Online Learning Accessibility during the COVID-19 Pandemic

Shanna Russ
Department of Information Systems
University of Maryland—Baltimore County
Baltimore, Maryland, USA
sruss1@umbc.edu

Foad Hamidi
Department of Information Systems
University of Maryland—Baltimore County
Baltimore, Maryland, USA
foadhamidi@umbc.edu

ABSTRACT

During the COVID-19 pandemic, many elementary, middle, and high schools made an emergency transition to online learning. Students have faced numerous access issues during this time, but little is known about how well students with disabilities can access online course content. Many teachers are unfamiliar with adapting, developing, and creating accessible online course content and there is scant research on younger students' experiences with accessible online course content and platforms. Previous research, however, provides insights on how to identify and address challenges that students with disabilities face when accessing online learning in institutions of higher education. In this paper, we review and analyze 14 papers published in the past 11 years on e-learning accessibility to translate insights into actionable recommendations to improve the accessibility of platforms at the time of the COVID-19 crisis, as well as future pandemics. Based on the reviewed research, we present several recommendations including building organizational cultures of accessibility with support for educators as accessible content creators and increased awareness of the many types of disabilities that may affect students and how accessible content can prevent increasing opportunity gaps. Although emergency online learning due to the COVID-19 pandemic will likely and hopefully end in the near future, the lessons learned should continue to inform future improvements in accessible education for all learners.

CCS CONCEPTS

• Human-centered computing   • Information Systems • Applied Computing

KEYWORDS

Accessibility, Online Learning, Education, COVID-19

1   Introduction

Distance learning has removed some barriers for some students with disabilities, enabling them to access postsecondary education – first with correspondence courses [3], [31] and then later, with the increased access to the internet, online courses [31]. The availability of online higher education courses has grown significantly, offering traditional students and working adults more flexibility [1]. The COVID-19 pandemic, however, has meant that many elementary, secondary, and postsecondary schools switched to emergency online learning for the first time [14]. Among the many challenges that schools have faced in this transition to online learning is accessibility for students with disabilities and/or their parents or caregivers with disabilities [27].

In the 2018/19 school year, 7.1 million students in the U.S. received special education services under the Individuals with Disabilities Education Act (IDEA), representing 13% of public-school enrollment [11]. Under IDEA, states are required to provide these students with free and appropriate education. Ensuring that these students receive their federally mandated appropriate education, without increasing opportunity gaps, is a major hurdle for states and school districts during emergency virtual learning.

Most research to date in this area has focused on accessibility for postsecondary students. School districts and teachers have been tasked with creating virtual learning lessons without awareness, preparation, or training [14]. Although the pandemic will likely end and students will return to classrooms, this emergency has brought to light the need for teachers, schools, districts, and state education agencies to prepare for emergency virtual learning in the future. Ensuring that those preparations include digital accessibility for students with disabilities will mean that emergency learning will not create barriers to access and further opportunity gaps for students with disabilities.

In this paper, we review 14 papers published in the past decade on e-learning accessibility to identify both lessons learned and future research opportunities in the area of platform accessibility during pandemics. We use both person-first and identity-first language to reflect that many self-advocacy groups have expressed that person-first language alone does not reflect their sense of self while many research professionals still prefer it [29].

2 Background and Motivation

As far back as the 1880s, distance learning offered people with disabilities access to education they may not have otherwise had access to [3]. Today, online learning is widely available in higher education and enrollment rates of students with disabilities have been steadily increasing [26]. Despite this, many students with disabilities in higher education are disadvantaged by difficulties with accessing accessible course materials [9], [26]. Studies examining the barriers that disabled students face in accessing online education have largely focused on students with learning disorders such as dyslexia [15], [24], [33]. However, students have varied types of disabilities, with many students having more than one [9]. Online course content should be developed to meet the needs of these students.

