Digital literacy skills of university students with visual impairment: A mixed-methods analysis

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Abstract

Both for new higher education students and especially for individuals with visual impairment (VI), becoming digitally literate is a necessity in order to be able to fully participate in society and to overcome certain educational barriers. This study explores the digital literacy (DL) skills of university students in Turkey with VI, along with the factors that can affect DL levels. A sequential explanatory mixed-methods design was employed. Quantitative data were collected from 60 participants during the first phase of the study through an online survey consisting of demographic questions and the DL Scale. Qualitative data were collected via semi-structured interviews held with eight participants as the second phase. The study found quite high levels for several self-reported technical and cognitive sub-factors of DL skills, and lower levels for the social sub-factor. Comparative analysis revealed no significant difference between gender, level of VI, and type of school. The results showed that daily use of the Internet had a significant positive effect on DL scores, and that there was a negative correlation between DL and age of starting to use technology. The qualitative findings suggested that the participants already possessed basic DL skills such as accessing information and creating files; however, they lacked skills in information management, effective collaboration, communication, and in digital content creation. The study sheds light on factors affecting DL of VI students and discusses implications for both researchers and practitioners.

Keywords Digital literacy · Visually impaired · Higher education · Mixed-methods

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1 Introduction

In today's digital age, dramatic developments have been seen in the variety of hardware and software now available. Improvements seen in recent years in the area of information and communication technology (ICTs) have transformed the way individuals learn, communicate, collaborate, interact, and socialize. In a rapidly changing workplace, as well as in the educational setting, being considered "digitally literate" has become an inevitable priority for the enhancement of knowledge and skills in both the academic and professional setting. Higher education now demands that students communicate and collaborate through using the affordances of ICTs in an effective, appropriate, creative, and ethical way, hence today's university students are required to possess certain digital literacy (DL) skills (Liu et al., 2010; Prior et al., 2016; Radovanović et al., 2015). Thus, DL is presumed to be a fundamental core skill in today's education system (Markless & Streatfield, 2007), since being digitally literate is seen as increasingly able to affect an individual's potential to becoming a competent student (Meyers et al., 2013).

ICT is being termed as the "great equalizer" (Michaels & McDermott, 2003) for individuals with visual impairment (VI) as it has the potential to empower them and to provide them with increased opportunities to access information equivalent to their sighted peers. Thus, possessing the appropriate DL skills is also specifically considered vital for individuals with VI, based on today's digital age and their dependency on technology to minimize the challenges they face due to their loss or partial loss of vision. Especially, having certain DL skills paves the way for assessing their individual needs and overcoming the barriers they may face (Kamali Arslantas et al., 2021; Baker et al., 2019; Bhowmick & Hazarika, 2017; Susanto & Nanda, 2018). In terms of higher education, individuals with VI draw upon the benefits of digital educational materials, which have become more capable of meeting the needs of individuals with VI.

For all of the ICT's pervasiveness, the literature reminds us that problems related to technology and information access for individuals with VI still exist (Akcil, 2018; Hollier, 2007; Subaşıoğlu & Atayurt Fenge, 2019). The literature provides a nuanced picture of the barriers and the problems that individuals with VI face in terms of ICT access and usage; as to their social media skills and preferences, however, the literature lacks detailed and comprehensive information in terms of the DL levels of individuals with VI and the factors affecting those DL levels. In-depth information is therefore needed with regard to the DL levels of individuals with VI. The current study aims to contribute to the literature by providing information about the DL levels of university students in Turkey with VI.

The following research questions were investigated based on the aim of this study:

1. What is the DL level of higher education students with VI?
2. What are the significant factors affecting the DL levels of higher education students with VI?

3. How do higher education students with VI explain their DL experiences, and how do these experiences help to explain their DL level and factors affecting their DL level?

1.1 Conceptual framework: Digital literacy

DL has received considerable worldwide attention of late (Greene et al., 2014; Mohammadyari & Singh, 2015; van Laar et al., 2017), since being digitally literate facilitates learners benefitting from the affordances of today's digital technologies, and thereby able to access educational content in a more efficient and effective way, to deal with the abundance of information now available, and to make best use of e-learning as an educational medium (Mohammadyari & Singh, 2015).

At first, DL was mainly associated with the use of computers (Gilster, 1997); however, over time and with the many technological advancements, DL has since evolved to become a more comprehensive term that is associated with several skills. Concentrating on all aspects of DL, Ng (2012) proposed a framework with three main intersecting dimensions as “technical,” “cognitive,” and “social-emotional.” The technical dimension is associated with technical and operational skills such as the usage of peripheral devices, protecting files, troubleshooting, searching and installing applications, and transferring data. The cognitive dimension relates to the ability to think critically in searching for and evaluating digital information, selecting appropriate software for specific tasks, and in creating products that best demonstrate new understanding. The social-emotional dimension is about using the Internet appropriately for the purposes of socializing, communicating and learning, and for protecting the safety and privacy of the individual. The current study sees DL as comprising the dimensions suggested by Ng (2012).

