary teachers in enhancing numeracy and literacy skills for pupils with hearing impairments in Tanzania. The purpose was to identify if primary teachers had the technological literacy skills necessary for utilizing various ICT tools in enhancing numeracy and literacy skills for pupils with hearing impairments. The results are shown in Table 7, which presents the teachers' responses on technological literacy among primary teachers towards using ICT to enhance numeracy and literacy skills for pupils with hearing impairments. The table also contains the overall mean score of each domain of technological literacy. The results revealed that the majority of teachers agree (60%) that ICTs can support early grade pupils centred learning, and 55% of the teachers agreed that ICTs provide valuable resources and tools to support early-grade pupils' learning. However, more than 50% disagree that ICTs have a limited capacity to provide benefits in the classroom on the variable understanding of ICTs in education. The mean value of 1.65±0.46 indicates that the teachers had a score below the neutral.

Regarding curriculum and assessment, most respondents agreed (41%) that they can use ICT to assess early grade pupils' acquisition of literacy and numeracy skills. Additionally, 46% of the teachers agreed that they can use ICTs to provide pupils with feedback on their progress using both formative and summative assessments. However, the curriculum and assessment domain had a mean value of 2.53±1.61, indicating that it falls below the neutral value. The majority of the teachers agreed (38%) that they can incorporate appropriate ICT activities into lesson plans to support early-grade pupils' acquisition of literacy and numeracy skills, while more than 50% of the teachers felt confident in using ICTs to master literacy and numeracy skills for early-grade pupils.

The mean value of 2.03±0.79 shows that many respondents scored below the neutral value. Furthermore, the findings also indicated that the majority of the teachers (54%) can describe and demonstrate the use of common hardware technologies. The mean value of 2.25±0.81 in the domain of basic ICT tools shows that, generally, teachers agreed that they can describe various ICT tools.

Furthermore, the findings revealed that more than 40% of the teachers can integrate and manage ongoing teaching activities with the use of a computer, while a larger number of teachers struggle to manage individual variations among early-grade pupils using ICT. The

findings also showed that the mean is 2.81±1.04 indicating that teachers agree that they can use ICT for the organization and administration of the teaching and learning activities. Regarding pedagogy, the findings show that most teachers agree (63%) that they can use ICT resources to support their acquisition of pedagogical knowledge. Additionally, 53% agree that can use ICT to access online courses related to enhancing literacy and numeracy skills for teaching pupils with hearing impairments. The findings also show that the mean of 1.20±0.39 indicates that the teachers agree that they can use ICT resources to support their teaching professional development.

Table 7

Technology literacy towards using ICT in teaching to enhance numeracy and literacy skills for learners with hearing Impairments

Variable	**Strongly agree N (%)**	**Agree N (%)**	**Neutral N (%)**	**Disagree N(%)**	**Strongly disagree (%)**	**Mean ±Std**
Understanding ICTs in education						
Students' use of ICTs can support early grade pupils centered learning	51(42)	60(50)	10(8)	0(0)	0(0)	1.66± 0.63
ICTs provide valuable resources and tools to support early-grade pupils learning.	53(44)	55(46)	11(1)	1(2)	0(0)	1.69±0.71
ICTs can be mainly used for efficient presentations in various learning aspects to early grade pupils	47(39)	52(43)	15(12)	4(3)	0(0)	1.88±0.93
ICTs have a limited capacity to provide benefits in the classroom	24(20)	23(19)	14(12)	43(35)	17(14)	3.05±1.38
Overall Understanding ICTs in education						1.65±0.46
Curriculum and assessment						
I can use ICT to assess early-grade pupils' acquisition of literacy and numeracy skills.	27(22)	50(41)	21(17)	14(12)	9(7)	2.41±1.17
I can help early-grade pupils acquire numeracy and literacy skills through ICT.	20(16)	56(46)	19(16)	16(13)	9(8)	2.55±1.39
I can use ICTs to provide pupils with feedback on their progress using both formative and summative assessments.	18(15)	54(45)	21(17)	21(17)	7(6)	2.55±1.11
I can match specific curriculum standards to particular ICT tools	16(13)	41(28)	23(16)	13(12)	12(10)	2.66±1.66