The COVID-19 pandemic has meant that many institutions of higher education (IHEs) switched to online learning to safeguard the health of their communities [13], [20]. Although IHEs have long had experience with online course delivery, many educators who had to adapt course content for online learning do not. Emergency online learning is not the same as planned online learning, and many students expressed dissatisfaction with online learning during the pandemic [20]. For K–12 students, the situation is even grimmer. Few traditional public-school teachers have experience with teaching younger students online, and while teachers are often skilled in meeting the needs of disabled learners in the classroom or have additional support from special educators and aides, they do not have preparation or training in meeting the needs of those learners online.

Re-examining previous research on accessible online education through the lens of the COVID-19 pandemic can offer many lessons for future emergencies. While some recent research projects have looked at different aspects of e-learning and online education experience during the pandemic (e.g., see [16] for a literature review), to our knowledge none have focused specifically on accessibility. In this paper, we provide an overview of research on the accessibility of online education resources and present an analysis of this research space through the lens of crisis preparedness. In the next sections, we first describe our paper selection process, followed by a presentation of the themes we identified in the reviewed papers. We follow by a discussion of previous findings through the lens of the COVID-19 crises and conclude with a set of recommendations, including future research opportunities.

3 An Overview of Online Learning Accessibility Research

The goal of this paper is to provide an analysis of existing research on the accessibility of online learning resources for kindergarten to grade 12 education to translate lessons learned for use at the time of crises, such as the COVD-19 pandemic.

3.1 Methods

We selected 14 papers from a combination of venues, including both journals (e.g., IEEE Transactions on Education, Educational Technology & Society, and the ACM Transactions on Accessible Computing, and Computers & Education), and conferences (e.g., W4All, DSAI, and ASSETS). We searched for papers using "online learning", "virtual learning", "accessibility", and "disability", as keywords on online search engines including Google Scholar, the ACM Digital Library, and IEEE Xplore. We only chose to review papers published after 2009 since online technologies have changed significantly in the past decade.

3.2 Themes in Online Learning Accessibility

3.2.1 Course platform accessibility

As schools quickly move to online learning during COVID-19 or expand their existing programs, they adopt a variety of virtual learning environments (VLE), such as Google Classroom, Schoology, Moodle, or Blackboard to deliver virtual lessons and content. Accessing their online classes through a VLE is the first step for students in participating in online learning. For students with a disability, these VLEs must be accessible to access course content and participate in lessons. Fortunately, these systems have been in development for years in response to the growing interest in and support for online learning in higher education, and efforts have been made to increase their accessibility [30]. Web Content Accessibility Guidelines (WCAG) are used as a baseline for evaluating the accessibility of these online platforms, ensuring that they are perceivable, operable, understandable, and robust [12], [34].

The reality, however, is far from ideal. Pearson and Koppi [21] conducted a study of the WebCT VLE in use at a university. They evaluated the system against WCAG guidelines, used a tool that analyzes web accessibility, sent a questionnaire to faculty about their experiences with and attitudes towards accessibility in online course materials, and interviewed designers and students with disabilities. They also evaluated the system with students using assistive technology. They found that WebCT fell short of its stated accessibility goals and did not meet WCAG guidelines. Faculty creating new courses often did so with limited support and short timeframes and did not incorporate accessibility into their course designs. Many faculty members were not aware of whether there were students with disabilities in their courses. Although the system met most WCAG accessibility guidelines, a few problems remained that could cause access problems for some students, including lack of text equivalents for icons and the use of tables. In another study, Fichten et al. gathered data about the online learning experiences of students with disabilities at Canadian post-secondary institutions via a questionnaire and found that all students that participated in the study encountered accessibility issues with university websites and VLEs [9].

3.2.2 Course content accessibility

Beyond platforms, for online courses to be accessible for students with disabilities, the course content must also be accessible [30], [31]. Courses often consist of many types of media, including web content, video, text documents, PDFs, and slide presentations [30], [31]. For each of these content types, accessibility guidelines and best practices outline the steps necessary to ensure that the content is accessible. The guidelines include practices for creating content that is inherently usable to many, as well as content that will be usable by students who use assistive technology, such as screen readers [31].

