Smart Universities, Smart Classrooms and Students with Disabilities

Jeffrey P. Bakken, Vladimir L. Uskov, Archana Penumatsa and Aishwarya Doddapaneni

Abstract To better educate in-classroom and remote students we will need to approach education and how we teach various types of students differently. In addition, students these days are more technological than ever and are demanding new and innovative ways to learn. One of the most promising approaches is based on design and development of smart universities and smart classrooms. This paper presents the up-to-date outcomes of research project that is aimed on analysis of students with disabilities and how they might benefit from smart software and hardware systems, and smart technology.

Keywords Smart university · Smart classroom · Learning disabilities · Visual impairments · Hearing impairments · Speech and language disabilities · Smart system

1 Introduction

Smart universities (SmU) and smart classrooms (SmC) can create multiple opportunities for students to learn material in a variety of ways. In addition, they can give access to materials in a variety of ways. Although not designed or even

J.P. Bakken (✉)
The Graduate School, Bradley University, Peoria, Illinois, USA
e-mail: jbakken@fsmail.bradley.edu

V.L. Uskov · A. Penumatsa · A. Doddapaneni
Department of Computer Science and Information Systems,
InterLabs Research Institute, Bradley University, Peoria, Illinois, USA
e-mail: uskov@fsmail.bradley.edu

A. Penumatsa
e-mail: apenumatsa@fsmail.bradley.edu

A. Doddapaneni
e-mail: adoddapaneni@fsmail.bradley.edu

V.L. Uskov et al. (eds.), *Smart Education and e-Learning 2016*,
Smart Innovation, Systems and Technologies 59,
DOI 10.1007/978-3-319-39690-3_2

conceptualized to benefit students with disabilities, this concept would definitely have an impact on the learning and access to material for students with disabilities.

1.1 Smart Classrooms: Literature Review

Pishva and Nishantha define a SmC as an intelligent classroom for teachers involved in distant education that enables teachers to use a real classroom type teaching approach to teach distant students. “Smart classrooms integrate voice-recognition, computer-vision, and other technologies, collectively referred to as intelligent agents, to provide a tele-education experience similar to a traditional classroom experience” [1].

Glogoric, Uzelac and Krco addressed the potential of using Internet-of-Things (IoT) technology to build a SmC. “Combining the IoT technology with social and behavioral analysis, an ordinary classroom can be transformed into a smart classroom that actively listens and analyzes voices, conversations, movements, behavior, etc., in order to reach a conclusion about the lecturers’ presentation and listeners’ satisfaction” [2].

Slotta, Tissenbaum and Lui described an infrastructure for SmC called the Scalable Architecture for Interactive Learning (SAIL) that “employs learning analytic techniques to allow students’ physical interactions and spatial positioning within the room to play a strong role in scripting and orchestration” [3].

Koutraki, Efthymiou, and Grigoris developed a real-time, context-aware system, applied in a SmC domain, which aims to assist its users after recognizing any occurring activity. The developed system “…assists instructors and students in a smart classroom, in order to avoid spending time in such minor issues and stay focused on the teaching process” [4].

Given all the research available that focus on SmC, no literature was located that dealt with analysis of possible impact of SmCs concepts, features and functionality on students with disabilities.

1.2 Smart Universities: Literature Review

Primary focus of smart universities is in the education area, but they also drive the change in other aspects such as management, safety, and environmental protection. The availability of newer and newer technology reflects on how the relevant processes should be performed in the current fast changing digital era. This leads to the adoption of a variety of smart solutions in university environments to enhance the quality of life and to improve the performances of both teachers and students. Nevertheless, we argue that being smart is not enough for a modern university. In fact, all universities should become smarter in order to optimize learning. By "smarter university" we mean a place where knowledge is shared between employees, teachers, students, and all stakeholders in a seamless way [5].

Aqeel-ur-Rehman et al. in [6] present the outcomes of their research on one feature of future SmU—sensing with RFID (Radio frequency identification) technology; it should benefit students and faculty with identification, tracking, smart lecture room, smart lab, room security, smart attendance taking, etc.