Numerous studies have been conducted to understand higher education students' skills in a variety of components such as information literacy, communication, collaboration, and digital content creation as being associated with DL (Blayone et al., 2017; Ng, 2012; Pamuk & Peker, 2009). The first finding here is that a digital divide may exist due to a number of factors such as socioeconomic status, cultural capital, and age (Bancroft, 2016; Barlow-Jones & van der Westhuizen, 2011; Sánchez-Caballé et al., 2020). In terms of gender, several studies have reported different findings. Whilst some studies have shown a potential difference between the genders in terms of DL skills, attitudes, ICT perceptions, and preferences (e.g., Aesaert & van Braak, 2015; Cai et al., 2017; Hargittai & Hinnant, 2008), other studies have revealed no significant association between gender and ICT competence (e.g., Claro et al., 2012; Pamuk & Peker, 2009).

The other finding is that digital natives were assumed to possess adequate DL skills (Prensky, 2001). However, the more recent literature indicates that whilst these students may possess the ability to find and access information using digital technology, they may experience problems in critically evaluating the information, in determining what is trustworthy and non-trustworthy data (Gabarda et al., 2017; Jenson, 2004; Manuel, 2002; Nasah et al., 2010; van Deursen & van Diepen, 2013), in digital content creation skills (López-Meneses et al., 2020), and thus lack some of

the required DL skills (Cabezas & Casillas, 2017; Ng, 2012). Hargittai et al. (2010) indicated that college students have high levels of confidence in their search engine choice; however, they do not feel the need to verify the information retrieved from their searches. Additionally, Blayone et al. (2017) reported that students' digital content creation skills were considered as lower intermediate, whilst Margaryan et al. (2011) indicated that the majority of university students preferred activities such as accessing content and using the Internet to communicate, rather than for the purposes of creating digital content.

The next finding of these studies is that higher education students use ICT mostly for communication and collaboration. Higher education students make significant use of social media and text-based communication such as email and messaging (Blayone et al., 2017). Additionally, research has shown that higher education students who balance their time on the Internet and employ a variety of tools, develop broader skills in terms of communication and collaboration (Armellini & De Stefani, 2015; Ellefsen, 2015). The literature has shown that students possess low-level competency in their use of major collaborative working tools (Blayone et al., 2017; Margaryan et al., 2011).

Accordingly, the literature suggests that being born into a digital world does not necessarily guarantee that one will be digitally literate or able to protect themselves from the potential risks. In fact, there may even be a vast difference between what they know about technology and what they are able to do with that technology (Meyers et al., 2013; Ng, 2012).

1.2 Digital literacy of individuals with visual impairment

Several studies have investigated the basic ICT skills and ICT usage of individuals with VI (Haneefa & Syamili, 2014; Şimşek et al., 2010; Soman & Sudhier, 2015; Yılmaz, 2019), their technological needs (Fuglerud, 2011), as well as the challenges they face related to technology access (Thongma-eng, 2015), and the related importance of these technologies (Ashraf et al., 2017; Douglas, 2001; Kumar & Sanaman, 2013; Okonji et al., 2020). These studies have revealed that individuals with VI can perform basic computer skills such as preparing documents, searching for information using the Internet, as well as sending emails and communicating with friends. In their study, Okonji et al. (2020) suggested that the sending and reading of emails, online banking, online shopping, and seeking online health information are considered the most important as well as the most difficult online activities for adults with VI to perform.

Few studies have examined the DL skills of individuals with VI (except for Akcil, 2018; Ratano, 2018), and especially within the higher education context. Similarly, several studies have highlighted that individuals with VI use social media for communication and may join certain online communities (Ratano, 2018; Thongma-eng, 2015; Yılmaz, 2019). Additionally, some research has implied that digital technologies can increase the performance of individuals with VI (Akcil, 2018; Kamali Arslantas et al., 2021), as well as to increase their participation in education (Douglas, 2001). The existing studies explain the DL skills of those with VI based on a specific focus, such as their social media usage or mobile technology familiarity;

