Accessible Online Education: Audiovisual Translation and Assistive Technology at the Crossroads

Emmanouela Patiniotaki

Imperial College London, Translation Studies Unit, South Kensington Campus, London SW7 2AZ, UK
emmanouela.patiniotaki08@imperial.ac.uk

Abstract. The purpose of this paper is to give prominence to the potential of the combination of access services emerging within Translation, and more specifically Audiovisual Translation and what is also known as Accessible Media or Media Accessibility, with Assistive Technology tools, which have been more widely realised as the media for accessibility. Through a thorough investigation of access provision practices within the two fields, the research aims to combine the best applications within the two fields to suggest potential implementation of AVT and AST elements towards accessible online educational environments while catering for the needs of students with sensory impairments.

Keywords: online education, assistive technology, audiovisual translation, accessibility, access services, subtitling, audio description, deaf, hard-of-hearing, sensory impairments, blind, partially sighted.

1 Introduction

In the age of e-Inclusion (European Commission, 2010) and equality in opportunities, it is crucial to define research by the skopos[1] it serves and combine knowledge in order to make it more effective and useful to society. In the case of accessibility and access services, it is particularly difficult to conduct fruitful research that would be of factual value for people with sensory impairments due to the complexity of its nature. Two completely heterogeneous and relatively new fields of research, Assistive Technology (AST) and Audiovisual Translation (AVT), have given signs of prosperity with regard to access services, particularly with the aim to provide accessible educational material on the Web. However, their combination is not an easy task, especially with the absence of a common theoretical background applying to educational purposes. The multiple risks of the 'uncontrolled' use and provision of access services regarding their source, manner of provision and coverage, make such an attempt an extremely challenging one, especially considering the purpose of such provision in

[1] Term used in Translation to indicate the 'purpose' satisfied through a translation task, as introduced by Vermeer [1]. It is expressed as IA(Trl) = f(Sk) (ibid: 100), indicating that translation is a function of its purpose. Adopted in this research in a wider context, to indicate the purpose of an attempt to provide content through the use of assistive practices.

C. Stephanidis and M. Antona (Eds.): UAHCI/HCII 2014, Part II, LNCS 8514, pp. 388–399, 2014.

education, meaning accurate and informative-educational transmission of input. The lack of visibility in the potential of AVT towards that end, as well as the lack of training and information about AST and its use might hold this attempt back. Still, the plentiful points of join and the usefulness of such a combination for the provision of a more holistic and inclusive approach in online education could overcome those barriers.

2 AVT, Access Services and AST

2.1 Access Services within Translation and AVT

AVT is widely considered as a field that is limited to screen translation, i.e. translation for cinemas, DVDs and TV programs, and thus that the skills required for the translation of AV material by AVT practitioners are limited to the translation of its content and their ability to use software for its preparation, taking into consideration mainly linguistic and technical restrictions, such as synchronization between text and sound, syntax, etc. The value of AVT services as means of access to entertainment for people with sensory impairments has led to a recent research trend towards the use of specific AVT types with the aim of accessibility, meaning the availability of content to people with sensory impairments, which they would otherwise not be able to access. These AVT types have evolved according to the purpose they serve and have led to the gradual establishment of access services within AVT.

The two main types of AVT put under the microscope for the needs of the current research are Subtitling for the deaf and hard-of-hearing (SDH) and Audio Description (AD). SDH is subtitling produced for deaf and hard-of-hearing viewers, featuring audiovisual material which is either broadcast or watched in any form of distribution of audiovisual material. It might also be used to advance interaction through the Internet and in technology applications in general (e.g. video games), often with an educational aim addressing a wide audience, too. SDH can be both intralingual and interlingual, two terms introduced by Jakobson [2]. Intralingual SDH is performed within the same language, i.e. from Greek into Greek for deaf and hard-of-hearing, while interlingual SDH is the same process albeit between one or more different languages, i.e. English into Greek for deaf and hard-of-hearing. SDH differs from typical interlingual subtitles mainly because it adheres to slightly different norms as far as the reading speed and the syntax of the subtitle content is concerned, and it includes additional information (e.g. indication of speakers through the use of standard colouring of the subtitles associated to them) [3]. AD is a process that "provides a narration of the visual elements – action, costumes, settings, and the like – of theatre, television/film, museums exhibitions, and other events" and it "allows patrons who are blind or have low-vision the opportunity to experience arts events more completely – the visual made verbal" [4]. AD falls under the intersemiotic category of translation as he describes this practice as "the conversion of nonverbal signs into words" [5].