Pearson and Koppi used a learner-centered courseware design model to evaluate the accessibility of an online course. The learner-centered model includes visual design, interface design, and content design. Among the problems they discovered in the accessibility of the online course content were a poor organization of content; a lack of text equivalents for graphics, figures, and illustrations; overuse of PDF file formats for text-based documents; the use of tables; and poor interface design such as insufficient color contrast, customized by instructors within the VLE [12]. The use of PDFs was found to be particularly common in courses [22].

Similarly, Fichten et al. also found that PDFs created by instructors were often inaccessible [9]. Although PDFs can be made accessible to individuals who use screen readers, preparing them takes knowledge and software that many teachers may not have [9], [30]. In a study that compared the accessibility of online course content using an automated checker and student-generated data, Kumar and Owston also found that students with disabilities experienced difficulty accessing course content due to the design of the content and not the course platform [12].

Rello and Baeza-Yates used eye-tracking software to measure the comparative reading speed of users with and without dyslexia with 12 different fonts; they found that fonts have an effect on readability for both users with dyslexia and users without dyslexia. Similarly, they found that the use of italics reduced readability, especially for users without dyslexia [24]. Previous research has shown that including captions to enable deaf or hard of hearing users access video content increases usability for all users [5].

In a study of e-learning mathematics tools, Wen et al. similarly found that text-intensive mathematics content presented challenges for students with specific learning disabilities. The authors also found that teachers used video captions to support students with auditory processing challenges related to specific learning disabilities [33].

3.2.3 Support for teachers as content developers

It is usually the responsibility of teachers to develop, procure, or adapt course materials [22], [30], but many teachers do not have the training or knowledge to ensure that course materials are accessible to students with disabilities [9]. Among the factors influencing teachers' and course developers' creation of non-accessible course materials are a lack of

awareness of these issues and a lack of technical skills to remedy them [9], [19], [31]. In addition, teachers may be concerned about the additional time and resources needed to create accessible course content [5].

Raising awareness among teachers of the barriers that inaccessible content can pose to students with disabilities can promote a deeper understanding of the need for accessible materials [5], [19], [31]. Training and ongoing teacher professional development can contribute to remedying the lack of awareness [5], [9], [19], [23], [31]. Providing teachers with training that includes examples of "good" and "bad" design – that is, design that is inclusive for users with disabilities and design that is not – can demonstrate specific issues that teachers may encounter [19]. These efforts need to be supported by administrators by specifically allocating time for teachers to attend training sessions and professional development activities. A collaborative and supportive structure such as a community of practice can help teachers in course content development by sharing resources and knowledge and improving practice [19].

Additionally, Wen et al. suggest incorporating special education teachers into the design of e-learning tools for students with specific learning disabilities to improve usability and increase adoption of the tools [33].

The issue of teachers having limited resources or preparation for creating accessible online learning experiences for their students was exacerbated during the rapid move to online learning in the face of COVID-19, with many students feeling overwhelmed or frustrated by rapid changes in educational planning and shifts [10].

In a study with special education teachers and administrators, Hamidi et al. found that both teachers and parents were overwhelmed by the amount of information they were receiving about changes in programming, platforms, and deliverables [14]. Furthermore, teachers found the preparation they had before the pandemic to deal with the ensuing crises inadequate.

3.2.5 Online learning accessibility evaluation

In our review, we identified two types of accessibility evaluation: conformance testing and user-centered evaluation. *Conformance testing* involves the use of software or experts to check the course content against a list of guidelines and best practices, such as Section 508 of the Rehabilitation Act and WCAG guidelines [9]. Automated conformance testing is inexpensive and fast [12]. Cifuentes et al. describe a process of evaluation that involves an expert checking the content against a checklist consisting of guidelines from the Americans with Disabilities Act of 1990, sections 504 and 508 of the Rehabilitation Act, the W3C Web Accessibility Initiative, and the seven principles of Universal Design. The course review includes checking videos for captions, testing the readability of text with the JAWS screen reader, and testing color contrast with the WebAIM color contrast checker [5].