however, they do not provide comprehensive insights about the DL levels, nor the associating factors. In his study, Akcil (2018) implemented mobile learning technologies and examined the specific skills required for adults with VI in using these technologies. That study identified technological incapacity, lack of DL skills, and not using mobile learning environments as the main problems in learning. Furthermore, it was also revealed that individuals with VI do not possess all the skills required to be considered digital citizens in today's world. In the dissertation study of Ratano (2018), the DL skills of young people with VI were investigated in terms of their social media usage. Ratano (2018) found that types of VI, starting session, and duration of social media usage were found to be correlated with DL skills. Students with VI were reported as being able to search for relative information; however, they were not willing to check for the accuracy of the information retrieved in social media. Also, it was indicated that different types of VI (i.e., low vision and blindness) had different levels of DL in social media usage in statistical terms and that those with blindness scored higher than those with low vision. As a result, it was suggested that DL would help to reduce the potential risks or problems that might otherwise occur. In another study, Yılmaz (2019) investigated the Internet and social media usage of individuals with VI and found that social media usage frequencies, goals, and information sharing to be similar between individuals who were sighted and those who were with VI.

Considering these studies, it could be said that limited research-based information exists regarding the DL levels of individuals with VI. Therefore, the DL skills of those with VI still remain unclear. Similarly, studies showing the factors that affect DL levels of VI are quite limited in number. Thus, the current study investigated several factors that may affect the DL skills of students with VI. Previous literature in the context of VI have suggested a potential correlation between types of VI and the duration of social media usage (Ratano, 2018). The researchers in the current study therefore investigated the correlation of visual loss level and daily Internet use with DL in order to provide further information to support the current literature limitation. Additionally, despite the literature revealing a correlation between gender and DL skills among sighted students, the literature lacks information in the VI context; hence, gender was also included as a variable in the current study. Despite the current literature lacking information about the initial Internet usage and its effect on DL, the researchers investigated the age of starting to use technology as a variable in the VI context. Students with VI may require more experience in technology usage from an early age due to vision loss potentially affecting their DL skills. Finally, school type was also included as a variable since students with VI in Turkey continue their education at one of three school types; schools for the VI, inclusive classrooms, or regular schools with separate classrooms (Tuncer, 2013). Thus, the researchers were interested in understanding whether or not the school type is a factor that might affect DL levels of the VI. The limited research that has been conducted amongst individuals with VI has directed researchers to explore certain concerns about their DL skills. This is considered to be a significant gap, as a lack of consideration for individuals with VI in understanding their DL skills prevents researchers from seeing the bigger picture in terms of inclusive higher education for all.

2 Methodology

This two-phase study employed a mixed-methods research design, which is a methodology that involves collecting and analyzing both quantitative and qualitative data in order to obtain a broader and more in-depth understanding of the investigated phenomenon (Creswell & Plano Clark, 2007). Based on the data collection order and the aim of collecting both qualitative and quantitative data, the current study was formed according to the sequential explanatory mixed-methods design.

During the first phase of the study, an online survey was utilized to collect quantitative data related to the DL skills of students with VI. In the second phase of the study, semi-structured interviews were conducted with a group of participants to aid interpretation of the first phase's results and to create a better understanding of the investigated phenomenon.

2.1 Participants

The participants of this study were higher education students with VI enrolled in undergraduate programs at a university in Turkey. For the first phase of the study, the participants were selected based on convenience sampling (Creswell, 2012). Although participants selected with this sampling method do not represent the population, the method is considered appropriate when it is not possible for researchers to apply either random or systematic non-random sampling methods (Fraenkel et al., 2012). As the current study does not intend to generalize the findings to the population and random sampling was not possible in the context of the study, convenience sampling was employed. In order to find a suitably wide range of participants, an online survey link, along with detailed information about the study, was shared with each university's disability support office, disability associations, as well as certain online disability groups. At the end of the prescribed 4-week data collection period, a total of 60 participants had completed the online survey. The demographic details of the participants are presented in Table 1.

The participant sample consisted of 39 (65%) male and 21 (35%) female students. Even though the ratio of male to female participants seems unbalanced, it is in line with the ratio of the total number of male ($n = 6126$) and female ($n = 2609$) undergraduate students in Turkey with VI (Yükseköğretim Kurulu [Turkish Council of Higher Education], 2020). The mean age of the students was 24.9 years old, with ages ranging from 17 to 40 years. While 35 (58.3%) of the students were deemed to be totally blind, 25 (41.7%) were partially blind. In terms of the primary and elementary education school type, 29 (48.3%) of the students had been educated in schools for the VI, whilst 25 (41.7%) were educated under the inclusive classroom directive, and six (10.0%) were educated in mainstream schools but in separate classrooms.