The matter of succession between conventional AVT and AVT in the form of access services is very complex considering that the first form of subtitles, intertiles, was not actually used to translate context between different languages, but rather to

transmit a message for purposes of comprehension. This fact alone is a proof for the rightful study of access services within the branch of AVT, which is also reinforced by the notion that "Accessibility is a form of translation and translation is a form of accessibility, uniting all population groups and ensuring that cultural events, in the broader sense of the word, can be enjoyed by all" [6]. Orero and Neves trace two mainstream access services, audio description (AD) and subtitling for the deaf and hard-of-hearing (SDH), back in the 1940s (for AD) and the 1970s (for SDH) in Spain and the UK respectively [7-8]. However, it was not until the last decade that AVT researchers took the plunge to call attention to access services within the academia, following their advent and use on a rather steady base on public and private TV channels around Europe. Media Accessibility is defined as "a new research line which has been perfectly accommodated under the umbrella of AVT studies" [9].

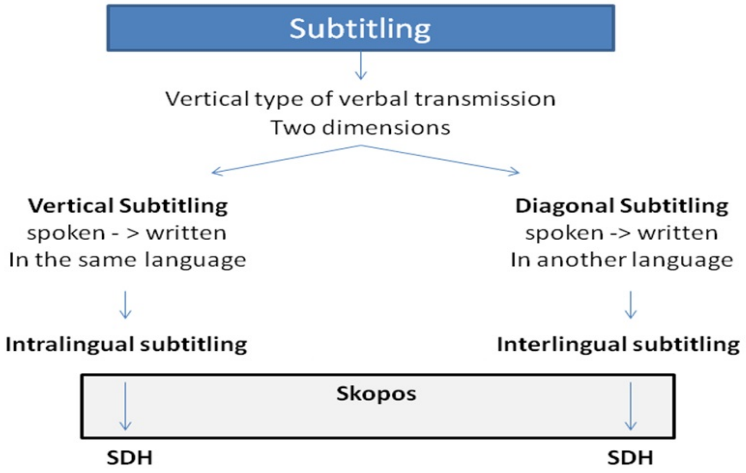

Fig. 1. Gottlieb and Jakobson's theories combined with skopos in SDH [2, 10-11]

The challenge of the transmission channel in Translation and AVT, along with the skopos served each time, forms a very solid basis for the explanation of the main differences between conventional and access AVT. While in Translation and Interpreting, the two main types of Translation, the verbal transmission is one-dimensional, i.e. transferring/translating spoken material to spoken material of text material to text material between two languages, Gottlieb identifies subtitling as a two-dimensional translation practice, since it can be both vertical and diagonal, terms relevant to what Jakobson describes as intralingual and interlingual [10]. In subtitling the media of transmission changes completely, making SDH a different task to that of conventional subtitling. On top of the common challenges of subtitling, with SDH there is the need to transfer sound, style, tone, etc. into image through 'translation' and there is a whole different skopos, i.e. to allow people to access the input of the screen and based on the type of input, meaning access-education or access-entertainment (Fig. 1). The task is also challenging with AD, and it is claimed within the AVT industry that audio describers need to be extremely skilled professionals, since they

need to do the opposite, often with more restrictions (time, length, resources, etc.). The audio describer needs to turn any visual elements into sound, changing the skopos of a conventional documentary commentary or voice-over, while this description of theirs does not always carry a meaning expressed with words, but rather faces, behaviors, etc.