Lane and Finsel emphasize an importance of big data movement and how it could help to build smarter universities. "Now is the time to examine how the Big Data movement could help build smarter universities—in situations that can use the huge amounts of data they generate to improve the student learning experience, enhance the research enterprise, support effective community outreach, and advance the campus's infrastructure. While much of the cutting-edge research being done with Big Data is happening at colleges and universities, higher education has yet to turn the digital mirror on itself to innovate the academic enterprise" [7]. Big data analytics systems will strongly support inferring feature of a SmU.

Al Shimmary et al. analyzed advantages of using RFID and WSN technology in development of SmU. "The developed prototype shows how evolving technologies of RFID and WSN can add in improving student's attendance method and power conservation" [8]. RFID, WSN as well as Internet-of-Things technology are expected to be significant parts of a SmU and strongly support sending characteristics of smart universities.

Doulai in [9] presents a developed system for a smart campus. This system "… offers an integrated series of educational tools that facilitate students' communication and collaboration along with a number of facilities for students' study aids and classroom management. The application of two technologies, namely dynamic web-based instruction and real-time streaming, in providing support for "smart and flexible campus" education is demonstrated. It is shown that the usage of technology-enabled methods in university campuses results in a model that works equally well for distance students and learners in virtual campuses".

Yu et al. argue that "… with the development of wireless communication and pervasive computing technology, smart campuses are built to benefit the faculty and students, manage the available resources and enhance user experience with proactive services. A smart campus ranges from a smart classroom, which benefits the teaching process within a classroom, to an intelligent campus that provides lots of proactive services in a campus-wide environment" [10]. The authors described 3 particular systems–Wher2Study, I-Sensing, and BlueShare—that provide sensing, adaptation, and inferring smart features of a SmU.

1.3 Research Project Goal and Objectives

The performed analysis of these and multiple additional publications and reports relevant to (1) SmU, (2) SmC, (3) smart learning environments (SmLE), (4) smart technologies, and (5) smart systems undoubtedly shows that (a) SmU, (b) SmC,

(c) smart pedagogy, and (d) smart faculty topics will be essential themes of multiple research, design and development projects in the upcoming 5–10 years. It is expected that in the near future SmC concepts and hardware/software solutions will have a significant role and be actively deployed by leading academic intuitions—smart universities—in the world.

Unfortunately, all analyzed publications are lacking a systematic approach to "smartness levels" of a smart educational system (i.e., school, college, university). Additionally, all analyzed publications are focused on traditional students/learners; however, we could not find publications on detailed analysis of "SmU, SmC and students with disabilities".

The goal of ongoing research project at the InterLabs Research Institute at Bradley University (Peoria, IL, U.S.A.) is to perform a detailed analysis and identify potential benefits of SmU and SmC components, features, systems, and technology for special type of students—students with various types of disabilities.

The objectives of this particular research project include but are not limited to:

(1) identification of smartness levels in a smart educational system;
(2) identification of characteristics of students with various types of disabilities;
(3) identification of software and hardware systems and technology to aid students with disabilities in highly technological SmCs.

The up-to-date outcomes of this research project are presented below.

2 Smart University and Students with Disabilities: Analysis Phase

SmU and SmC can create multiple opportunities for students to learn material in a variety of ways. In addition, they can give access to materials in a variety of ways. Although not designed or even conceptualized to benefit students with disabilities, this concept would definitely have an impact on the learning and access to material for students with disabilities.

2.1 Smart Educational System: Smartness Levels

Based on our vision of a SmU and up-to-date obtained research outcomes, we believe that a SmU should significantly emphasize not only software/hardware/technology features but also "smart" features and functionality of smart systems (Table 1) [11].