For the second phase, the researchers recruited volunteers from the study to participate in the interviews. The participants were contacted via email and

Table 1 Demographics

Characteristic	<i>n</i>	%
Gender		
Male	39	65.0
Female	21	35.0
Age (years)		
19 or below	3	5.0
20–24	36	60.0
25–29	9	15.0
30 or above	12	20.0
Blindness category		
Totally blind	35	58.3
Partially blind	25	41.7
School type		
School for the VI	29	48.3
Regular school with mixed (inclusive) classrooms	25	41.7
Regular school with separate classroom	6	10.0

volunteer participants sought for follow-up telephone interviews. The interview process continued until reaching the point of data saturation from the participants' responses, and this point was reached after a total of eight participant interviews.

2.2 Data collection and analysis

Quantitative data were collected during the first phase of the study through the application of an online survey. Prior to deciding on the format of the survey (online or Braille printed), the researchers consulted with the university's disability support office and with disability associations. Based on their feedback, an online format was opted for, as to administer a survey in Braille-printed format would present difficulties in reaching adequate participant numbers. In addition, it was noted that the majority of VI students regularly use smartphones with voice-over functionality and are also familiar with the usage of online forms. In order to provide accessibility-related support, the contact information of the corresponding disability support office and disability organization was shared with the participants along with the online survey.

The online survey consisted of demographic questions (e.g., gender, age, vision loss level, major) and the Digital Literacy Scale (DLS) as developed by Ng (2012). The original DLS had 17 items presented as a 5-point, Likert-type scale. It was then adapted to the Turkish context by Hamutoğlu et al. (2017), and its revised factor structure and internal consistency were checked by the researchers. The revised Turkish version had four sub-factors; "attitude," "technical," "cognitive," and "social." Furthermore, the Cronbach Alpha correlation coefficients for the overall

revised scale's reliability were reported as .93, with sub-factors as .88 for the attitude dimension; .89 for the technical dimension, .70 for the cognitive dimension, and .72 for the social dimension.

In order to investigate the second research question, a series of independent-samples t-tests and one-way analysis of variance (ANOVA) were conducted. For all tests, normality and homogeneity of variance assumptions were checked and no violations were observed. "Gender," "School type," and "Daily Internet use" were selected as the independent variables, whilst "Digital literacy score" (mean total score of attitude, technical, cognitive, and social dimensions) was selected as the dependent variable.

Multiple regression analysis was conducted in order to test whether or not the students' vision loss level and age of starting to use technology predicted their DL level. Prior to testing the regression models, preliminary analysis and assumption checking were conducted. Homoscedasticity, normality, multicollinearity, and independence of errors assumptions were each checked and, after ensuring that there were no violations for testing the multiple regression models, the results were subsequently interpreted.

After completing the quantitative data collection, semi-structured interviews were held with eight of the students. A semi-structured interview form that consisted of eight open-ended questions was prepared based on the available DL literature. The prepared interview questions each related to the students' educational background and current practice of using digital technologies such as technical, communication, collaboration, and information access. The interviews were each conducted over the telephone rather than face-to-face due to physical distancing restrictions in place associated with the COVID-19 pandemic at the time of conducting the second phase of the study. The telephone interviews were audio-recorded and subsequently transcribed verbatim.

As the first step of the qualitative data analysis, the interview transcripts were each coded by the researchers. Then, the identified codes were organized and categorized systematically, which led to the formation of the themes. In order to ensure reliability, coding data was performed independently by two researchers, and then the results were compared. Differences that were found to exist between the researchers' codes and themes were discussed until a consensus was reached (Miles et al., 2014).

3 Results

3.1 What is the DL level of higher education students with VI?

Table 2 reports the mean and standard deviation values of the overall DL score and its four sub-factors. The results for the technical, attitude, and cognitive sub-factors of DL were found to be quite high, with very close values for both mean and standard deviation. On the other hand, the social sub-factor showed lower mean yet higher standard deviation values compared to the three other sub-factors. All factors' mean

Table 2 Descriptive Statistics for Digital Literacy Scale

Sub-factor	M	SD
Technical	3.99	0.74
Attitude	4.00	0.63
Cognitive	4.01	0.76
Social	3.56	1.09
Total	3.95	0.65

Table 3 Frequency of technological device used

Device	Frequency
Smartphone	58
Laptop computer	53
Flash drive	48
Desktop computer	24
Tablet computer	14
MP3 player	14
E-book reader	7
Games console	3

scores were observed to be above the midpoint of 3 (for each item, the minimum score was 1 and the maximum was 5).

The frequencies of the participants' use of technological devices are presented in Table 3. The results show that the most used devices are smartphones, laptop computers, and flash (USB) drives, while the least used devices are tablet computers, MP3 players, e-book readers, and games consoles.

