BrailleApp
Educational Mobile Application to Assist in the Learning of Braille Language

Raul Benites Paradeda[1], Ailton Francisco de Luna e Silva[1], Jones Granatyr[2] and Alberto Signoretti[1]
[1]*Research Group of Computational Intelligence, Computer Science Department of University of State of Rio Grande do Norte, Av. Dr. João Medeiros Filho, s/n - Potengi, Natal - RN, 59120-200, Brazil*
[2]*Research Group of Computational Intelligence – University of Contestado, Jaquim Nabuco Street, Porto União-SC, Brazil*

Keywords: Braille System, Accessibility, Android Platform, Educational Application.

Abstract: Aiming to facilitate the learning process of the Braille System, we developed an educational application to assist people for learning this system. We developed the application initially in Portuguese, it was named as BrailleApp, and it was designed for mobile devices, which uses the Android Platform. All accessibility standards were implemented to make it as accessible as possible to all people, helping visually impaired people and not visually impaired in the learning process of this language. In this first version, the help to learning Braille is specifically to not blind people, although, with some difficulties, it is possible a blind person use the application. In future versions we hope to improve and facilitate the use of this application by blind people too. It is important to emphasize we do not intend to replace the conventional methods which assist in this task, but to be an application to complement the already existing techniques. In an empirical analysis, the results show that the application was positive in the sense of system requirements, functionalities, and accessibility. We expect BrailleApp will be another option to assist users in the teaching-learning process and contribute to the social integration of visually impaired with technologies.

1 INTRODUCTION

The use of educational tools as teaching resources aims to facilitate the educational processes, which led students to build knowledge about specifics subjects. The inclusion of technology in education brought a range of new possibilities to facilitate these learning processes.

One of those possibilities is the Educational Software (ES). According to Oliveira et al. (2001, p.74), an ES must have the following features to help in the interactive knowledge construction processes:

- Grounded in pedagogical resources to enable its understanding;
- Didactics purposes to lead students to build knowledge about the observed subject;
- Interaction between the student and the software;
- Ease to use and not requiring specifics or advanced knowledge in technology, permitting that anyone can use the software easily and in a fast way, even in the first contact.

In addition to knowledge construction, they also are focused on social aspects, where communication plays an important role, such as verbally or gestural (Carrão, 2006) (Goldin-Meadow, 1999). For instance, a visually impaired person may find many difficulties to communicate in writing languages, since people around may not know how to communicate in the Braille System.

This fact will represent a social problem to this person; once he/she will not be enabled to communicate his/her needs to other people. A possible solution for this problem is the existence of computational tools which helps in the learning process of Braille language, so it would be easy to people who present or not visual deficiencies. Based on this, the first version of our application is based on an educational mobile application directed to sighted people, especially the ones who are beginners on Braille. Indeed, a blind person used the application with some difficulties. We hope that in the next versions it could also be used by blind people in an easy way, such as using a Braille panel, to be still developed. However, to facilitate the use, the application was developed based on the concept of Universal Design, which presents accessibilities guidelines by the application of services and accessibility features. We hope we can encourage and increase the use of Braille, as well as provides social

Paradeda R., Francisco de Luna e Silva A., Granatyr J. and Signoretti A..
BrailleApp - Educational Mobile Application to Assist in the Learning of Braille Language.
DOI: 10.5220/0005427805230529
In *Proceedings of the 7th International Conference on Computer Supported Education* (CSEDU-2015), pages 523-529
ISBN: 978-989-758-108-3

inclusion to the technological world to visually impaired people. Importantly, initially the application was implemented in Portuguese to attend the local community.

The remaining part of this paper is organized as follows: Section 2 presents the Braille language and its main features. Section 3 approaches a briefly overview about the Android Platform we used as a base to the application development. Section 4, in turn, shows techniques to ensure usability, as well as tests that can be employed to guarantee the quality. Section 5 describes the developed application, while Section 6 discusses the obtained results and ideas about future research. Finally, Section 7 concludes the paper.

2 BRAILLE SYSTEM

The Braille system was created by Frenchman Louis Braille in 1825 (Bickel, 1988). From 1854 the Braille system was adopted in Brazil in its original form, but in mid-1940 it was necessary to make some changes due to spelling issues according to Portuguese language. Since 1996, the Braille commissions from Brazil and Portugal have been working together in the development of a normative document to standardize the system. Nowadays, this cooperation has legal support in the Collaboration Protocol Brazil/Portugal in the Mobility Application of Braille system, which was signed in Lisbon on May 25, 2000 (Brasil, 2006).