2.2 Assistive Technology on the Web for Sensory Impairments

During the last decades, Assistive Technology has been gaining ground within Information and Communications Technology (ICT), Human-Computer Interaction (HCI) and the Web, providing various ways to make the use of computers possible, easier and more flexible for people with disabilities. The first instance of modern AST[2] in the broader term of "any item, piece of equipment, or system, whether acquired commercially, modified, or customized, that is commonly used to increase, maintain, or improve functional capabilities of individuals with disabilities" (section 508 ADA) [12], dates as early as in 1874 with the invention of the audiophone bone conduction amplifier. Assistive Technology no longer limits itself to assistive and adaptive hardware as introduced by the Individuals with Disabilities Education Act of 1990 in the United States. More recent definitions of AST, for example "any item, piece of equipment, or product system… that is used to increase, maintain, or improve functional capacities of individuals with disabilities" [13], are much more inclusive and more relevant to the current research context. Software developments, such as screen readers, are gradually substituting hardware since they have proved to be affordable, more practical and rather multifunctional, and in many cases accompany them in their use for more effective results. With the development of the field, assistive technology can be categorized even further according to the disabilities it caters for, e.g. mobility, visual and assistive listening, since it encompasses multiple resources.

However, another two important parameters need to be considered within the context of assistive technology used in education by people with sensory impairments, – which is the scope of the Accessible Online Education research– although those parameters could facilitate the choice of AST in different contexts and for different purposes too. The mere provision of AST, no matter how well it has been matched to the needs of the intended user, will probably not suffice without the right interventions that will enable the proper use of a given technology [14]. Within this context, such interventions need to be provided and communicated by educational and social institutions to trainees and their families/support mechanisms. Interventions in a more wide sense could vary from training to use of supplementary aids and their aim is for users to handle technologies effectively. Another important parameter is the nature of assistive technologies: hardware or software, online and offline, by the user or by the provider (e.g. website host), as well as features of assistive technology that rank them in the continuum of low and high-tech assistive tools for young children with disabilities, including factors like cost, training requirements and transportability [15].

---

[2] As opposed to assistive tools that have accompanied human nature since its existence, e.g. wooden splints.

People with sensory impairments use assistive technologies in their everyday life through commonly used devices, in order to satisfy the basic needs of communication, information and entertainment. In education, these also include from expanded keyboards to on-screen tools. At the same time, several applications are implemented 'internally', by specific hosts/providers of applications and services, making life even easier for users who visit their websites. The Web is an area that has massively affected the growth in use of assistive technologies and set the ground for the development of online and user-interface-based solutions, like screen readers. The new, more democratic 'Web for all' opens new possibilities in education. With regulations and directives demanding it, like the eGovernment Action Plan of the European Union and the European Accessibility Act of the EU Disability Strategy for the decade 2010-2020, as well as guidelines that instruct developers and content providers in order to achieve this goal, like the Web Content Accessibility Guidelines of the World Wide Web Consortium (W3C), AST on the Web has been gaining ground and spreading very fast. Even if "improvements in Web accessibility have arisen, in part, as side effects of changes in Web technology and associated shifts in the way Web pages are designed and coded" [16], they have played a crucial role in the inclusion of users with sensory disabilities on the Web.