3.2 What are the factors affecting DL levels of higher education students with VI?

3.2.1 Comparative analysis

The results revealed no significant gender-based difference between the male ($M=4.04$, $SD=0.65$) and female ($M=3.79$, $SD=0.64$) students on their DL scores ($t(58)=1.45$, $p>.05$). Another grouped variable was the type of education that the student had received prior to attending university. One-way ANOVA results revealed no statistically significant differences between the DL mean scores ($F(2, 57)=.86$, $p>.05$) of schools for the VI ($M=3.85$, $SD=0.67$), inclusive classrooms ($M=4.08$, $SD=0.61$), and regular school with separate classrooms ($M=3.93$, $SD=0.65$). Finally, the results showed that daily use of the Internet did have a significant effect on the DL scores ($F(3, 56)=6.54$, $p<.005$). Post-hoc Tukey's HSD tests further revealed that there was a significant difference only between students using the Internet for 1 h or less ($M=3.26$, $SD=.56$) and the other groups; 2–3 h ($M=3.92$, $SD=0.65$), 4–5 h ($M=3.97$, $SD=0.45$), and 6 h or more ($M=4.40$, $SD=0.53$).

Table 4 Mean, standard deviation and intercorrelations of the variables

Variable	<i>M</i>	<i>SD</i>	1	2	3
1. Digital literacy	3.95	0.65	–	.07	–.38*
2. Vision loss level	86.25	14.34		–	.15
3. Age of starting to use technology	13.97	3.99			–

* $p < .05$

3.2.2 Regression analyses

The correlation matrix (see Table 4) results show that the only significant correlation between the variables was a negative correlation between DL and the age of starting to use technology.

A multiple linear regression analysis was conducted in order to predict the participants' DL based on vision loss level and age of starting to use technology. The regression results (see Table 5) indicated a significant prediction model ($F(2, 57) = 5.46, p < .01$), which explained 16% of the total variance. Model coefficient results revealed that while age of starting to use technology had a significant partial effect ($\beta = -.40, t = -3.26, p < .01$) and was able to predict 16% of the total model variance, vision loss level was not found to be a significant predictor in the model.

3.3 How do higher education students in Turkey with VI describe their DL experiences, and what are those experiences?

Analysis of the semi-structured interviews revealed findings under six major themes. Table 6 presents the themes and the categories.

3.3.1 Background of DL education

The background to DL education is described based on the education of the participants, training, and certification, expert help, and according to their individual efforts.

All of the participants expressed that the DL education they received from primary school through to higher education was ineffective for students with VI. The most noted reason was that teachers lacked sufficient knowledge about their special

Table 5 Summary of multiple regression analysis

Variable	<i>B</i>	<i>SE B</i>	β	<i>t</i>	<i>sr</i> ²	ΔR^2	ΔF
Model 1						.16	5.46*
1. Vision loss level	.01	.01	.13	1.03	.02		
2. Age started using the Internet	–.07	.02	–.40	–3.26	.16*		

* $p < .01$

Table 6 Themes and categories

Background of DL education	Education in school Training and certification Expert help Individual effort
ICT knowledge and usage	–
Communication	Social media E-mail Video communication
Collaboration	–
Information management	Access Organization Evaluation
Professional development	–

needs in terms of accessibility, specialized software, and technical tools. In addition, those students who received education within the inclusive classroom arrangement expressed having inadequate opportunity to practice in computer lessons, but that most of the time they were ignored due to overcrowded classrooms. The majority of the participants suggested that DL courses needed updating to specifically include the special needs of students with disabilities.

Participants with a higher DL level had received additional training and certification outside of the school system and expressed that such courses had contributed significantly to their development. These training and certification programs were provided by non-profit disability-focused organizations and institutions in which they were taught basic computer skills, Internet usage, office software, and accessibility software such as voice-over and dictation software. Half of the participants noted that they had improved their DL skills with individual effort such as searching online themselves for accessibility software. The participants’ individual effort was considered valuable in order to be able to follow the latest technological developments and for the adoption of new tools.

3.3.2 ICT knowledge and usage

ICT knowledge and usage was a theme that emerged based on the technical knowledge regarding technological devices and software used for performing specific tasks such as text editing, browsing the Internet, file management, installing software, and the use of Web 2.0 tools.

The participants mainly used smartphones in their daily activities, whilst desktop and laptop computers were only used for the purposes of homework. The findings showed that a significant gap existed between smartphone usage ability and desktop and laptop usage ability. While all of the students expressed feeling competent and confident in using their smartphones, only two held similar levels of confidence in their skills of using a desktop and/or laptop computer. As stated by the participants, the main reasons behind this gap were seen as mobility, quality of voice-over functionality, voice-recognition, navigation, and keyboard usage. Finally, the participants noted the quality and usability differences between the two major mobile operating

systems, with Apple's iOS system preferred by all of the participants over Android due to its voice-over quality and usability.