Overall curriculum and assessment						2.53±1.61
Pedagogy (teaching and learning)						
I can incorporate appropriate ICT activities into lesson plans to support early-grade pupils' acquisition of literacy and numeracy skills.	24(20)	48(38)	26(22)	20(17)	3(3)	2.42±1.06
I can use presentation software and various digital resources to support the learning of literacy and numeracy skills among early-grade pupils.	19(16)	42(35)	29(24)	23(18)	8(7)	2.66±1.15
I can describe how didactic teaching and ICT, can be used to support early grade pupils' acquisition of literacy and numeracy skills.	19(16)	47(39)	26(21)	22(18)	7(6)	2.60±1.13
I can use ICTs to master literacy and numeracy skills for early-grade pupils.	19(16)	55(46)	21(17)	17(14)	9(7)	2.52±1.14
Overall Pedagogy (teaching and learning)						2.03±0.79
Basic ICT Tools						
I can describe and demonstrate the use of common hardware technologies	25(21)	65(54)	18(15)	11(9)	2(1)	2.17±0.92
I can describe and demonstrate the basic tasks and uses of PowerPoint projectors to display content to early-grade pupils.	22(18)	53(44)	30(25)	13(11)	3(2)	2.36±0.98
I can describe the purpose and basic function of graphic software	17(14)	52(43)	33(27)	15(13)	4(3)	2.48±0.99
I can describe the Internet and the World Wide Web, and use a website address (URL) to access a website.	29(24)	53(44)	27(22)	9(7)	3(3)	2.21±0.97
I can use the computer to record grades, maintain early grade pupils' records	37(31)	56(46)	17(14)	7(5)	4(3)	2.05±0.99
Overall basic ICT tools						2.25±0.81
Organization and administration						

I can integrate the use of a computer laboratory into ongoing teaching activities.	16(13)	32(26)	44(37)	23(19)	6(5)	2.76±0.99
I can manage the use of supplemental ICT resources with individuals and small groups of early-grade pupils in the regular classroom so as not to disrupt other instructional activities in the class.	8(6)	45(37)	31(26)	31(26)	6(5)	2.85±1.06
I can use ICT to manage individual variations among early-grade pupils.	10(8)	45(37)	33(27)	22(18)	11(9)	2.81±1.04
Teaching professional development						
I can use ICT resources to enhance my productivity	27(22)	63(52)	25(21)	5(4)	1(1)	2.09±0.81
I can use ICT resources to support my acquisition of pedagogical knowledge.	27(22)	76(63)	13(10)	10(4)	1(1)	1.98±0.74
I can use ICT to access online courses related to literacy and numeracy-enhanced skills	33(27)	64(53)	21(17)	3(3)	0(0)	1.95±0.74
Overall teaching professional development						1.20±0.39

4.3. The effect of gender, Level of education, age, education qualification name, and working experience, towards technology literacy among teachers in enhancing literacy and numeracy skills among pupils with hearing impairments

The study aimed to assess the effect of various demographic factors such as gender, level of education, age, education qualification name, working experience, and technological literacy among primary teachers on ICT usage to enhance literacy and numeracy skills among pupils with hearing impairments. A data normality test was conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests to determine if the data followed a normal distribution.

Due to the large sample size, the Kolmogorov-Smirnov test was used. The results indicated that the p-value was less than 0.05 for all six technology literacy dimensions as shown in Table 3, indicating that the data were not normally distributed. Therefore, non-parametric analysis was used. Both the Man Whitney U test and the Kruskal Walis Test were performed to assess the variables affecting the teachers' technological literacy in using ICT for teaching pupils with hearing impairment.

Table 8

Test of Data Normality

Technology literacy dimensions	Kolmogorov-Smirnov		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
Understanding ICT in education	.130	.000	.952	.000

Curriculum and assessment	.173	.000	.927	.000
Pedagogy	.123	.000	.957	.001
Basic ICT tools	.124	.000	.955	.000
Organization and administration	.107	.002	.967	.004
Teaching professional development	.199	.000	.919	.000

4.3.1. Effect of gender on technology literacy

A Mann-Whitney U Test was conducted to assess whether there was a statistically significant difference between the males and females. The assumption made before the test was that there would be no difference in technological literacy between male and female participants.

The results revealed a statistical difference between male and female participants in terms of technology literacy (Male= 52, Mean Rank=49.29, Female=69, Mean Rank= 69.83), U=1185.000, with a small effect size r=0.29, and p-value =0.001 which is less than 0.05 as shown in Table 9 and Table 10 and Figure 5. This indicates that female participants had higher technology literacy than male participants.