3 SDH and AD: Assisting Users on the Web

According to version 2.0 of the W3C guidelines [17], developers need to provide alternatives for time-based media when they offer such material on their websites. These alternatives include equivalents for pre-recorded audio-only and video-only media, captions, conventional or extended/descriptive audio description for pre-recorded media, as well as live captions for live audio content in synchronised media. With this step, SDH and AD establish their role as access services in online contexts. Before that, SDH and AD were mostly present on the Web either in the form of amateur services provided by AVT enthusiasts (e.g. in the form of fansubbing[3]) or as parts of pre-recorded material whenever providers decided to publish this material on the Web. The HTML5 development made the inclusion of forms of SDH and AD easier for developers. HTML5 is the outcome of the collaboration between the Web Hypertext Application Technology Working Group and W3C. It natively supports video without the need for third party plugins. Its <video> and <audio> elements can be inserted in a website's code for media playback while the <track> element allows authors to specify alternatives, or more correctly, support content to multi-media content.

These developments might seemingly favour SDH, AD and AST, still they have brought about big changes to the nature and preparatory process of the services. The first major change with regard to AST was the emergence of the "open source

[3] Fansubs or amateur subtitles are subtitles created by fans who want to watch movies or television broadcasts by downloading them from the Internet. Their quality is widely questioned as they do not adhere to specific guidelines or rules and thus they can be very creative or sometimes too unconventional.

movement" [18], which is based on the general idea that software product distribution should go hand in hand with source code distribution for successful implementation. This kind of software includes infrastructure technologies, server and desktop operating systems, Web browsers, desktop application software and Web applications, but its implementation lacks long-term support or comprehensive user documentation and causes issues with regard to data sensitivity [18]. It is also significant that once they are applied on the Web, access services and tools are nowadays implemented to several devices very fast, including smartphones and iPads, as well as new Web products, like "the cloud" and Web/hybrid TV, making the task even more complex.

These developments, in turn, require more labour and time, which has led to the rise of crowd-sourcing, as well as mechanic and synthesized "on demand" or real-time captioning and AD, two trends that are widely accused of threatening the quality of access services, especially in terms of accuracy and precision. Synthesized AD, speech-to-text narration, video description and annotation, are some of the latest developments in the field of synthesized speech and voice recognition that attempt to substitute audience-targeted and humanly produced SDH and AD. The possibilities they offer, especially with regard to AD, are many and they include text-to-speech narration for AD that has been initially produced by the script editor and annotation for the enrichment of videos with the use of speech synthesis and earcons (i.e. non-verbal audio messages) by enrichment producers [19]. In an attempt to evaluate synthesized video descriptions, Kobayashi et al. [20] conducted research in Japan and the USA and reached the conclusion that they are generally accepted regardless of the quality of language, but that they should be used where the aim is to inform rather than to entertain. This conclusion supports access services as seen within AVT, i.e. services provided for people with sensory impairments, in order to satisfy their particular needs.

With regard to subtitling, crowdsourcing has become available through both simple and more sophisticated means. Open source software and platforms hosting audiovisual material offer users a simple working environment in order to create captions for their videos or to acquire captions that have been produced through machine translation and speech recognition. The open availability of subtitles for editing purposes, the lack of conventions that make them address deaf and hard-of-hearing audiences, as well as the lack of identification of their editors can often contribute to questioning their quality and usefulness. At the same time, networks of crowdsourcing subtitling are being built in an attempt to produce fast real-time captioning with minimum latency and maximum precision with hybrid contributors, rather than solely humans. One indicative example of crowd-sourced subtitling is Legion:Scribe, a system that "captions speech on-demand and with less than 3 seconds latency", as the company claims, "by automatically merging the simultaneous input of multiple crowd workers" [21].

Although these developments seem to undermine the importance of the human factor in the process of SDH and AD preparation —and automatic captioning is nowhere near proper SDH with regard to the skopos it serves since it does not include the conventions that make SDH subtitling for deaf people through the provision of acoustic information or conventions used for identification of speakers, etc.—, they have led to a number of positive developments and realizations. AD is now also treated as a tool