Most of the participants professed to possessing basic computer skills such as navigation as well as file and folder management. However, only two of them professed to have knowledge and experience of installing programs, whilst all of the others had requested help in such operations. Another interesting contrast was between the participants' ability to use office software; while most mentioned having basic skills of text editing, only two had basic skills of using any spreadsheet software, and none had knowledge of or experience in using presentation software. In addition, the participants' text-editing skills were limited to basic editing operations and file saving; however, they did not possess skills regarding the formatting of text or arranging page layout.

While the participants did not mention having issues with browsing the Internet or performing common browser-based tasks, they mostly do not check the accuracy of the information they search. Furthermore, the majority of the participants mentioned problems using Web 2.0 tools, particularly in that the interactivity features of such tools caused them issues with accessibility and thereby made them difficult to use.

The participants highlighted that, despite recent technological improvements, they still faced challenges in ICT usage which affects their DL skills. The most cited challenge was regarding software accessibility issues. Second, even though the participants appreciated the improvements seen in voice-over tools, limitations of image recognition software and the quality of voice-over apps were considered as another major challenge for VI users. As the participants emphasized, accessibility issues challenge and prevent them, especially in areas such as digital content creation. They indicated they can perform the basic skills; however, the one thing that could help them move one step further on is overcoming accessibility issues.

3.3.3 Communication

All of the participants stated that social media platforms were their primary communication channel. These platforms were said to be extensively used by students to communicate with their peers and for the sharing of information. One of the students said that communicating using social media decreased dependency on others, and enabled help to be found more quickly and frequently. Similar to social media, email was also reportedly used by all of the participants, and mostly for homework and for sharing files. While two of the participants with high-level DL had some previous experience of using video-based communication tools, the other participants did not. Participants with low-level DL preferred text-based and voice-only means of communication via instant messaging apps or social media apps.

Although the participants actively used ICT for the purposes of communication, some challenges were noted. First, some of the students had concerns regarding miscommunication due to issues with dictation apps and image-based content. For instance, one of the students expressed feeling isolated when certain images were shared in chat groups, having not understood the content of the image and had not felt comfortable asking about it due to anxiety of potentially

being judged or ignored. Similarly, photo-based social media platforms were not used by some of the students due to similar concerns, even though there have been some improvements introduced regarding image auto-caption features.

3.3.4 Collaboration

The participants' use of ICT tools for collaboration was very limited. Although some of them were aware of the existence of such tools, none had any previous experience of collaborating with others within an online environment. Furthermore, two of the participants noted that due to the highly interactive and complex nature of online collaboration tools, they were unable to make use of them.

3.3.5 Information management

Most of the participants had some knowledge and experience accessing information online from sources such as online libraries, news websites, Wikipedia, and online forums. Participants were able to search for and locate specific information according to their requirements.

There was a contrast found to exist between digitally competent and non-competent participants in terms of their information organization. While those who were digitally competent were able to use various software and tools such as note-taking apps and cloud storage services to organize the information they held on desktop computers and smartphones, those considered as non-competent were only able to utilize the basic features of their computers such as creating folders, and copying, deleting, and moving files.

The majority of the participants experienced challenges in terms of information evaluation. Evaluating the reliability of resources and extracting the pertinent information was considered as a major challenge, and in which the participants requested help from others for such tasks.

3.3.6 Professional development

All of the participants found DL to be a requirement for today's professional work environment, and that they considered it to be a significant factor in their professional development. For instance, one of the participants, who was studying to be a teacher, underlined the need for DL skills, otherwise, his future students could make fun at his expense or see him as incompetent. Also, the participants noted that DL and computer skills could open up new opportunities for them, as they would be more easily able to tackle computer-based tasks even though they experienced certain difficulties with some physical tasks. One of the participants shared having plans for learning programming languages in order to work as a programmer; a profession that could be achieved working remotely from home.

4 Discussion

Many studies in the literature have shown that DL is a key component for educational success in the current higher education context (Meyers et al., 2013; Prior et al., 2016; Radovanović et al., 2015), which is considerably intensified for individuals with VI, due to their dependency on technology for accessing content (Kamali Arslantas et al., 2021; Baker et al., 2019; Bhowmick & Hazarika, 2017; Susanto & Nanda, 2018). The current study contributes to the current small body of literature in terms of providing information about the DL level of students with VI, along with factors affecting their DL level.

The descriptive results of the current study revealed quite a high level of overall DL, which is similar to the findings of other studies published in the literature for sighted students (Ng, 2012; Üstündağ et al., 2017). When examining the current study's results according to the sub-factors of DL, the students achieved quite high scores for the technical, cognitive, and attitude dimensions, whilst the social dimension was found to be lower.