In order for SmU and SMC to be effective and efficient for various types of students and learners there are certain smartness levels (Table 1) that should be addressed. These levels or features should guide designers and developers of SmC,

Table 1 Classification of levels of “smartness” of a smart system [11]

Smartness levels (i.e. ability to …)	Details
Adapt	Ability to modify physical or behavioral characteristics to fit the environment or better survive in it
Sense	Ability to identify, recognize, understand and/or become aware of phenomenon, event, object, impact, etc.
Infer	Ability to make logical conclusion(s) on the basis of raw data, processed information, observations, evidence, assumptions, rules, and logic reasoning
Learn	Ability to acquire new or modify existing knowledge, experience, behavior to improve performance, effectiveness, skills, etc.
Anticipate	Ability of thinking or reasoning to predict what is going to happen or what to do next
Self-organize	Ability of a system to change its internal structure (components), self-regenerate and self-sustain in purposeful (non-random) manner under appropriate conditions but without an external agent/entity

smart labs, smart libraries, smart offices, etc. In doing so, we can then identify the most effective hardware, software, pedagogy and learning activities for all students, including students with disabilities…

2.2 Characteristics of Students with Disabilities

Types of students with disabilities that SmU and SmC can impact include students with (1) learning disabilities, (2) speech or language impairments, (3) visual impairments and (4) hearing impairments. Brief characteristics of each designated type of disability are given below.

Learning Disabilities [12, 13]. Learning disabilities are associated with many different problems that include difficulties in listening, reasoning, memory, attention, selecting and focusing on relevant stimuli, and the perception and processing of visual and/or auditory information. These perceptual and cognitive processing difficulties are assumed to be the underlying reason why students with learning disabilities experience one or more of the following characteristics: reading problems, deficits in written language, and underachievement in math. Not all students with learning disabilities will exhibit these characteristics, and many students who demonstrate these same behaviors are quite successful in the classroom. These students are a diverse group of individuals, exhibiting potential difficulties in many different areas. For example, one child with a learning disability may experience significant reading problems, while another may experience no reading problems whatsoever, but has significant difficulties with written expression. Learning disabilities may also be mild, moderate, or severe which complicates instruction for these students in the classroom even further.

Speech or Language Impairments [14, 15]. The characteristics of speech or language impairments will vary depending upon the type of impairment involved. There may also be a combination of several problems. Students could have difficulties with articulation (difficulty making certain sounds), fluency (something is disrupting the rhythmic and forward flow of speech), or voice (problems with the pitch, loudness, resonance, or quality of the voice). Students may also have difficulties with language. Language has to do with meanings, rather than sounds. A language disorder refers to an impaired ability to understand and/or use words in context [14]. A child may have an expressive language disorder (difficulty in expressing ideas or needs), a receptive language disorder (difficulty in understanding what others are saying), or a mixed language disorder (which involves both). Some characteristics of language disorders include: (1) improper use of words and their meanings, (2) inability to express ideas, (3) inappropriate grammatical patterns, (4) reduced vocabulary, and (5) inability to follow directions. Children may hear or see a word but not be able to understand its meaning. They may also have trouble getting others to understand what they are trying to communicate.

Visual Impairments [14, 16, 17]. Total blindness is the inability to tell light from dark, or the total inability to see. Visual impairment or low vision is a severe reduction in vision that cannot be corrected with standard glasses or contact lenses and reduces a person's ability to function at certain or all tasks. Legal blindness (which is actually a severe visual impairment) refers to a best-corrected central vision of 20/200 or worse in the better eye or a visual acuity of better than 20/200 but with a visual field no greater than 20° (e.g., side vision that is so reduced that it appears as if the person is looking through a tunnel) [16]. Being able to see gives us tremendous access to learning about the world around us. That's because so much learning typically occurs visually. When vision loss goes undetected, children are delayed in developing a wide range of skills. While they can do virtually all the activities and tasks that sighted children take for granted, children who are visually impaired often need to learn to do them in a different way or using different tools or materials. Central to their learning will be touching, listening, smelling, tasting, moving, and using whatever vision they have [17].