2.1 Understanding Braille

The Braille system is composed by 63 symbols or signs formed by the combination of six raised dots arranged in two columns of three dots (Fig. 1). This arrangement of points is called as the fundamental signals and the space it occupies is called Braille cell. By this, it is possible to represent letters, numbers, mathematic and scientific symbols, signs used in music and in computer contexts, being considered the best alternative regarding communication to visually impaired people (Brasil, 2006).

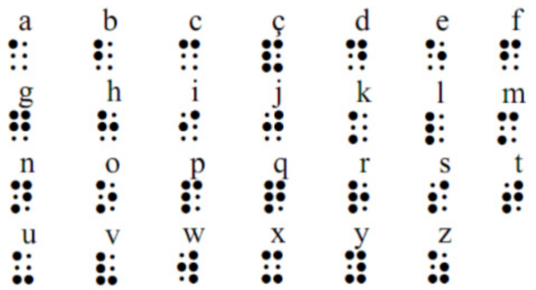

Figure 1: Braille Alphabet.

Aiming to make its understanding easy, the dots which form the signals are numbered from one to six, from left to right, and from top to bottom. As example, the first column is represented by the numbers 1, 2 and 3 while the second column is represented by the numbers 4, 5 and 6.

2.2 Reading Braille

To read Braille is necessary to feel the symbols from left to right and usually using the forefinger, but some people prefer using the middle finger or the ring finger (SAC, 2014) (Bertelson et al., 2007).

To facilitate the reading of the symbols, the raised dots in a cell Braille (Fig. 2) must be accurate and have the same dimension (Bruno, 2006) (Loomis, 1981).

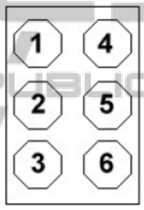

Figure 2: Braille cell in reading mode.

2.3 Writing Braille

Braille symbols can be written basically in two different levels. The first one is called integral Braille and the words are written in full and character-by-character (signal by signal). On the other hand, the second level is called abbreviated Braille and the words can be abbreviated and one signal may represent two or more letters of a whole word (Brasil, 2006).

Technological development brought some instruments created to help in the writing task, and some common examples are “reglete” and “puncture” and the Braille typewriter (TECE, 2014).

2.4 Application Standards

Most part of the symbols retains its original meaning of the French language; however, there are some signals that are represented by unique signs of Braille. Usually, the signals are applied according to the normative of the current language and there are norms and standards that must be followed.

We recommend the work by Brasil (2006) for a wide and deep view of the Braille language.

3 ANDROID PLATAFORM

Android is a complete platform focused in mobile devices, which is composed by a set of software's on a flexible layer compound by an operating system, a middleware, and applications (Komatineni and MacLean, 2012).

The main reasons for the use of this platform in our work are the following: (i) it is a free platform, which permits the use of its APIs (Application Programming Interface) without investment; (ii) it offers a rich API that includes accessibility resources; (iii) it is based on the Java programming language, which is one of the most used on this kind of application (TIOBE, 2014); and finally, (iv) it is the most used platform for mobile devices according to Data Corporation (IDC, 2014), allowing to reach many users.

We recommend the work by Deitel and Deitel (2014) to have more details about Android.

4 ACCESSIBILITY IN ANDROID

According to the official website for Android developers, one of the main objectives of the platform is to provide resources which allow the presentation of useful and accessible information (Android Developer, 2014a). In this context, accessibility is seen as a measure about the success of a product, and its mission is applied to all users, including visual impaired, color-blinded, hearing impaired, and motor limited.

An important concept in the accessibility field is the Universal Design, which consists in the development of products that are accessible to all people regardless their personal characteristics, age or abilities. Its main idea is about a unique design that will avoid the need for special products directed to disabled people (Steinfeld and Maisel, 2012).

Android provides several accessibility tools to assist impaired people in the execution of their tasks, facilitating navigation on the device and the execution of applications. Most part of these tools are directed to visually impaired people, and it is included resources such as screen reader, explore by touch, navigate through gestures and directional controllers. There are also other accessibility features that allow increase font size, change audio options, change speed of reading, and define the voice synthesis engine.