for navigation for blind and illiterate people, while new types of AD have made their appearance, adding value to the access service and attracting more researchers. A new kind of "enhanced AD" has been proposed with the aim to attract a wider audience, including visually impaired viewers, and to turn AD into a "revenue generation product widely adopted by production companies" [22]. Another suggestion in the field is "Dynamic Captioning approach" with the implementation of a number of technologies, including visual saliency analysis and face detection, for the enhancement of AD with scripts that aid comprehension of the video material [23]. A similar approach is that applied by the Smith-Kettlewell Video Description Research and Development Center, which advanced video annotation methods for use in various educational settings. Within this technological bloom, the existence and importance of SDH and AD are spread to countries where the provision of access services is at a very low level. However, it is crucial to differentiate between conventional captioning and SDH and in the case of synthesised or crowd-sourced captioning, the realisation of the need of the human mediator in order for captions to serve SDH purposes plays an important role when these methods are suggested for the provision of online educational material.

4 Accessible Online Education

The value of AV material in education was recognized long before computers existed in class. With the use of video recorders and TV sets, students could watch video tapes with educational content. And although technology would seem to promote the use of AV material in education, the paradox of different perceptions can be summarized in the following quotes [24-25]:

> "We know the importance of pedagogy in the use of audio-visual aids. […] …we must look at audio-visual aids and the various questions which they raise." (Lestage in UNESCO)

> "Given the speed constraints of networks today and the lack of necessary hardware and software available to learners, we advise instructors to use multimedia resources sparingly." (Haughey and Anderson)

The paradox is not limited to the fact that technology should enhance the use of other than the traditional teaching models. It is the time when these quotes were made that could intrigue education specialists as it would be expected that technology would be seen as an aid rather than a hurdle in class in the 1990s. However, different provisions and contexts within educational institutions might have led to people being discouraged to use AV material, as well as advanced technologies in class. Nowadays, AV material has a dominant position in education. A major factor that has contributed to that is their availability on the Web, as well as new technologies that have made their use and reproduction much easier for educators. With the advent of podcasts, webinars and video file hosting services online (e.g. TeacherTube), education has found an enormous resource both for students and teachers, whether this is indeed used in class or not.

AVT has often been studied in terms of its potential in education and has mostly been related to second language learning. However, and especially during the last decade, SDH and AD have been examined as tools for education and have both been associated with Special Education in particular. While SDH and AD gain their position in entertainment, they are gradually being discovered from the angle of education for people with sensory impairments, as well as in second language acquisition. Since 2008, research has indicated that AD is a very useful tool for children's education, yet it is necessary to adjust it to the particular age and general needs of the intended audience. Described and captioned media have proved to be important in learning environments with the aim to raise literacy levels, while SDH proves to be functional for deaf children. SDH is greatly valued as a service that advances learners' reading and writing skills in the same way that AD enhances their speaking and listening skills. At the same time, and from a more sociological point of view, SDH bridges the gap between pre-lingual and post-lingual deafness, since it provides a solution for those who use sign language as well as people who lost their hearing at a later stage in their lives and in many cases prefer not to learn another language, but rather use written texts as a means for communication. Finally, just as SDH and AD have been designed for particular audiences and they end up being used by wider groups of people (e.g. elderly or illiterate), they can cater for more disabilities and learning difficulty-related problems, such as dyslexia and color blindness.

Online Education, e-Learning or Online Learning are three terms generally used to refer to education provided on the Web with the use of ICT technology. The material provided in the context of Online Education can be distinguished between those used in class or as supplementary class content/resources and those provided on the Web alone as individual online courses. Computers were used in education since the 1960s, when the first virtual classroom was formed in the University of Illinois. Computer-assisted training in class was introduced in the 1970s, while the first online courses appeared as early as in the 1980s. Web-based learning is generally differentiated among three models [26]: Web-support for information storage, dissemination and retrieval, Web-support for two-way interaction and Web-based teaching, all of which are currently performed with the use of AV material through virtual libraries, video-calls, live lectures, etc. Today, many universities around the world offer online courses where students can attend and participate in a virtual class using their computer. With the e-Inclusion policy of the European Commission, the elevation of the idea of the 'accessible Web' with standards and guidelines that make it inclusive, as well as the prominence of AST and access services, e-Learning gains more potential by addressing wider audiences and provides opportunities for development in online accessibility. Two trends can be observed in the use online contexts for higher education with or without the support of assistive technology. Universities might offer online courses or resources but avoid the use of AV material (live or pre-recorded), while they might also use online platforms for educational purposes without making the material accessible to users. Many universities include non-accessible AV material on their general websites and others make attempts to provide access services, for selected material in most cases, but do not do so collectively, i.e. by providing these services in an overall accessible context and at a regular pace. In a multi-method