Table 9

Ranks for technology literacy based on gender

	Gender of respondents	N	Mean Rank	Sum of Ranks
Technology literacy	Male	52	49.29	2563.00
	Female	69	69.83	4818.00
	Total	121		

Table 10

Mann-Whitney U test for technology literacy based on gender

	Technology literacy
Mann-Whitney U	1185.000
Wilcoxon W	2563.000
Z	-3.190
Asymp. Sig. (2-tailed)	.001

Also, in Figure 5, there is a clear distribution of the data which shows that the median line of the female teachers is higher than the male teachers, indicating that teachers with female teachers had higher technological literacy than male teachers.

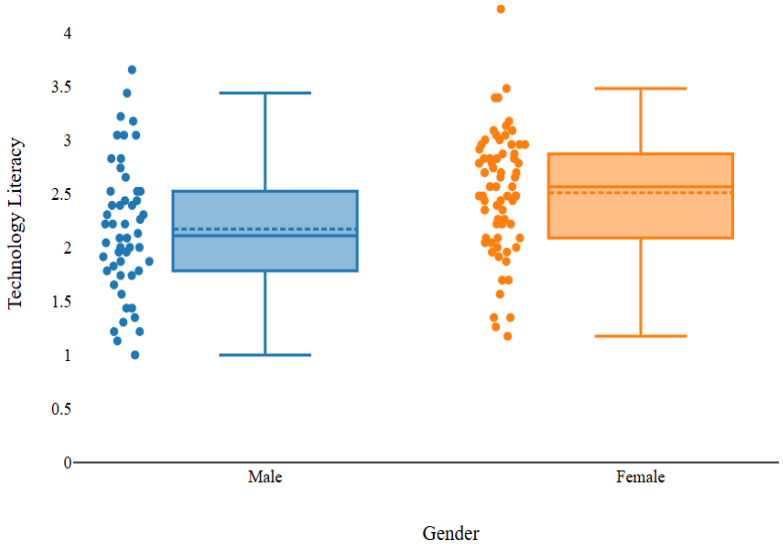


Figure 5. Box plot for technology literacy based on gender

4.3.2. Effect of age on technology literacy

Kruskal Wallis Test was conducted to assess the mean rank difference between age groups and technological literacy. The null hypothesis was that the distribution of technology literacy is the same across categories of age. The results revealed that there was no statistical mean rank difference between age groups, below 25 (Mean Rank =51.55), 25-29 years (Mean Rank=66.43), 30-39 years (Mean Rank=50.83), 40-49 years (Mean Rank=66.68),50-59(Mean Rank 68.77), 60 -more years (Mean Rank=60.50), and p-value=0.292 which is greater than 0.05 as shown in Table 11 and Table 12.

Table 11

Ranks for technology literacy based on age

	Age group	N	Mean Rank
Technology literacy	0-24	10	51.55
	25-29	22	66.43
	30-39	36	50.83
	40-49	30	66.68
	50-59	22	68.77
	60-more	1	60.50
	Total	121	

Table 12

Kruskal Wallis Test for technology literacy based on age

	Technology literacy
Chi-Square	6.152
df	5
Asymp. Sig.	.292

4.3.3. Effect of level of education on technology literacy

The Kruskal-Wallis Test was performed to assess the mean rank difference between various levels of education and technology. The assumption was that the distribution of

technology literacy is the same across categories of level of education as the null hypothesis. The results revealed that there was a statistical mean rank difference between various levels of education, Certificate (N=31, Mean Rank=63.01), Diploma (N=39, Mean Rank =70.92), Bachelor's degree (Mean Rank=53.66), Master's degree (N=3, Mean Rank=27.83), and p-value=0.045 which is less than 0.05 as shown in Table 13 and Table 14 and Figure 6. The teachers with lower education levels were found to have higher technology literacy than those with higher levels of education.

Table 13

Ranks for technology literacy based on educational levels.

	Level of education	N	Mean Rank
Technology literacy	Certificate	31	63.10
	Diploma	39	70.92
	Bachelor's degree	48	53.66
	Master's degree	3	27.83
	Total	121	

Table 14

Kruskal Wallis Test for technology literacy based on the educational levels.

	Technology literacy
Chi-Square	8.026
df	3
Asymp. Sig.	.045

Also, in Figure 6, there is a clear distribution of the data which shows that the median line of the teachers with diploma and certificate qualifications is higher than for other levels of education, indicating that teachers with lower levels of education had higher technological literacy than the higher levels of education.