Student- or *user-centered evaluation* includes usability testing, either in a moderated session in a lab or via remote asynchronous testing [12]. Usability is not synonymous with accessibility, however, and unless a number of students with disabilities are recruited for usability testing, accessibility issues may not come to light in usability testing. Kumar and Owston suggest a possible middle, "gray" area for usable accessibility testing that may capture overlapping aspects of usability and accessibility [12]. A user-centered evaluation may also include student surveys, questionnaires, and feedback interviews

Coughlan et al. discuss ways that open-comment feedback from students can be gathered and analyzed to evaluate course content accessibility, in addition to automated methods [8]. They argue that adherence to guidelines and usability testing cannot solve accessibility issues and that it is not possible to objectively assess content as accessible without regard to specific users [8]. Kumar and Owston similarly found that results from an analysis of course content with automated tools did not align with the subjective experiences of students with learning disabilities [12].

The process of evaluating online learning courses for accessibility may start with conformance testing but is not complete without data from users with disabilities [28]. Evaluation data should further inform future improvements [8].

3.2.7   Building accessibility into pedagogy

Accessible online course design, like in-person courses, should be based on effective pedagogy [6]. Tandy and Meacham argue that the pedagogical principles should inform the course design and technology used while keeping the needs of diverse learners in mind [31]. The Universal Design principle of flexibility in use can inform these design decisions; for instance, if the goal is to engage in collaborative learning, students may be offered numerous methods of participation, such as asynchronous discussion boards, synchronous text chat, or synchronous video chat [23]. Offering only one method of participation may exclude students with disabilities, but multiple pathways can ensure that all students have a mode of participation.

Seale and Cooper frame accessibility as intrinsic in pedagogy and recommend supporting teachers' course design with both accessibility and pedagogical tools [25]. They argue that pedagogy is inherent in accessibility, and therefore teachers have a responsibility for understanding accessibility and incorporating it into their teaching practice. They review a number of pedagogical tools that support teachers in course design to determine whether incorporate digital accessibility. They found that the learning design tools did not incorporate accessibility without modification and propose combining accessibility and pedagogical tools [25].

3.2.8   Improved academic outcomes

Beyond the moral and often legal reasons for ensuring that online courses are accessible to students with disabilities, providing course content that students with disabilities can access without hindrance or difficulty may improve their persistence, retention, and academic outcomes. Batanero et al. adapted the Moodle VLE to enable content creators to add differentiated content and to support students with disabilities to access adapted content that meets their needs [1]. The authors wanted to know whether this adaptation would improve learning outcomes for deaf, blind, and deaf-blind students. They conducted a study with three cohorts of students—10 deaf, 10 blind, and 3 deaf and blind students ranging from 27 to 55 years old. Two video tutorials used in online classes were adapted to include accessible supports, including audio descriptions, captions, sign language, and long descriptions. Students accessed the non-adapted course content and answered questions to determine whether they met learning outcomes for the course. Students then took the adapted courses and answered the same questions. The study found that when online course content was adapted specifically for use by blind and deaf engineering students, the students' learning performance was significantly increased [1]. Similarly, Rello and Baeza-Yates found that font choices had a significant effect on reading performance for students with dyslexia [24].

3.2.9   Supporting students with mental health issues

The majority of the papers we reviewed covered a range of disabilities, including visual impairments [1], [8], [9], [23], hearing impairments [1],[8], [9], [23], autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) [8], [9], and specific learning disabilities, such as dyslexia [8], [9], [23], [24]. An area that was missing was research on students experiencing mental illness, such as anxiety or depression, and how these conditions, especially as amplified by uncertainty caused by crises, may interact with other disabilities. Only one paper in this review [15] specifically looked at the experiences and needs of online learning students experiencing mental health disorders. McManus et al. conducted semi-structured interviews with students at an Australian university enrolled in online education and registered with the university disability services unit as having a mental health disorder; they found that, despite the widely accepted belief that online learning increases access to higher ed, students with a mental health disorder experienced learning barriers and feelings of isolation in their online learning experiences [15].