analysis conducted by Kane et al. for home pages of 100 top international universities, results showed that there are still many accessibility problems that are in essence obstacles to accessible Online Education [27].

Using a Functional Accessibility Evaluator, they measured the functionality of home pages. Although this sample is partial as the research does not examine the provision of online AV material or even whole websites, since the status of the home page of each university indicates that on average accessibility guidelines are only partially implemented, then it could be argued that these universities did not seem to offer a friendly environment to people with disabilities. However, based on the Europe 2020 Initiative, it is expected that educational institutions will have to provide accessible Online Education within the idea of "accessibility as a right for all" (European Commission, 2010) [28] with focus on digital technologies and assistive tools. As distance learning is becoming more popular within and outside Europe, educational institutes could benefit from the provision of accessible educational material, both AV and other (e.g. editable texts allowing magnification, selection, screen-reading, etc.), as such a provision would attract more students, as well as set the grounds for more in-depth and pioneer research in education from several angles (including Special Education and Sociology).

A number of products, most of which result from research projects in the field of AST, have emerged as an attempt to provide more inclusive solutions with regard to Online Education and AV material, still offering various levels of accessibility, rather than holistic solutions. Most of them seem to focus on assisting either deaf and hard-of-hearing or blind and partially sighted students. Some interesting recent research projects include ClassInFocus, DELE, SSTAT, MVP and the Photonote system.

Table 1. Functional accessibility of top 100 university sites (Kane et al.: 153).

Functional category	Average error (%)	Accessibility status
Navigation & Orientation	36.07	Not Implemented
Text Equivalents	51.24	Partially Implemented
Scripting	54.00	Partially Implemented
Styling	50.95	Partially Implemented
HTML Standards	69.74	Partially Implemented

SSTAT (Semantic and Syntactic Transcription Analysing Tool) provides accurate lecture transcriptions through analyzing and editing Automatic Speech Recognition-generated transcripts, while ClassInFocus offers in-class information in one screen, allowing deaf and hard-of-hearing students to engage in group work, capture the class to review any missing information and observe sign language interpreters along with the instructor. The Photonote system combines visual information in the same way to provide pre-recorded lectures to deaf and hard-of-hearing students. DELE (Deaf-centered E-Learning Environment) is a fully-iconic e-learning environment through

which tutors can "define, generate and test e-learning courses for deaf people, which are automatically managed, published and served by the system itself." [29]. Finally, MVP (Multiple-View Platform) can be used by students in class to edit lecture visuals through their own devices, as well as cooperate in groups.

Most of the research conducted in the field focuses on the provision of captioning for deaf students and it seems that this is also the trend in commercial solutions obtained by universities around the world. Among the most prominent commercial solutions that are in use are Panopto, Tegrity, MediaSite and Echo306. All of them are systems which form learning environments that capture video, audio and screen activity. They support captions, whether these are produced by people or machines (speech-to-text technologies) and offer users the opportunity to edit videos, make notes annotated to the video, as well as have access to further material provided by the instructor, e.g. PowerPoint presentations. Individual open-source solutions that allow providers to create accessible AV material through AD and captioning include Amara, YouTube, MAGpie, CapScribe and LiveDescribe. These are tools rather than learning solutions, which however satisfy the needs of both blind and deaf students when combined accordingly by teachers. Finally, large-scale projects funded by the EU are gradually aiming towards educational solutions for students with sensory impairments with the use of AVT and other related practices, with the example of ClipFlair (2011) which aims to develop an online social network for the provision of material for learning languages purposes through a series of access services (including captioning and re-voicing) and lesson plans that allow learners to practise their speaking, listening, reading and writing skills.