Factors affecting the DL levels of the participants were determined according to an investigation of the current literature. Gender, school type attended prior to university, daily Internet usage, level of vision impairment, and age when starting to use technology were the variables analyzed in the study. The results revealed no gender-based difference of the participants' DL levels between the male and female students. There was no common consensus regarding these variables according to the literature, with some studies having found a difference between males and females (e.g., Aesaert & van Braak, 2015; Cai et al., 2017; Hargittai & Hinnant, 2008), whilst others reported no significant association established between gender and DL levels (e.g., Claro et al., 2012; Pamuk & Peker, 2009). Furthermore, it could be hypothesized that the type of school attended prior to university might be a differentiating factor for DL level, with schools specialized for students with VI performing more effectively in the area of digital skills. However, no difference was found between the three school types. The third comparative aspect was the participants' daily use of the Internet, which was found to be a significant factor. This finding corroborates the literature, showing that higher education students who spend a reasonable amount of time using the Internet and a variety of tools develop more digital skills (Armellini & De Stefani, 2015; Ellefsen, 2015; Ratano, 2018).

The regression results showed that vision loss level was not a predictor of DL level. This might be due to both students with total blindness and students partially blind using the same accessibility tools and their having similar patterns of technology use. Furthermore, it can be asserted that partial vision does not provide an advantage over those with total blindness in terms of their DL skills. However, this finding does not corroborate with the results of a study by Ratano (2018), who found that students with blindness held higher DL scores when compared to those with low vision. This contradictory result may be due to the participants of the current study; as most of the low-vision participants' vision-loss level was quite high.

The second finding of regression analysis was that the age of starting to use technology was a significant predictor of DL level. In other words, the younger

that students with VI first encounter technology, the higher the level of DL they develop. This result can be further explained through the qualitative results, as students who have access to technological devices such as smartphones and laptop computers at an early age have the greater opportunity to practice and learn. Furthermore, early-age technology usage promotes students' confidence in using digital devices; thereby developing improved speed and accuracy of usage (Jara et al., 2015).

In order to better understand the findings of the study's quantitative phase, qualitative data were collected in the second phase. First, although the participants' self-perception of their DL level was found to be high, the qualitative finding revealed the students to be competent only in basic skills such as searching for information, communicating using instant messaging apps, and in the use of social media. Furthermore, whilst they were able to use smartphones efficiently, some were not competent in the effective use of desktop or laptop computers due to usability issues and the quality of available voice-over software. These findings imply that, when individuals with VI have the opportunity to access technology, their vision impairment does not prevent them from acquiring DL skills.

When it comes to the gender differential and time spent online, the qualitative results supported the quantitative findings of the study. Results from the semi-structured interviews showed that both male and female students with VI showed similar technology usage patterns and no gender-related theme emerged from the data. Similarly, the significant difference for time spent online was found to be in line with the semi-structured interview results; with students who spent more time online found to hold a greater interest in technology, and were motivated to perform individually in learning about digital tools, enrolling in training programs offered by non-profit organizations, and in seeking out expert support.

The study's quantitative results revealed no difference in terms of the school type that the students with VI had attended. This result may be better understood through examination of the qualitative results, in which the students expressed that teachers in all three school types did not have adequate access to sufficient pedagogical and technical support to effectively teach their IV students computer skills. The participants reported that the teachers possessed inadequate knowledge regarding accessibility tools, and that as students they were afforded insufficient opportunity to practice their learned skills in computer labs. This result demonstrates that teacher-education programs at universities and teacher-training colleges should include specific training for the teaching of students with VI, and that preservice teachers need to be better equipped with the required pedagogical and technical knowledge (Bausch & Hasselbring, 2004; Edyburn, 2004). The latest literature also supports this, despite increases seen in the area of inclusion practices, teachers still face issues in meeting the individualized educational needs of students with VI (Moberg et al., 2020; Okoye & Adirika, 2019), since teachers do not receive adequate training or follow-up support with regard to technology usage for students with VI (Nam et al., 2013; Opie, 2018).

Qualitative data related to the ICT knowledge patterns of the participants showed that students with VI were much more competent and confident in using smartphones when compared to their usage of laptops and/or desktop computers; with

the obvious reason being that mobility is the key imperative. In addition, integrated voice-over features of smartphones, the quality of voice-over and voice-recognition software, and issues with usability, simplicity, and navigation were all factors affecting their skills as users of digital devices. The students experienced issues with installing software, including voice-over software, on both laptop and desktop computers, which led to a lesser level of usage of these tools. Moreover, they noted that they experience problems in critically evaluating the information (Gabarda et al., 2017) as they do not find it necessary to check the accuracy of the information. This issue is also a common problem among sighted higher education students who experience problems in critically evaluating information (Claro et al., 2012; Gabarda et al., 2017). Due to accessibility problems, they lack the skills to create digital content, especially using the affordances of emerging interactive technologies, which also corroborates the findings of Blayone et al. (2017). However, this problem is also seen among sighted higher education students who do not engage as actively with content creation; for example, the creating of websites (López-Meneses et al., 2020).