3.2.4   Accessibility by design: Universal design and cultural awareness

Universal Design is a design approach specifically created to address and overcome accessibility barriers, initially in physical built environments, and more recently in virtual spaces [5], [28]. The Universal Design for Learning framework is specifically intended to support the creation of inclusive teaching and learning experiences for all people [4], [32].

Pittman and Heiselt [23] describe how each of the seven principles of Universal Design can be applied to the development of online coursework. The seven principles are equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use. They argue that incorporating these principles will not only benefit disabled students but will benefit all students, including second language learners and those new to online learning [23].

Cifeuentes et al. proposed a model for creating accessible course content based on the principles of Universal Design. The model includes support infrastructure, support software and training, instructional designers trained in accessibility and universal design, professional development for course instructors, course reviews, and outcome evaluations [5]. Tandy and Meacham argue for the importance of incorporating usability for as many people as possible into the design of course content, rather than adapting content for disabled users after the fact [31]. Doing so incorporates accessibility for students who may not disclose their disability, have an undiagnosed disability or develop a disability after the start of the course.

In addition to designing and creating solutions, a number of reviewed research projects argued for developing an institutional culture that fosters favorable attitudes toward accessibility [5],[19], [30]. Working toward cultivating positive beliefs, feelings, and actions toward accessibility can help break down some of the barriers to this work, such as fears about the time commitment, resources needed, or integrity of the coursework [5], [31]. Communities of practice can further support the maintenance of such a culture [19].

4 Discussion

Despite the prevalence of online education – both in the postsecondary space as well as in ad-hoc learning such as massive open online courses (MOOCs) and self-guided courses – there is still much that can be explored by research into accessible online learning. This is especially true given the rapid advancement of technology and given its large scale and rapid uptake during the COVID-19 pandemic. The research we reviewed showed that online course platforms generally incorporate some accessibility features per guidelines for accessibility, such as WCAG standards. However, course content still poses barriers to inclusion for students with disabilities.

Course content may consist of videos, PDF documents, Word documents, web text, images, PowerPoint slides, and other formats. Each poses special challenges for many users that can be addressed by the content creator with sufficient training. Recommendations include ensuring that documents follow a logical flow and use appropriately nested headings; document properties are accurate; images include descriptive alt text; videos include captioning; PowerPoints are developed using included content frames; dyslexia-friendly fonts are used;

colors selected include sufficient color contrast with text; and meaning is not conveyed solely in color [17], [34].

Despite increasing instructional resources, course content designers often do not have the awareness, knowledge, or technical skills to design, evaluate, and remedy these issues. They may also have concerns about the time and resources needed to do this work. An organizational culture that actively supports and promotes accessibility by providing resources, training and continuous improvement in online course content accessibility is needed to ensure that disabled students have equal access to course materials.

Further, an awareness of the many types of disabilities that may affect students is needed. Most of the studies reviewed focused on a small subset of disabilities, including specific learning disabilities [8], [9], [23], [24] [33], developmental disabilities [8], [9], visual disabilities [1], [8], [9], [23], and hearing disabilities [1], [8], [9], [23]. Only one study specifically considered mental health disorders [15], while others [8], [9] included it among a number of disabilities. None specifically considered motor disabilities, while two [8], [23] included motor disabilities among a number of other disabilities. None specifically considered difficulties with emotional regulation or neurological disorders such as epilepsy or migraine headaches. Framework approaches have been suggested for supporting teachers in the preparation of accessible course content [4], [32]. These frameworks variously include awareness of the issue, understanding the problems associated with access, organizational support, communities of practice, software, and training [5], [19]. However, none of the frameworks include student feedback to inform continuous improvement processes.