5 Concluding Remarks

Based on the above, it is important to provide holistic solutions that will encompass the needs of all students with sensory impairments. AST and access services have proved to be the catalysts towards that direction, but what is missing is a functional approach that will allow students to enter learning environments as self-serviced individuals, an idea introduced by Cornford and Pollock [30], illustrating the meaningfulness of Web-based learning for the students who use it avoiding the need for guardians in education. Towards that end, and based on the specificity of the skopos for the provision of access services, the latter should be respected in terms of their nature too. Where synthetic and machine-oriented solutions are not appropriate in education, solutions that provide this kind of accessibility should be critically viewed and carefully chosen. It is also important to re-evaluate the existing standards and guidelines for the provision of accessible content on the Web. These guidelines may often make demands for accessible AV material, still they do not specify the process of their production and provision. Finally, AST tools and access services should be combined in order to achieve that aim and maybe the best place to start is by bridging the gap between these disciplines at a research level. The Accessible Online Education research aims to (a) set the theoretical background for the collaboration of the two fields, (b) provide an overview of attempts towards the design and effective use

of accessible educational environments and (c) data for the level of accessibility offered by selected universities through an online survey, and (d) make a coherent and practical suggestion for the design of a new universal educational platform that will cater for the needs of the intended users in higher education as it is provided online. The research considers all the limitations explained in this paper, giving emphasis to the quality of educational material which is considered crucial.

References

1. Vermeer, H.J.: Skopos and commission in translational action. Chesterman A (trans.). In: Venuti, L. (ed.) The Translation Studies Reader, pp. 221–233. Routledge, London (2000)
2. Jakobson, R.: On Linguistic Aspects of Translation. Harvard University Press, New York (1959)
3. Ivarsson, J., Carrol, M.: Subtitling. TransEdit, Simrishamn (1998)
4. Snyder, J.: Fundamentals of Audio Description. Teaching Audio Description: An On-Line Approach. In: 4th International Conference Media for All 4, June 28-July 1. Imperial College, London (2011)
5. Díaz Cintas, J.: Audiovisual Translation Today – A Question of Accessibility for All. Translating Today 4, 3–5 (2005)
6. Díaz Cintas, J., Orero, P., Remael, A. (eds.): Media for All: Subtitling for the Deaf, Audio Description, and Sign Language. Rodopi, Amsterdam (2007)
7. Orero, P.: Sampling Audio Description in Europe. In: Díaz Cintas, J., Orero, P., Remael, A. (eds.) Media for All: Subtitling for the Deaf, Audio Description, and Sign Language, pp. 111–125. Rodopi, Amsterdam (2007)
8. Neves, J.: Audiovisual Translation: Subtitling for the Deaf and Hard of Hearing. Roehampton University, London. PhD Thesis (2005)
9. Díaz Cintas, J., Matamala, A., Neves, J. (eds.): Media for All 2: New Insights into Audiovisual Translation and Media Accessibility. Rodopi, Amsterdam (2010)
10. Gottlieb, H.: Teaching Translation and Interpreting 2: Insights, aims and visions. In: Dollerup, C., Lindegaard, A. (eds.) Papers from the Second Language International Conference Elsinore 1993, pp. 262–274 (1994)
11. Patiniotaki, E.: An approach to subtitling for deaf and hard of hearing audience in Greece. Dissertation. Imperial College, London, pp. 41–43 (2009)
12. Information and Technological Assistance of the Americans with Disabilities Act (ADA): SECTION 508 SURVEYS and REPORTS, http://www.ada.gov/508/
13. SEDL: Empowering Rural Students with Disabilities Through Assistive Technology, http://www.sedl.org/rural/seeds/assistivetech/atdefine.html
14. Lancioni, G.E., Sigafoof, J., O'Reilly, M.F., Singh, N.N.: Assistive Technology: Inteventions for Individuals with Severe/Profound Multiple Disabilities. Springer Science and Business Media, New York (2013)
15. Parette, H.P., Parette Jr., H.P., Murdick, N.L.: Assistive Technology and lEPs for Young Children with Disabilities. Early Childhood Education Journal 25, 3 (1998)
16. Richards, J.T., Montague, K., Hanson, V.L.: Web Accessibility as a Side Effect. In: ASSETS 2012, Colorado, October 22-24, pp. 79–86 (2012)
17. World Wide Web Consortium (W3C). Web Content Accessibility Guidelines (WCAG) 2.0 (2008), http://www.w3.org/TR/WCAG/
18. Heron, M., Hanson, V.L., Ricketts, I.: Open source and accessibility: advantages and limitations. Journal of Interaction Science 1 (2013)