The communication patterns of students with VI in using digital devices highlighted the importance of social media and instant messaging apps. These platforms were seen as crucial both for them to communicate and also as a means to requesting assistance which was also supported in the literature (Ratano, 2018; Thongma-eng, 2015; Yılmaz, 2019). Email, however, was mostly used for educational purposes, and especially for submitting homework assignments. On the other hand, communicating over video-based tools was considered challenging, and that the students with VI were unable to use them effectively. It is also important to note some of the challenges faced by students with VI when communicating digitally. Concerns over miscommunication and the widespread usage of image-only content could result in students with VI feeling isolated from an inclusive online communication experience, especially within the group environment. Finally, the participant students did not possess knowledge or experience related to the use of ICTs for the purposes of collaboration. The main reason put forward was that online collaboration tools, such as Web 2.0 tools, were considered too complex for them to be operated by users with VI. Studies conducted with sighted higher education students have also shown that they experienced problems with mastering digital collaborative working skills (López-Meneses et al., 2020; Margaryan et al., 2011). However, should students with VI have the ability to collaborate with others using the affordances of today's digital technologies, they could be better armed to address their social needs (Salas et al., 2002).

5 Conclusion

The current study presents one of the first attempts to investigate the DL levels of students with VI, along with the factors that may affect their DL level. The study's findings showed that students with VI possess certain DL skills, and also that their vision loss is not considered a barrier for them. The findings also revealed daily Internet usage as being a significant factor. Considering the Internet includes

numerous resources for academic and personal development, students with VI who spent quality time using the Internet understandably showed higher degrees of DL. The current study also revealed the age of starting to use technology as another significant factor. Due to their vision loss, students need to practice with technology from an early age in order to improve their technology use, both in terms of speed and accuracy. The qualitative analysis showed that, despite showing basic DL skills, students with VI face problems in digital content creation, critical information evaluation, and in working collaboratively. Thus, teachers should aim to provide more support to students with VI in these specific areas. Moreover, the study's findings pointed out that teachers cannot meet the individual needs of students with VI since they often lack the necessary pedagogical knowledge to help educate their students, as well as inadequate knowledge of the necessary accessibility tools.

5.1 Limitations and future research

The current study presents certain limitations. Due to the low number of undergraduate students with VI, data were collected from a relatively small sample size. In addition, collecting quantitative data by way of a self-reported online survey in itself may be perceived as being biased, as students who completed the survey may have had better levels of DL skills, yet others who did not feel as comfortable may not have attempted it. The study's results, therefore, should be interpreted based on these limitations, and that future research could therefore be based upon larger sample size and using an alternative (e.g., Braille printed) medium of data collection.

Further research could also focus on the comparative DL skills of students with VI and their sighted peers in order to reveal similarities and differences between the groups. In addition, studies are needed to develop training programs and tools that help to improve the DL skills of students with VI.

5.2 Implications for practice

The findings of the current study present potentially important implications for researchers, practitioners, and educators alike. One of the significant findings of the study was that teachers in schools possess inadequate technical and pedagogical competencies for the teaching of DL skills to students with VI. Preservice teacher-education programs, therefore, should incorporate specialist training or courses specifically related to accessibility, voice-over software, information management, and collaboration in order to more successfully teach students with VI and thereby meeting their special needs. Another noteworthy finding was that the students with VI were found to be more competent in using their smartphones compared to desktop and/or laptop computers. This indicates that educators should bear this in mind and make course planning decisions accordingly. A third implication is that students with VI do not possess adequate skills for information management and collaboration in a digital environment, which indicates the need for improvements to be introduced in DL education. The study's findings also showed that disability-related organizations, non-profit organizations, as well as online communities, play a crucial role in

the DL development of students with VI; therefore, such organizations should be adequately supported in order that they can provide additional training programs and play a more significant role in the education of students with VI. Finally, students with VI consider DL skills as imperative for their professional development and believe that such skills could potentially open more doors for them and provide more opportunities. If students with VI possess the required DL skills and can therefore use digital technologies more effectively, then they could fulfill more active roles in the workforce and thereby help to eliminate biases against them, such as only being able to perform simple tasks such as answering the telephone.

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Declarations

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare that they have no conflict of interest.

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