None of the papers reviewed addressed accessibility issues related to synchronous vs. asynchronous content delivery. This aspect of online learning may be relevant for students with cognitive disabilities, but just one paper addressed concerns for these students [15]. Additionally, some evidence exists that interfaces that differ from what users are familiar with increase cognitive load and decrease performance [18]. This may be a consideration when transitioning from paper and pencil work to computer-based work, especially for younger students or students who may not be used to using a computer. For example, consider the scenario where a young learner (about 7-8 years old) who is still learning to express mathematical ideas verbally and with pencil and paper is now asked to navigate several programs that require them to use online tools to draw and type those mathematical ideas. See Figure 1 for an example assignment. For this assignment, the student must first navigate the VLE to find the assignment, then open the file with a separate program to allow them to edit the PDF. The student may then use a combination of typing, drawing, and audio recording tools to complete the assignment. All of the additional steps add to the difficulty of the assignment and may require adult help, especially at the beginning of the switch to online learning. The particular VLE and other programs used

might pass accessibility guidelines, but they clearly may present barriers to many children with or without disabilities. More research is needed to understand how to overcome barriers that may arise in these scenarios and that may span more than one program or platform.

Figure 1:A second-grade mathematics assignment. The student edited the PDF in Kami, a PDF annotation tool, using text, shape, drawing, and voice recording tools.

We were unable to find any literature that specifically considered the accessibility needs of K–12 students in online learning. All of the papers reviewed looked at online learning accessibility as it relates to postsecondary students. This is likely in part because online education is largely used in postsecondary education, and to a lesser extent in secondary education in the form of credit recovery – courses that allow students to obtain credit for courses they have previously failed – dual enrollment or college courses, electives, Advanced Placement courses, and other programs [7]. There are online programs at the elementary level, however.

Many of the same access issues identified for postsecondary students are likely to apply to K–12 students as well. Although the landscape of K–12 education looks very different than postsecondary education, some students may encounter similar issues with accessing course content. K–12 students with disabilities likely face many other issues with online learning not yet understood in the field of accessibility. This may have wider legal implications, as students with disabilities in the United States have legal rights to appropriate education.

It is also worth noting that, while K–12 schools may be aware of the specific needs of their students with disabilities for legal purposes, they may not be aware of the disability status of parents or caregivers supporting those learners at home during emergency online learning during the COVID-19 pandemic. Those caregivers may support younger students with accessing materials and synchronous classes, understanding assignment instructions, submitting assignments, and navigating the VLE.

5 Conclusion & Future Work

Emergency online learning during the COVID-19 pandemic has exposed gaps in the research on accessible online learning, especially as it relates to K–12 students. Future work can consider the specific needs of younger students with disabilities as they relate to online education. Younger children may have difficulty navigating online environments, so understanding the specific needs of the younger learners in relation to online learning regardless of disability status is also an area for future work. Teachers at the elementary and high school level also need specific training, either in preparation programs or in ongoing professional development, to create online course content that is usable by all students and their caregivers.

While many school districts adapted to online learning during the COVID-19 pandemic to reduce the spread of disease and safeguard their communities, there is little research to support their efforts to create course content that is usable for all students. Students with disabilities – as well as young students without disabilities but with limited fine motor skills and limited understanding of online environments – may struggle with accessing course content and completing lessons because of factors such as poor content organization or interface design. Accessible design can benefit all users. Many factors may impact inequities in emergency online learning. The lessons from this pandemic can help school districts prepare to serve all students for future emergency online learning situations, as well as planned online learning.

ACKNOWLEDGEMENT

REFERENCES

[1] Allen, I. E., & Seaman, J. (2014). Grade Change: Tracking Online Education in the United States. Babson Survey Research Group and Quahog Research Group,LLC. http://www.onlinelearningsurvey.com/reports/gradechange.pdf Accessed February 21, 2021.

[2] Batanero , C., de-Marcos, L., Holvikivi, J., Hilera, J. R., & Otón, S. (2019). Effects of New Supportive Technologies for Blind and Deaf Engineering Students in Online Learning. In *IEEE Transactions on Education*, 62(4).