Hearing Impairments [18, 19]. The term "hearing impaired" refers to any person with any type or degree of hearing loss. The term may be used with qualifying adjectives such as "mild," "moderate," "severe," and "profound" to denote the degree of impairment. "Deaf" refers to a hearing-impaired person in whom the auditory sense is sufficiently damaged to preclude the auditory development and comprehension of speech and language with or without sound amplification. "Hard of hearing" is used to define a hearing-impaired person in whom the sense of hearing, although defective, is functional with or without a hearing aid and whose speech and language, although deviant, will be developed through an auditory base. The major challenge faced by students with hearing impairments is communication. Hearing-impaired students vary widely in their communication skills. Age of onset plays a crucial role in the development of language. Persons with prelingual hearing loss (present at birth or occurring before the acquisition of language and the development of speech patterns) are more functionally disabled than those who lose some degree of hearing after the development of language and speech. Many students with hearing impairments can and do speak. Most deaf students have normal speech organs and have learned to use them through speech therapy. Some deaf students cannot monitor or automatically control the tone and volume of their speech, so their speech may be initially difficult to understand. Understanding improves as one becomes more familiar with the deaf student's speech pattern.

3 Smart University and Students with Disabilities: Design Phase

3.1 Considerations for Students with Disabilities

The implementation of a SmC model could potentially have a huge impact on the learning of students with disabilities in general and more specifically students with learning disabilities, speech and language impairments, visual impairments, and hearing impairments. Many of the smart features of SmC are the exact areas where students with these disabilities have documented weaknesses. Most noted are deficiencies with learning, inferring, and self-organizing. Thus, the SmC should be considered when working with students with all of these disabilities [20].

Although we cannot create an exhaustive list of software and hardware technologies that should be incorporated into a SmC, we can suggest some things to consider. One must realize that one technology will not necessarily work or be effective with all students with disabilities, but when choosing software one must choose the software that will benefit the most students. As students enter your classrooms with more specific needs then those can be dealt with at that time. For example, some examples of objectives, hardware, and software of a SmC [21] that could be beneficial to students with disabilities are presented in Table 2 below.

3.2 Students with Disabilities and SMART Boards

Given the difficulties that students with disabilities encounter during their lives and in school SmC would benefit them and help them learn more efficiently and effectively. Where traditional classrooms do not specifically address the levels of smartness unless specific lessons focus on them, the implementation of SmC would be suggested to meet the difficulties students with learning disabilities encounter. This way, the exact areas that are of difficulty for students with learning disabilities would be addressed often and continuously in the classroom.

Table 2 SmC Objectives, hardware and software systems for students with disabilities

Scope	Main functions or features [21]
Objectives	• Seamlessly connect several remote SmCs to share lectures and information via networking • Seamless connect various types of users' mobile smart devices and technical platforms; provide scalability and timely update of software systems and applications used by various users • Automatically record all class activities and provide students with post-class review activities, for example, to review/learn content at student's own pace and comfort level • Accommodate, adapt and implement newest and emerging technologies and innovative trends, for example, computer vision, face recognition, speech recognition, noise cancellation, gesture recognition, etc. • Provide voice recognition, quality and fats automatic translation from English language to other languages, and visa versa • Empower instructor with voice recognition, face recognition, gestures and smart pointing devices and boards to navigate, edit and display information on smart boards • Provide remote students a regular face-to-face learning like experience to online/remote students logging into a session in a SmC/lab
Hardware	• Array of video cameras installed to capture main classroom activities, movements, discussions, expressions, gestures, etc. • Ceiling-mounted projector(s) with 1 or 2 big size screen to display main activities in actual classroom; in some cases—3D projectors • Student boards (big screen displays or TV) to display images of remote/online students from different locations • Bluetooth and Internet enabled devices like cell phones, smart phones, PDAs and laptops to facilitate communication and information exchange • Sensors (location detection, voice detection, motion sensors, thermal sensors, humidity, sensors for facial and voice recognition, etc.
Software	• Learning management system (LMS) or access to university wide LMS • Advanced software for rich multimedia streaming, control and processing • Software systems to address needs of special students, for example, visually impaired students (speech and gesture based writing/editing/navigation and accessibility tools to facilitate reading and understanding) • Smart cameraman software (for panoramic cameras) • Recognition software: face, voice, gesture • Motion or hand motion stabilizing software • Noise cancellation software

We know the more opportunities provided to students will give them a better chance to learn so having this type of system implemented and part of daily instruction would give the more practice and learning situations to improve the exact areas that they need to improve and work on. For example, a list of possible impacts of SMART boards on students with academic difficulties is presented in Table 3.