To a broad view of all resources provided by the platform, we recommend the consult of the Android Developer (2014b).

4.1 Developing Accessible Applications

To improve accessibility and guarantee usability of an application, especially in the creation of interfaces using standard Android components, some steps are necessary according to Android Developer (2014c):

- Add descriptive text in user interface controls, especially in images, button, and checkbox;
- Verify if all interface elements which work with inputs controls (touch or typing) can be achieved with a directional controller, as a trackball, D-pad, or a navigator by gestures, for instance;
- Verify if all warning audios are always accompanied by other visual alert or notification. It will help visually or hearing impaired users;
- And finally, test the application using only accessibility resources.

4.1.1 Guidelines

According to Android Developer (2014d), to guarantee a considerable level of accessibility on Android applications, the following guidelines must the respected:

- Intuitive navigation: users must always know where they are in the application regardless their limitations. A well-structured project is necessary to allow the construction of a mental map of the system, a user-friendly navigation, and a tactical, audible, and visual feedback. Directional navigation is also suitable;
- Use of suitable sizes for touch elements: the recommended size is 45dp (density-independent is a virtual unit related to screen size). However, educational applications demand the use of larger elements;
- Alternatives to display temporal elements: users cannot perceive elements on the screen that are displayed for a period of time and then they disappear. As an example, a screen reader should not present a temporary text unless it is focused, otherwise users may not know its content.

Also according to Android Developer (2014d), there are some others guidelines which can influence the performance of accessibility:

- Tooltips in text fields: it is recommended to set help texts to indicate the expected content when the field is empty;
- Controls with more than one function: controls or buttons which change their function according to the context of the application should provide audio prompts to indicate its current state;
- Images and decorative graphics: this kind of

elements, especially the ones which do not present content or do not allow actions should not be having accessibility descriptions.

There are other special cases, such as the implementation of custom user interface through Android API, which should be observed and taken into account to provide better accessibility. The compliance of these guidelines must be followed by the test step, which we will describe in the next section.

4.2 Accessibility Tests

The test step is an important phase to make the application accessible to all users, since accessibility problems that were not detected on the development phase may be detected now.

According to Android Developer (2014e), the following guidelines must be taken into account to guarantee the minimum accessibility to an application:

- Directional navigators: verify if the application can be used only by directional controllers to perform the main tasks of the system, without the use of touch screen;
- Audio prompts: verify if the elements that present information (texts, images, graphics) or the ones responsible for actions present clear audio descriptions;
- Explore by touch: verify if the elements that present information (texts, images, graphics) or the ones responsible for actions present clear descriptions, when the “explore by touch” resource is activated;
- Size of touchable elements: all the elements that the user can select or perform some action must follow the minimum recommendation of 45dp;
- Gestures and screen readers: verify if items, such as image zoom and scrolling bar skill, work when a screen reader is enabled;
- Feedbacks: all audio alerts should be accompanied by another kink of notification, such as tactile feedback or visual alert.

4.2.1 Test Recommendations

According to Android Developer (2014e), the following guidelines are necessary to ensure the accessibility and quality of an application:

- Repetitive audio alert: verify if the closely related elements do not repeat the same alert. For example, in a contacts list that contains a contact picture, written name and title, the prompts should not simply repeat the same name for each item.
- Overload or under load of audio alerts: verify if the closely related elements present an adequate number of audio information to allow users understand and act on a screen element. A very short or very long can make it difficult to understand.

5 BrailleApp

Our application was developed for mobile devices, which uses Android 4.0 or higher. As stated before on this paper, the application aims to assist all type of people who would like to learn Braille. Its development was based on the Universal Design concept and following the guidelines described on the last sections.

Our application was based on Braille specifically to the Portuguese language, and it has the following features:

- Translation from Braille to Portuguese: there is an interactive virtual Braille cell where the user is able to write the texts, being possible to send SMS (Short Message Service);
- Translation from Portuguese to Braille: the user writes the text in a common keyboard;
- Listing of Braille signs: all signs and meanings are listed on the screen;
- Reference guide: there is a document where the user is able to consult Braille signs in Portuguese language;
- Braille reading exercises: written words in Braille are presented and the user can try to translate them to Portuguese;
- Braille writing exercises: written words in Portuguese are presented and the user can try to translate them to Braille.