[3] Bruder, A. (2011). Dear Alma Mater: Women's Epistolary Education in the Society to Encourage Studies at Home, 1873—1897. *The New England Quarterly, 84*(4), 588-620. Retrieved from http://www.jstor.org/stable/23054818

[4] Burgstahler, S. E., & Cory, R. C. (Eds.). (2010). *Universal design in higher education: From principles to practice*. Harvard Education Press.

[5] Cifuentes, L., Janney, A., Guerra, L., & Weir, J. (2016). A Working Model for Complying with Accessibility Guidelines for Online Learning. *TechTrends* 60, 557–564, DOI: 10.1007/s11528-016-0086-8.

[6] Clarke, T. & Clarke, E. (2009). Born digital? Pedagogy and computer-assisted learning, *Education + Training* 51 (5/6), 395-407.

[7] Clements, M., Pazzaglia, A. M., & Zweig, J. (2015). *Online course use in New York high schools: Results from a survey in the Greater Capital Region* (REL 2015–075). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Northeast & Islands. Retrieved from http://ies.ed.gov/ncee/edlabs.

[8] Coughlan, T., Ullmann, T. D., & Lister, K. (2017). Understanding Accessibility as a Process through the Analysis of Feedback from Disabled Students. In *Proceedings of the 14th Web for All Conference on The Future of Accessible Work* (W4A '17). Association for Computing Machinery, New York, NY, USA, Article 14, 1–10.

[9] Fichten, C. S., Ferraro, V., Asuncion, J. V., Chwojka, C., Barile, M., Nguyen, M. N., et al. (2009). Disabilities and e-learning problems and solutions: an exploratory study, *Educational Technology & Society*, 12(4), 241-256.

[10] Gleason, C., Valencia, S., Kirabo, L., Wu, J., Guo, A., Jeanne Carter, E., Bigham, J., Bennett, C. & Pavel, A. (2020). Disability and the COVID-19 Pandemic: Using Twitter to Understand Accessibility during Rapid Societal Transition. In *Proceedings of ASSETS'20*, 1-14.

[11] Hussar, B., Zhang, J., Hein, S., Wang, K., Roberts, A., Cui, J., Smith, M., Bullock Mann, F., Barmer, A., & Dilig, R. (2020). *The Condition of Education 2020* (NCES 2020-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

[12] Kumar, K.L., & Owston, R. (2016). Evaluating e-learning accessibility by automated and student-centered methods. *Educational Technology Research and Development*, 64, 263–283.

[13] Kurbakova, S., Volkova, Z., & Alexander Kurbakov. (2020). Virtual Learning and Educational Environment: New Opportunities and Challenges under the COVID-19 Pandemic. In *4th International Conference on Education and Multimedia Technology* (ICEMT 2020). Association for Computing Machinery, New York, NY, USA, pp. 167–171.

[14] Long, E., Vijaykumar, S., Gyi, S., & Hamidi, F. (2021). Rapid transitions: Experiences with Accessibility and Special Education during the COVID-19 Crisis. *Frontiers in Computer Science*, 2:617006. doi: 10.3389/fcomp.2020.617006

[15] McManus, D., Dryer, R., & Henning, M. (2017). Barriers to learning online experienced by students with a mental health disability. *Distance Education*, 38:3, 336-352, DOI: 10.1080/01587919.2017.1369348.

[16] Mseleku, Z. (2020). A Literature Review of E-Learning and E-Teaching in the Era of Covid-19 Pandemic. SAGE 57, no. 52 (2020): 6.

[17] Microsoft. (n.d.) Make your PowerPoint presentations accessible to people with disabilities. Retrieved from https://support.microsoft.com/en-us/office/make-your-powerpoint-presentations-accessible-to-people-with-disabilities-6f7772b2-2f33-4bd2-8ca7-dae3b2b3ef25 on December 27, 2020.

[18] Oviatt, S., Arthur, A., & Cohen, J. (2006). Quiet interfaces that help students think. In *Proceedings of the 19th annual ACM symposium on User interface software and technology* (UIST '06). Association for Computing Machinery, New York, NY, USA, 191–200.