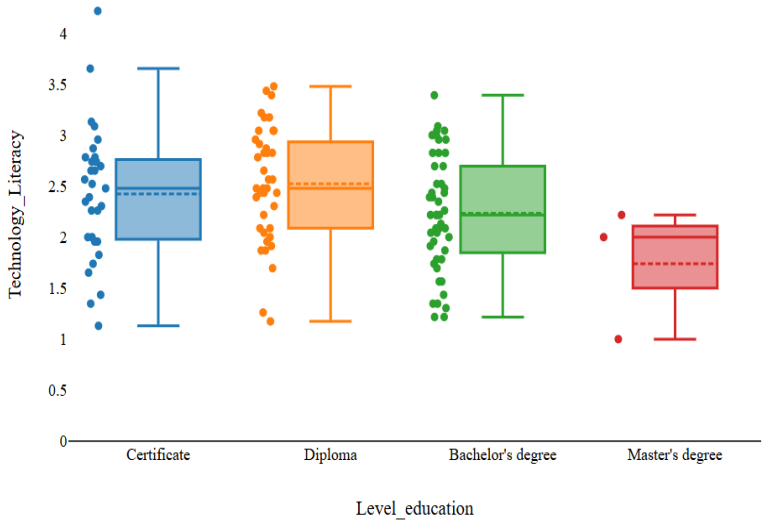


Figure 6. Box plot for technology literacy based on the educational levels

4.3.4. Effect of years of working experience on technology literacy

Kruskal Wallis Test was computed to assess the mean rank difference between years of working experience and technology literacy. The null hypothesis was that the distribution of technology literacy in pedagogy is the same across categories of years of working experience. The results revealed that there was no statistical mean rank difference between working experience, 0-4 years (N=28, Mean Rank =52.82), 4-8 years (Mean Rank=73.02), 8-12 years (Mean Rank = 61.58), 12-16 years (Mean Rank=60.29), 16-more years (Mean Rank=58.44), and p-value=0.313 which is greater than 0.05 as shown in Table 15 and Table 16.

Table 15

Ranks for technology literacy based on the working experience

	Working experience	N	Mean Rank
Technology literacy	0-4	28	52.82
	4-8	26	73.02
	8-12	18	61.58
	12-16	17	60.29
	16-more	32	58.44
	Total	121	

Table 16

Kruskal Wallis Test for technology literacy based on the working experience

	Technology literacy
Chi-Square	4.762
df	4
Asymp. Sig.	.313

4.3.5. Effect of education qualification name on technology literacy

A Mann-Whitney U Test was computed to assess whether there was a statistically difference between teachers with special needs based educational qualifications and non special needs-based education qualifications and technology literacy. Before the test, it was assumed that the distribution of technology literacy is the same across categories of the name of education based qualification which is the null hypothesis. The results revealed that there is a statistical difference between special needs and non special needs based qualifications in terms of technology literacy (Special needs based= 69, Mean Rank=68.93), nonspecial needs based =52, Mean Rank= 55.02), with a small effect size r=0.19 and a p-value =0.031 which is less than 0.05 as shown in Table 17 and Table 18 and Figure 7. This means that teachers with special needs based qualifications had higher technological skills than those teachers with non-special needs based education qualifications.

Table 17

Ranks for technology literacy based on the name of education qualification

	Name of education qualification	N	Mean Rank	Sum of Ranks
Technology literacy	Special needs based education qualification	69	68.93	3796.50
	Nonspecial needs based education qualification	52	55.02	3584.50
	Total	121		

Table 18

Mann Whitney U Test for technology literacy based on the name of education qualification.

	Technology literacy
Mann-Whitney U	1381.500
Wilcoxon W	3796.500
Z	-2.161
Asymp. Sig. (2-tailed)	.031

From the data in Figure 7, there is a clear distribution of the data which shows that the median line of the teachers with special needs based education qualifications is higher than for teachers with non-special needs based education qualifications, indicating that teachers specialized in special needs education have higher technology literacy than those who didn't specialize in special needs education.