19. Encelle, B., Ollagnier-Beldame, M., Pouchot, S., Yannick, P.: Annotation-based Video Enrichment for Blind People: A Pilot Study on the use of Earcons and Speech Synthesis. In: ASSETS 2011, Dundee, October 24-26, pp. 123–130 (2011)
20. Kobayashi, M., O'Connell, T., Gould, B., Takagi, H., Chieko, A.: Are Synthesized Video Descriptions Acceptable? In: ASSETS 2010, Florida, October 25-27, pp. 163–170 (2010)
21. Rochester Human Computer Interaction (ROC HCI): Legion:Scribe (2012), http://hci.cs.rochester.edu/currentprojects.php?proj=scb
22. Sade, J., Naz, K., Plaza, M.: Enhancing Audio Description: A Value Added Approach. In: Miesenberger, K., Karshmer, A., Penaz, P., Zagler, W. (eds.) ICCHP 2012, Part I. LNCS, vol. 7382, pp. 270–277. Springer, Heidelberg (2012)
23. Hong, R., Meng, W., Mengdi, X., Shuicheng, Y., Tat-Seng, C.: Dynamic Captioning: Video Accessibility Enhancement for Hearing Impairment. In: MM 2010, Firenze, October 25-29, pp. 421–430 (2010)
24. UNESCO. UNESCO Chronicle: The use of audiovisual aids in education (1959), http://www.unesco.org/education/nfsunesco/pdf/LESTAG_E.PDF
25. Haughey, M., Anderson, T.: Network Learning: The Pedagogy of the Internet. Chenelière/McGraw-Hill, Montreal (1998)
26. Aggarwal, A.: Web-based Education. In: Aggarwal, A. (ed.) Web-Based Learning and Teaching Technologies: Opportunities and Challenges, Idea Group Publishing, Hersley (2000)
27. Kane, S.K., Shulman, J.A., Shokley, T.J., Ladner, R.E.: A Web Accessibility Report Card for Top International University Web Sites. In: W4A 2007 Communications Paper, Banff, May 7-8, pp. 148–156 (2007)
28. European Commission: Digital Agenda for Europe: A Europe, Initiative – Action 63: Evaluate accessibility in legislation (2020), http://ec.europa.eu/digital-agenda/en/pillar-vi-enhancing-digital-literacy-skills-and-inclusion/action-63-evaluate-accessibility
29. Bottoni, P., Capuano, D., De Marsico, M., Labella, A., Velialdi, S.: Experimenting DELE: a Deaf-centered e-Learning Visual Environment. In: AVI 2012, Capri Island, May 21-25, pp. 780–781 (2012)
30. Cornford, J., Pollock, N.: Putting the University Online: Information, Technology and Organizational Change. SRHE and Open University Press, Buckingham (2003)