Table 3 Impact of SMART boards on academic difficulties

Scope	Main functions or features [22]
Reading comprehension	• Enlarging text on the SMART board to make it more legible • Highlighting parts of the text with digital highlighter ink or the SMART pen tools • Using the "Spotlight" feature to only reveal certain, relevant areas of text • Integrating a SMART document cameras to display text book pages and other hard copy literature on the SMART board • Change text colors and backgrounds to make it more readable on the SMART board
Writing compre-hension	• Students using the SMART board can write on it using a finger, a pen from the SMART pen tray or a soft object like a tennis ball or hacky sack to practice their handwriting. The SMART notebook software can convert handwritten letters to text using its handwriting recognition capabilities • Teachers can show pre-lined paper templates on the SMART board to make it easy for students to keep writing on the SMART board straight • Teachers can help students with constructing letter forms by asking them to trace over built in alphabet letters and numerical symbols that are included with SMART notebook software • Students can annotate over web pages, images and electronic documents on the SMART board to practice their writing skills

3.3 Students with Disabilities and Systems/Technologies to Be Used in SmC

When looking at SmU/SmC and the possible impact on students with disabilities the outlook is very good. Not all students with disabilities will probably attend a university, but it is very likely that (1) students with learning disabilities, (2) students with speech or language impairments, (3) students who are blind or visually impaired, and (4) students who are deaf or hearing impaired will potentially attend a university. These students combined make up 58 % of the total population of students with disabilities and about 8 % of the total school population [23]. As a result, those students are in the primary focus of our current research. Based on performed analysis, below there are examples of software/hardware systems or technologies available for designated types of students with disabilities (Tables 4, 5, 6 and 7). Active utilization of those systems can serve as a starting point for colleges and universities to aid students with disabilities to learn in highly technological SmC.

(A note: if accepted, conference full paper will include a comparison of main functions of existing SW systems for various groups of students with disabilities in terms of functions' relevance to features and characteristics of SmC).

Table 4 Technologies to aid students with learning disabilities in SmC

Scope	Main functions or examples of existing systems
Reading-assistive technology	• Text-to-Speech • Wynn Reader (from Scientific Freedom) • TextAloud (from NextUp Technologies) • NaturalReader (from AT&T) • ReadPlease (ReadPlease Corporation) • Kurzweil 3000 (Kurzweil Educational Systems, Inc.) • Dragon Naturally Speaking from Nuance
Writing-assistive technology	• Neo2 • Writers Plus • Inspiration® • Kidspiaration • Webspiaration
Math assistive technology	• Various calculators (4-function, graphing and scientific calculators) • Manipulatives (geoboards, pictorial representations, symbol and virtual manipulatives, Cuisenairerods) • Computer-assisted instruction • Arithmetic-focused software • Assistive technology for students with learning disabilities

Table 5 Technologies to aid students with speech and language disabilities in SmC

System name	Main functions or features
DynaVox 3100 [14]	The DynaVox 3100 is a hardware/software application which assists the user in carrying a conversation by speaking for them. Words, pictures, sentences and ideas can be selected via a touch screen, mouse, joystick and multiple switches. The DynaVox can also be used in multiple languages. This communication device will greatly reduce the frustration for children who cannot speak or whose speech is unrecognizable [24]
CH-7KIVORY [25]	A handset designed to assist someone weak speech by amplifying their outbound speech. An example of how this type of technology would assist a student is if they were using a telephone for research, interviewing a professional and many other educational purposes
Chattervox [25]	A portable voice amplification system designed to raise the vocal output of people with temporary or permanent voice impairments. This device can assist students who cannot produce enough decibels naturally so that they can be heard
Servox [25]	An artificial larynx that can assist anyone who has lost their voices due to injury and illness as well as those who have to rest their vocal cords or are attached to a respiration device