Figure 3 shows the application features through a use case diagram. It is possible to see all functions of the application. When the user start the application, the database is created (containing all Braille signals, information about the software e for future needs of the system, how, the personalization of application according to profile user) and the voice package is downloaded, then the main page is presented. In this page, there is the possibility to choose to translate to Portuguese and Braille, check a list of signals, and also a reference guideline is available, in which it is possible to do exercises (both writing or reading Braille), configure the application (change volume, vibration or font size) and read more information about the developer.

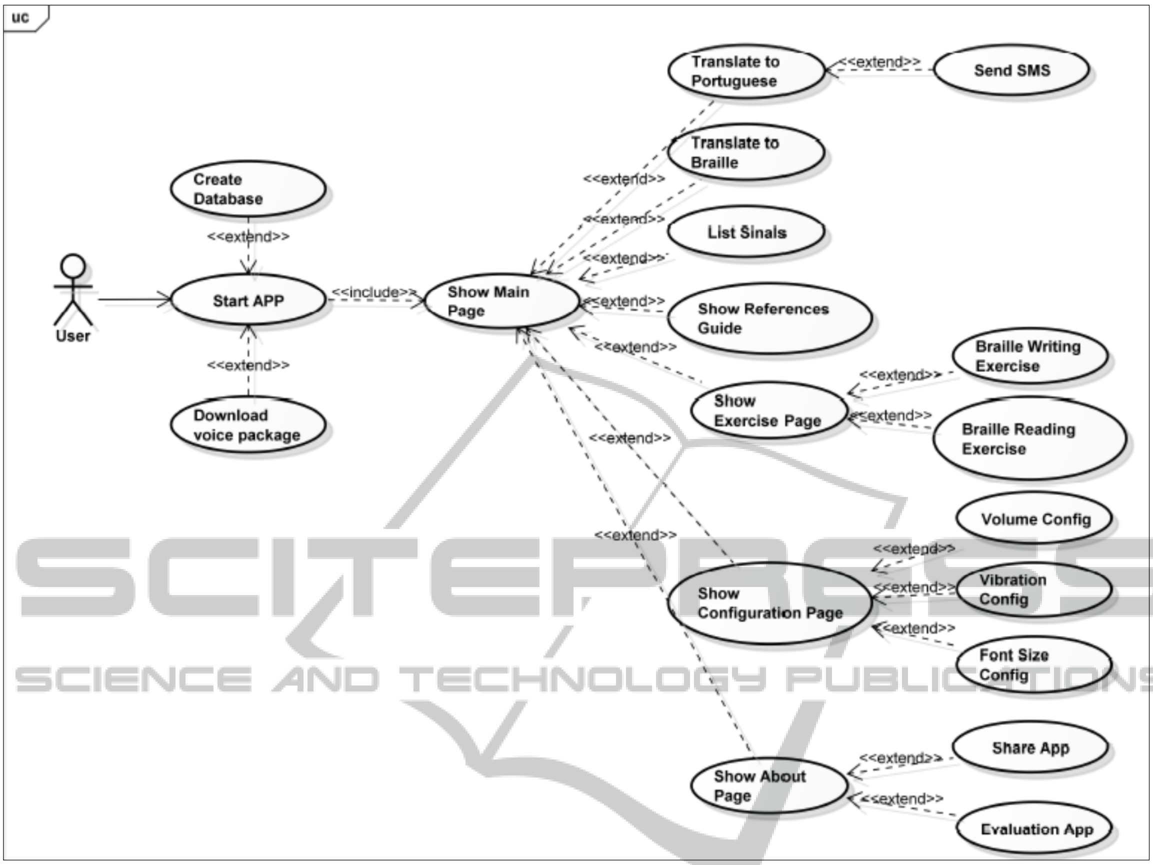

Figure 3: Use Case Diagram of BrailleApp.

5.1 User Interface

According to Bevan (1995), usability in information systems is directly related to the quality of system´s interaction with the users and depends on several aspects, such as: ease of use, learning facility, user satisfaction, flexibility, and productivity.

The user interface on BrailleApp was developed according to the standards defined in Android Developer (2014c). These standards suggest some characteristics, such as structure, layout, navigation, action bar, notification, accessibility, among others.

Figure 4 shows the initial screen of BrailleApp and the following features are presented: Transcritor BR (users write in Braille and the application displays the word in Portuguese, Fig. 5 left), Transcritor PT (users write in Portuguese and the application displays the word in Braille, Fig. 5 right), List of signals (Fig. 6 left), Reference guide (Fig. 6 right), and Exercises (Fig. 7).