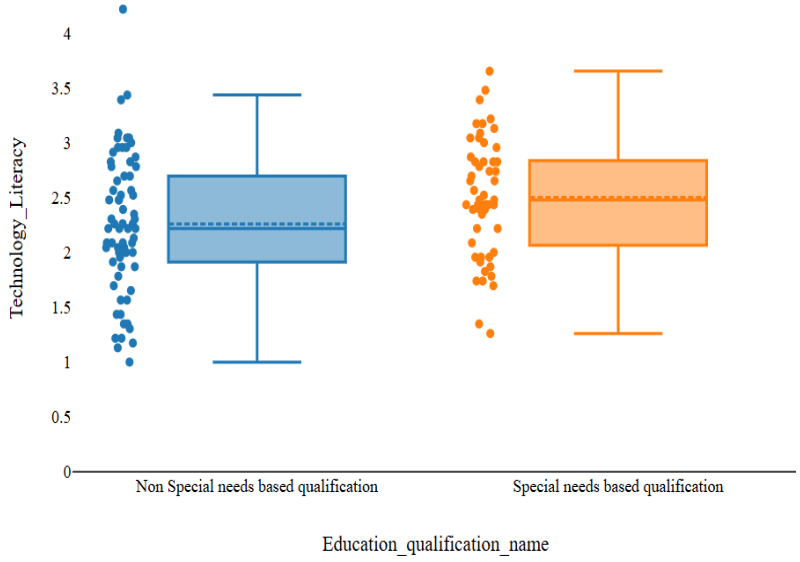


Figure 7. Boxplot for technology literacy based on the name of education qualification

This study aimed to investigate primary teachers' technological literacy and how they apply those skills in enhancing literacy and numeracy skills among pupils with hearing impairment. The study made use of the UNESCO ICT competency framework. The results indicate that teachers had technological literacy skills for all dimensions. This is supported by a study done by Kalinga and Ndibalema [22] who found that the majority of the teachers have higher technological literacy than deepening knowledge and creation knowledge due to insufficient ICT training, and the availability of ICT resources. Moreover, Lubuva *et al* [13] discovered that tutors in teaching colleges were found to have higher technology literacy levels than deepening and creation knowledge levels.

The evidence indicates that technological literacy among teachers is vital in enhancing learners' academic achievement, especially for those with special needs. The availability of ICT resources and easy access influenced teachers' decisions to use multimedia-enhanced content to teach their students in secondary schools [24]. Technological literacy skills are essential for enabling students to access digital content. Teachers with low technological literacy may struggle to access digital resources, limiting their ability to gather relevant and credible

information for their teaching purposes [25]. Also, teachers' technology instructional guides would benefit pupils with disabilities through the use of ICT in the classroom [24].

Along with the results, the study by Ruth [26] found that teachers' use of technology such as games would improve the understanding of hearing-impaired pupils in class and enhance the overall teaching and learning of basic mathematics operations. This is contrary to the research done by kavua [27], who discovered teachers had average self-efficacy in facilitating learning for learners with disabilities in Kenyan and Czech primary schools. Kavua [27] recommended that in-service training programs are necessary for improving teachers' self-efficacy to achieve higher technological literacy.

There was a significant difference in teachers' technological literacy based on education level, gender, and specialization. The present study revealed that gender significantly impacts teachers' technological literacy in using ICT for enhancing literacy and numeracy skills among pupils with hearing impairments. Female teachers were found to have higher technological literacy than male teachers. This is contrary to the study done by Kalinga and Ndibalema [22], Saluky *et al*. [28], Korkmaz and Akçay [17], and Lucas *et al*. [28], which found that male teachers were found to have had higher technological literacy than female teachers.

Indeed, some studies show conflicting results [16], [29], indicating that technology literacy can be influenced by other factors such as access to technology and teachers' attitudes toward technology. Furthermore, the study by Mtebe and Raphael [30] found no significant differences for all technological pedagogical content knowledge in terms of gender. The results are somewhat similar to those of Konan [27], who found a statistical difference between female and male teachers. This difference may be due to the availability of many ICT programs in the country such as Girls in ICT, and Women in Tech, that support more women than men.

According to the results of the analysis carried out to determine whether the technological literacy levels of the primary school teachers were based on the age variable, no statistically significant difference was found. However, a study by Korkomaz and Akçay [17] showed a significant difference between various demographic information such as age, gender, seniority in the profession, educational status, and technology literacy. The study found that teachers' technological literacy increases when age decreases, meaning teachers with younger ages had more technological literacy than older ones. Kalinga and Ndibalema [22] found that age showed no significant variation among teachers. This indicates both teachers' age and working experience do not affect their technological literacy, whether they are in primary or secondary school.

The current research found a significant difference between levels of education and teachers' technological literacy in enhancing the literacy and numeracy skills among learners with hearing impairments. Teachers who had lower levels of education had higher technology literacy than those with higher levels of education. Also, Konan [14] observed a statistical difference between teachers with high and low education levels. Also, the study by Kalinga and Ndibalema [22] discovered a significant difference between secondary teachers' level of education and the technological competencies they hold, however, the age and working experience showed no significant variation among them. Diplomas and certificate curricula in the country emphasize more on practical skills over higher program qualifications. Zhang [16] found similar results by observing no significant difference between technological literacy and the working experience.