Table 6 Technologies to aid students who are visually impaired or blind in SmC

System name or scope	Main functions or features [26]
Lunar	Lunar is a screen magnification software system for computer users. It has a number of advanced features to help you manage the enlarged screen more efficiently. Magnification from 2x to 32x with five different viewing modes
Screen readers	JAWS (Job Access With Speech) is a screen reader, developed for computer users whose vision loss prevents them from seeing screen content or navigating with a mouse. JAWS provides speech and Braille output for the most popular computer applications on your PC
Duxbury	Grade 2 braille editing and translation software. It is available in versions for DOS, Windows and Macintosh computers. Duxbury is easy to use and is compatible with speech and braille output. It supports dozens of word processors through highly accurate ASCII and WordPerfect import bridges
Kurzweil 1000	Software that works on your personal computer and a scanner to convert the printed word into speech. It has the ability to find key words or phrases within a document, editing of scanned text, magnification of scanned documents to accommodate users with visual impairments, and the ability to specify unlimited bookmarks within a document

Table 7 Technologies to aid students who are hearing impaired or deaf in SmC

Scope	Main functions or features [27]
FM systems	Use radio signals to transmit amplified sounds. They are often used in classrooms, where the instructor wears a small microphone connected to a transmitter and the student wears the receiver, which is tuned to a specific frequency, or channel. FM systems can transmit signals up to 300 feet and are able to be used in many public places
Infrared systems	Use infrared light to transmit sound. A transmitter converts sound into a light signal and beams it to a receiver that is worn by a listener. The receiver decodes the infrared signal back to sound
Handwriting recognition	There are commercially available products that convert hand written materials into computer-generated text. Depending on the device, the information can be saved and printed as written or can convert the hand written materials into printed text for easier reading similar to a voice recognition system
Dragon Naturally SpeakingTM	A voice recognition software package that was developed for general public use that can be beneficial for deaf and hard of hearing individuals by creating text documents out of voice files

4 Conclusions. Future Steps

Conclusions. The performed research, helped us identify new ways of thinking and our research findings enabled us to make the following conclusions:

1. SMU and SmC can significantly benefit students with disabilities even though they are not the focus.
2. Many technologies geared towards students without disabilities in SmC will actually impact the learning of students with disabilities.
3. Some students with disabilities may need specialized technology to be successful.
4. Some technologies focusing on the success of students with disabilities may help students without disabilities to be successful.
5. More research needs to be completed addressing SmC and access for students with disabilities.

Future steps. Based on obtained research findings and outcomes, the future steps of this research are to (1) test, evaluate and analyze different software (commercial and open source) and hardware applications for students with disabilities, (2) conduct assessments on the effectiveness of different technological applications, (3) design and develop components of a SmC for students with and without disabilities in local or in a distance learning environments, and (4) create a list of what technologies should be in an optimal SmC.

References

1. Pishva, D., Nishantha, G.G.D.: Smart classrooms for distance education and their adoption to multiple classroom architecture. J. Netw. **3**(5) (2008)
2. Gligorić, N., Uzelac, A., Krco, S. Smart classroom: real-time feedback on lecture quality In: Proceedings of 2012 IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOM Workshops), 19–23 Mar 2012, pp. 391–394. IEEE, Lugano, Switzerland (2012). doi:10.1109/PerComW.2012.6197517
3. Slotta, J., Tissenbaum, M., Lui, M.: Orchestrating of complex inquiry: three roles for learning analytics in a smart classroom infrastructure. In: Proceedings of the Third International Conference on Learning Analytics and Knowledge LAK'13, pp. 270–274. ACM, New York, NY, USA (2013). doi:10.1145/2460296.2460352
4. Maria, K., Vasilis, E., Grigoris, A.: S-CRETA: smart classroom real-time assistance. In: Ambient Intelligence—Software and Applications. Advances in Intelligent and Soft Computing, vol. 153, pp. 67–74, Springer (2012)
5. Coccoli, M., et al.: Smarter universities: a vision for the fast changing digital era. J. Vis. Lang. Comput. **25**, 103–1011 (2014)
6. Rehman, A.U., Abbasi, A.Z., Shaikh, Z.A.: Building a smart university using RFID technology. In: 2008 International Conference on Computer Science and Software Engineering (2008)
7. Lane, J., Finsel, A.: Fostering smarter colleges and universities data, big data, and analytics. State University of New York Press (2014). http://www.sunypress.edu/pdf/63130.pdf