To improve the communication between blind and not blind person using a mobile, it was necessary an alternative to make the software easy. One of the possibile solutions is to provide a screen reader. The screen reader system allows a blind person use the application, since it reads the texts aloud, the user can easily perform the requested action.

Figure 4: Initial Screen of BrailleApp.

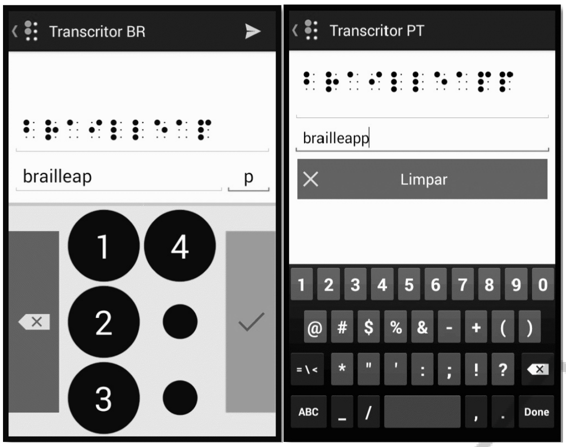

Figure 5: On the left is presented the translation into Portuguese. On the right is showed the translation into Braille.

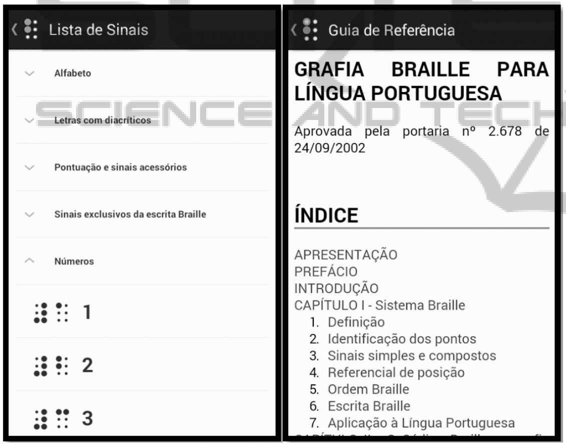

Figure 6: On the left is presented the list of signals. On the right is showed the guidelines about the language.

Figure 7: On the left is presented an exercise where the user needs to know the Portuguese word that is presented in Braille. The opposite is presented on the right.

6 RESULTS

In an empiric analysis, we argue BrailleApp complies the guidelines with accessible applications, such as norms, standards, and the translations defined on the normative document. In addition, it meets the requirements of educational software.

All accessibility tests, according the guidelines mentioned before, were carried out and the requirements were met.

Additionally, the application was tested by a totally blind person, and this was possible because of some reasons, such as: (i) the way how the software was built allowed the correct use of some resources of usability in Android, (ii) availability and interaction with screens readers systems, and finally (iii) Android functionalities which facilitate the use of the system by blind people. We have received good feedback about the performed tests, for instance: it was possible to use the system even without seeing, missed of something to feel when he is touching the mobile phone, like the raised dots of Braille system, this is because the screen of cellphone tested was a touch screen. However, he said, the system is a good step to improve the learning of Braille and the communication between blind and not blind.

The application is available to download in the Google Play store (https://play.google.com/store/apps/developer?id=Ailton+Luna). The installation number is between 100 and 500 (accessed on December 5, 2014) and an amount of 13 reviews, 12 five stars (maximum possible) and 1 four stars.

There is also, the possibility to improve BrailleApp, developing a functionality such as a Braille keyboard to input data. The layout of this keyboard may be set similarly to "reglete" or a Perkins typewriter. Additionally, other future research is the development of text editing using the Braille virtual keyboard, web version, and finally, a Braille board that would permit the read of digital books using a tactile way.

7 CONCLUSIONS

We believe the use of our application will assist visually impaired users in the learning process of the Braille language. Additionally, it will contribute to their social inclusion, stimulating them in social interactions.

According to the feedback of the user (which is entirely blind), this application is a good tool to the improvement of the learning Braille techniques.

However, it is important to emphasize that the application has better results mainly with sighted people who want to learn the Braille signals. Although, the system can be used by blind people with the purpose of training and improving their skills. This use on a touch screen mobile it is possible through to your functionality of screen read aloud. With this, it is possible the user know where your finger is above, and, completing or not the action. However, there is much to do, this is the first version of this idea, and we believe in the future, this app can be an essential tool for learning and communication in Braille.