Also, the findings revealed teachers who specialized in special needs education had higher technology literacy than those who didn't specialize in special needs education. This is due to the fact, that those specialized in special needs received more specific training on integrating ICT into their teaching practices which enabled them to handle the diverse needs of the learners with hearing impairments. This also indicates that these primary teachers have an awareness of the importance of using ICT in supporting pupils with hearing impairments.

4.6. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The findings draw attention to the government regarding technology literacy among primary teachers. For teachers' technological literacy to reach a fully adequate level, comprehensive training programs specifically tailored for integrating ICT in teaching pupils with hearing impairments are needed. Since the study found that teachers lack skills in using ICT to manage individual variations among the students, a more personalized and adaptive learning system would help overcome these challenges. However, teachers' ICT literacy is essential to effectively utilize such a system. The number of specialized ICT facilities was found to be insufficient in almost all primary schools, Therefore, the Ministry of Education, Science, and Technology, and the PO-RALG should ensure an adequate supply of computers and prioritize schools with a large number of hearing-impaired pupils. Equal access to training should be provided to both male and female teachers to eliminate the disparities. Future research should focus on exploring the specific challenges and barriers to ICT integration in special needs education and developing targeted interventions to address these issues as well as designing a more personalized system to enhance literacy and numeracy skills among the pupils with hearing impairments in Tanzania.

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ТЕХНОЛОГІЧНА ГРАМОТНІСТЬ УЧИТЕЛІВ ПОЧАТКОВОЇ ШКОЛИ ДЛЯ ПІДВИЩЕННЯ НАВИЧОК РАХУВАННЯ ТА ПИСЬМА УЧНІВ МОЛОДШИХ КЛАСІВ З ПОРУШЕННЯМИ СЛУХУ В ТАНЗАНІЇ

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Анотація. Інформаційно-комунікаційні технології (ІКТ) суттєво змінили освітній ландшафт і надають значні переваги для учнів з особливими потребами, зокрема з порушеннями слуху. Основна мета цього дослідження полягає у визначенні рівня технологічної грамотності вчителів початкових класів з використання ІКТ для підтримки навичок письма та математики в учнів з порушеннями слуху та порівняльному аналізі на основі демографічної інформації. Було використано підхід кількісного аналізу. У дослідженні взяли участь учителі початкової школи для глухих у кількості 121 особи, які заповнили анкету самооцінки на основі Шкали оцінювання технологічної грамотності, розробленої ЮНЕСКО. Для порівняння технологічної грамотності вчителів з використанням ІКТ були використані середні бали, U-критерій Манна-Уітні та критерій Крускала-Уоллі. Результати показали, що демографічні дані вчителів суттєво пов’язані з технологічною грамотністю на рівні p=0,05. Крім цього, учителі-жінки мають вищий рівень технологічної грамотності, ніж учителі-чоловіки. Також було виявлено, що вчителі з нижчим рівнем освіти мають вищий рівень технологічної грамотності, ніж учителі з вищим рівнем освіти. Серед характеристик учителів досвід роботи та вік не мали значущої різниці з технологічною грамотністю, оскільки їхні p-значення становили 0,313 та 0,212 відповідно. Цікаво, що вчителі, які спеціалізуються на освіті дітей з особливими потребами, мають вищий рівень технологічної грамотності, ніж ті, хто не спеціалізується на освіті дітей з особливими потребами.

Результати дослідження показали, що рівень технологічної грамотності серед учителів початкових класів, які навчають учнів з порушеннями слуху, є високим, що свідчить про впевненість у базових навичках використання ІКТ для покращення навичок грамотності та математики серед учнів з порушеннями слуху. Однак було виявлено некомпетентність в інтеграції ІКТ в організацію та адміністрування, особливо в управлінні персоналізованим навчанням учнів з порушеннями слуху, враховуючи їх особисті відмінності. Крім цього, навчальні програми та процес оцінювання було визначено балами, які нижче середніх за показниками Рамки ІКТ-компетентності вчителів ЮНЕСКО (ICT-CFT). Ці результати свідчать про те, що адаптивні та персоналізовані системи навчання мають важливе значення, а для ефективного використання в класі необхідна всебічна підготовка з питань інтеграції ІКТ, спеціально адаптована для навчання учнів з порушеннями слуху.

Ключові слова: технологічна грамотність; ІКТ; адаптивне та персоналізоване навчання; навички читання; навички рахування; порушення слуху.