[19] Papadopoulos, G., Pearson, E., & Green, S. (2012). A provisional framework for supporting academics in accessible and inclusive e-materials development. In *Proceedings of the 24th Australian Computer-Human Interaction Conference* (OzCHI '12). Association for Computing Machinery, New York, NY, USA, 459–468.

[20] Patricia, A. (2020). College Students' Use and Acceptance of Emergency Online Learning Due to COVID-19, *International Journal of Educational Research Open*, DOI: 10.1016/j.ijedro.2020.100011.

[21] Pearson, E., & Koppi, T. (2002). Inclusion and online learning opportunities: Designing for accessibility, ALT-J, 10:2, 17-28, DOI: 10.1080/0968776020100203

[22] Pearson, E. & Koppi, T. (2006). A pragmatic and strategic approach to supporting staff in inclusive practices for online learning. In *Proceedings of the 23rd annual Ascilite conference: Who's learning? Whose technology?*

[23] Pittman, C., & Heiselt, A. (2014). Increasing Accessibility: Using Universal Design Principles to Address Disability Impairments in the Online Learning Environment. *Online Journal of Distance Learning Administration*, 17(3).

[24] Rello, L., & Baeza-Yates, R. (2016). The effect of font type on screen readability by people with Dyslexia. *ACM Trans. Access. Comput*. 8, 4, Article 15, DOI: 10.1145/2897736.

[25] Seale, J. & Cooper, M. (2010). E-learning and accessibility: An exploration of the potential role of generic pedagogical tools, *Computers & Education*, 54(4), pp. 1107-1116.

[26] Seale, J., Georgeson, J., Mamas, C., & Swain, J. (2015). Not the right kind of 'digital capital'? An examination of the complex relationship between disabled students, their technologies and higher education institutions. *Computers & Education*. 82, 118–128.

[27] Shapiro, E. & Harris, E.A. (2020). "This Is Schooling Now for 200,000 N.Y.C. Children in Special Education." *The New York Times*, April 16, 2020. Accessed December 24, 2020.

[28] Shinohara, K., Bennett, C., Pratt, W., & Wobbrock, J. (2018). Tenets for Social Accessibility: Towards Humanizing Disabled People in Design. *ACM Trans. Access. Comput*. 11(1), DOI: 10.1145/3178855.

[29] Sinclair. J. (2013). Why I dislike "person first" Language. *Autonomy, the Critical Journal of Interdisciplinary Autism Studies* 1, 2 (Oct. 2013).

[30] Sloan, D., Horton, S., & Gregory, B. (2016). Masterplanning the digital campus to support learners with disabilities. In *Proceedings of the 13th Web for All Conference* (W4A '16). Association for Computing Machinery, New York, NY, USA, Article 31, 1–4. DOI: 10.1145/2899475.2899497.

[31] Tandy, C., & Meacham, M. (2009). Removing the Barriers for Students with Disabilities: Accessible Online and Web-Enhanced Courses, Journal of Teaching In Social Work, 29:3, 313-328, DOI: 10.1080/08841230903022118

[32] The UDL Guidelines (n.d.). CAST. Retrieved from http://udlguidelines.cast.org/.

[33] Wen, Z.A., Silverstein, E. O., Zhao, Y., Amog, A. L. S., Garnett, K., & Azenkot, S. (2020.) Teacher Views of Math E-learning Tools for Students with Specifc Learning Disabilities. In *The 22nd International ACM SIGACCESS Conference on Computers and Accessibilit*y (ASSETS '20), Association for Computing Machinery, New York, NY, USA, 13 pages. https://doi.org/10.1145/3373625.3417029

[34] World Wide Web Consortium. (2020). Web Content Accessibility Guidelines (WCAG) Overview. Updated October 17, 2020. Retrieved from https://www.w3.org/WAI/standards-guidelines/wcag/ on December 27, 2020.