Additionally, we hope the application will provide to blind people more independence and quality of life, as well as serving as a tool for training students and teachers in the Braille language.

ACKNOWLEDGEMENTS

The present work was realized due to the support of CNPq, National Council of Scientific and Technological development - Brazil, and University of State of Rio Grande do Norte – Natal, RN.

REFERENCES

Android Developer, 2014a. *Accessibility*. Available at: <http://developer.android.com/guide/topics/ui/accessibility/index.html> [Accessed on 03 December of 2014]

Android Developer, 2014b. *Building Accessibility Services*. Available at: <http://developer.android.com/guide/topics/ui/accessibility/services.html> [Accessed on 03 December of 2014]

Android Developer, 2014c. *Making Applications Accessible.* Available at: <http://developer.android.com/guide/topics/ui/accessibility/apps.html> [Accessed on 03 December of 2014]

Android Developer, 2014d. *Accessibility Developer Checklist*. Available at: <http://developer.android.com/guide/topics/ui/accessibility/checklist.html> [Accessed on 03 December of 2014]

Android Developer, 2014e. *Accessibility Testing Checklist*. Available at: <https://developer.android.com/tools/testing/testing_accessibility.html> [Accessed on 03 December of 2014]

Bertelson, P., Mousty, P., D`Alimonte, G., 2007. *A study of braille reading: 2. Patterns of hand activity in one-handed and two-handed reading*. The Quarterly Journal of Experimental Psychology Section A. Vol. 37, Iss. 2, 1985.

Bevan, N., 1995. *Measuring usability as quality of use*. Software Quality Journal 4(2): 115-130.

Bickel, L., 1988. *Triumph Over Darkness: The Life of Louis Braille*. Sydney: Allen & Unwin. Adult biography.

Brasil, 2006. *Grafia Braille para a Língua Portuguesa*. Ministério da Educação. Secretaria de Educação Especial. SEESP. Brasília, 2nd edition. Elaboration: Cerqueira, J. B. [et al.]. Secretaria de Educação Especial. Available at: <http://portal.mec.gov.br/seesp/arquivos/pdf/grafiaport.pdf> [Accessed on 03 December of 2014]

Bruno, M. M. G., 2006. E*ducação infantil: saberes e práticas da inclusão: dificuldades de comunicação sinalização: deficiência visual*. Secretaria de Educação Especial. MEC. Brasília, 4nd edition.

Carrão, E. V., 2006. *Repensar a informática educativa: construção de um dispositivo para dar vez e voz aos professores na utilização de softwares educacionais*. Doctoral Thesis. Universidade do Minho, Portugal. Available at: <http://hdl.handle.net/1822/5547> [Accessed on 05 December of 2014]

Deitel, H., P. Deitel, 2014. *Android: How to Program*. Pearson Education, Limited.

Goldin-Meadow, S., 1999. *The role of gesture in communication and thinking*. Trends in Cognitive Sciences, Elsevier. Volume 3, Issue 11, 419 – 429.

IDC, 2014. *International Data Corporation*. Available at: <http://www.idc.com/getdoc.jsp?containerId=prUS24676414> [Accessed on 15 May of 2014]

Komatineni, S., MacLean, D., 2012. *Pro Android 4*. Apress.

Loomis, J., 1981. *On the tangibility of letters and braille*. Perception & Psychophysics 29(1): 37-46.

Oliveira, C. C., da Costa, J. W., Moreira, M., 2001. *Ambientes Informatizados de Aprendizagem: Produção e Avaliação de software Educativo*. Papirus. Campinas-SP, 1st edition.

SAC, 2014. Sociedade de Assistência aos Cegos. Available at: <http://www.sac.org.br/APR_BR2.htm> [Accessed on 15 May of 2014]

Steinfeld, E., Maisel, J., 2012. *Universal Design: Creating Inclusive Environments.* Wiley.

TECE, 2014. *Tecnologia e Ciência Educacional Ltda. Manual de uso de regletes*. Available at: <http://www.tece.com.br> [Accessed on 14 June of 2014]

TIOBE, 2014. *TIOBE Software: TIOBE Index*. Available at: <http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html> [Accessed on 12 April of 201]