8. Al Shimmary, M.K., Al Nayar, M.M., Kubba, A.R.: Designing Smart University using RFID and WSN (2008). https://www.researchgate.net/publication/221195787_Building_a_Smart_University_Using_RFID_Technology
9. Doulai, P.: Smart and flexible campus: technology enabled university education. In: Proceedings of the World Internet and Electronic Cities Conference (WIECC), Kish Island, Iran, 1–3 May 2001, pp. 94–101 (2001)
10. Yu, Z., et al.: Towards a smart campus with mobile social networking. In: Proceedings on the 2011 International Conference on Cyber, Physical and Social Computing, 19–21 Oct 2011, pp. 162–169. IEEE, Dalian, China (2011)
11. Derzko, W.: Smart Technologies (2007). http://archives.ocediscovery.com/discovery2007/presentations/Session3WalterDrezkoFINAL.pdf
12. Fletcher, M.: Learning Disabilities: From Identification to Intervention, 324 p. The Guilford Press (2006)
13. Smith, C., Strick, L.: Learning Disabilities: A to Z: A Complete Guide to Learning Disabilities from Preschool to Adulthood, 528 p. Free Press (2010)
14. Center for Parent Information and Resources. http://www.parentcenterhub.org
15. Bishop, D., Leonard, L.: Speech and Language Impairments in Children: Causes, Characteristics, Intervention and Outcome, 320 p. Psychology Press (2001)
16. Mason, H., Stone, J.: Visual Impairment: Access to Education for Children and Young People, 495 p. David Fulton Publishers (1997)
17. The Free medical Dictionary. http://medical-dictionary.thefreedictionary.com/Visual+Impairment
18. Ling, D.: Speech and the Hearing-Impaired Child: Theory and Practice, 2nd edn., 402 p. Deaf and Hard of Hearing (2002)
19. Allegheny College. http://sites.allegheny.edu/disabilityservices/students-who-are-deaf-or-hard-of-hearing/
20. National Center for Educational Statistics. http://nces.ed.gov/programs/coe/indicator_cgg.asp
21. Uskov, V.L., Bakken, J.P., Pandey, A.: The ontology of next generation smart classrooms. In: Proceedings of the 2nd International Conference on Smart Education and e-Learning SEEL-2016, 17–19 June 2015, pp. 1–11. Springer, Sorrento, Italy (2015)
22. Information about the features of SMART Board interactive whiteboards that can help students who have special learning needs. https://www.blossomlearning.com
23. National Center for Education Statistics. Fast facts: Students with disabilities (2015). http://nces.ed.gov/fastfacts/display.asp?id=64
24. Courtad, C.A., Bouck, E.M.: Assistive technology for students with learning disabilities. In: Bakken, J.P., Obiakor, F.E., Rotatori, A.F. (eds.) Advances in Special Education: Learning Disabilities: Practice Concerns and Students with LD, vol. 25, pp. 153–174. Emerald Group Publishing Limited, Bingley, United Kingdom (2013)
25. HITEC company. http://www.hitec.com
26. Texas School for the Blind and Visually Impaired. http://www.tsbvi.edu/math/67-early-childhood/1074-overview-of-technology-for-visually-impaired-and-blind-students
27. Assistive Technology for Students who are Deaf or Hard of Hearing, http://www.wati.org/content/supports/free/pdf/Ch13-Hearing.pdf

Smart Education and e-Learning 2016
Uskov, V.L.; Howlett, R.J.; Jain, L.C. (Eds.)
2016, XII, 643 p. 153 illus., Hardcover
ISBN: 978-3-319-39689-7