

# Early Interaction Experiences of Deaf Children and Teachers with the OLPC Educational Laptop

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**Abstract.** The adoption of computing technologies in the schools has the potential for supporting the digital and social inclusion. However, whether such technologies are not accessible they can deepen the exclusion of students with disabilities, and other minorities. This work investigated questions regarding the use of the laptops from OLPC by deaf children between 7 and 12 years old and by teachers from a bilingual school. The results indicate that children were excited due the use of the device; even they behaved reticent during the interaction. The study also identified interaction problems regarding both hardware and software in the use of the laptop.

**Keywords:** Accessibility, XO laptop, computer-based learning, deaf children, OLPC.

## 1 Introduction

The preliminary ideas of introducing computer technologies in educational context emerged in the 60s. In 1968, Kay and Papert introduced the concept of Dynabook (*i.e.* similar to computer laptops today) and believed that the laptop would play a key role in education and also in other aspects of contemporary society [16]. In 2001, the One Laptop Per Child (OLPC), a non-profit organization, inspired by the concept of the Dynabook and constructionist learning theory [14], designed and developed the low-cost educational laptop XO to be used by children in developing countries [13].

Considering the use of computer technologies in Brazilian schools and the XO laptop as an important instrument of access to knowledge, it is necessary to ensure that these technologies can be used by all students, independent of their cultural, physical or intellectual diversities. As noted by the challenge number 4 of the Brazilian Computer Society [1] it is necessary to research ways to reduce barriers of access to knowledge. Thus, it is expected that, when introduced in the classroom and in the students' homes, laptops could be relevant instruments to digital and social inclusion

of minorities. Also Schneider et al. [19], who conducted studies on the use of educational laptops in Brazilian classrooms, concluded that changes may occur in the social dimensions of people with disabilities when mediated by educational laptops in schools. In this sense, there is room for fruitful investigations on the interaction of deaf public with these educational laptops.

Studies on the use of technologies for deaf children indicate that they are visual learners and mainly use pictures to illustrate the meaning of words [18]. Thus, the computing technologies that use pictures, sign language, graphics and animations for their interaction are more effective for learning of deaf children [6]. Moreover, some studies involving deaf children point to difficulties in reading and writing texts, since they are not their primary language. Sign language (SL), that is visual, consequently affects the level of lexical, morphological and inferential comprehension [21].

This work investigates the first contacts of deaf children and teachers with the XO laptop. The research was conducted through 4 tasks involving the contact of users with the laptop's hardware, the Sugar environment, the applications Record and Drawing.

During the experience users were enthusiastic on and, also, showed interaction problems that may interfere with student learning. Some of these problems have also been previously reported by other investigators, who researched for different publics.

It is noteworthy that this work does not address political and pedagogical issues about the relationship between inclusive and specialized schools. But it is relevant informing that the tests were conducted along with children and teachers who study and work in an institution of bilingual education. Bilingualism, considered the most suitable approach for the education of deaf people; it is the movement that claims the use of at least two languages: SL as the first language (L1) and as the second language the writing mode (L2) [4]. In the Brazilian context, the L1 is the Brazilian Sign Language (LIBRAS) and the Portuguese, the official language of Brazil orally, is L2.

This article is organized as follows: Section 2 presents the research related to the use of the XO laptop, Section 3 describes the method used in this work, Section 4 summarizes the results of the activities; Section 5 presents a discussion of the work and finally, Section 6 presents our conclusions.

## 2 XO in School and Beyond

The XO laptop has an operating system that presents a graphical environment called Sugar, which runs on the Fedora Linux distribution. The Sugar environment was designed by researchers at the Massachusetts Institute of Technology (MIT) to be used by children [13]. Applications built-in the Sugar are designed with the aim to contribute to student learning.

The distribution project of the XO laptop has reached many countries, among them: Uruguay, Peru, Argentina, Mexico, Ethiopia and Rwanda. In these countries, pilot projects reported positive changes in the socio-educational context, as enrollment increases, the decrease of absences in classes, greater student participation in activities in the classroom and more disciplined students [9]. The projects reported

that students and teachers have demonstrated great enthusiasm about using the XO, however, students and teachers were confused and found difficulties in using the educational applications of the laptop.

Hansen *et al.* [7] conducted tests with children in Ethiopia and concluded that the use of XO in schools and in their homes, contributed to the academic performance and the development of abstract reasoning of students. In underserved schools in China, Yang *et al.* [22] found that the use of the XO laptop was an effective means of improving student learning. In Uruguay, Hourcade *et al.* [8] reported the first experiences of using the XO by children in the classroom and the difficulties regarding the use of touchpad and user file manager called Everyday interface. Still in Uruguay, Flores & Hourcade [5] conducted tests with adults and identified difficulties in opening the laptop and using the touchpad.

In Brazil, some studies were conducted in order to explore the use of the XO laptop. Martinazzo *et al.* [10] conducted usability tests of the application Drawing with children and found some problems, such as difficulties of users in exiting the application and handling the touchpad. Canal *et al.* [2] analyzed the simplicity of the OLPC laptop and some problems related to its interaction design of both hardware and software.

Miranda *et al.* [12] identified usability problems and accessibility barriers on the laptop. Canal *et al.* [3] evaluated the accessibility applications of the XO laptop and some problems were found, such as the use of the Sugar environment and the applications to take pictures. Venâncio *et al.* [20] reported experiences of using the XO in school and concluded that the use of the laptop had significant influence on student learning. However, the authors reported that some students had difficulty using the laptop and that students experienced more difficult to use it were those with problems in reading and writing, or students who have problems in learning

### 3 Method

Based on the investigations already made with other different publics, the method adopted in this study consists of an initial exploration into the use of hardware and software for the XO laptop by deaf children in a bilingual school. The method was based on the recommended guidelines for conducting software review proposals involving deaf children by Mitch [11]. The author points out that software testing with deaf children are best conducted in public spaces, such as schools, with duration of no more than 30 minutes of testing, and that the instructions are better passed to children orally and sign language. As this study addressed the initial contact of deaf children with the XO laptop, the exploration was conducted individually, point that differs from the adopted guidelines. The method also relied on guidelines for conducting user testing proposed by Preece *et al.* [15]; like explaining to participants the purpose of the study and how should be their participation, as well as direct observation of user interaction during the tests .

### 3.1 Study Participants

The activity involved 6 deaf children between 7-12 years of a bilingual school in the city of São José dos Pinhais, in the metropolitan region of Curitiba. Two teachers of the school (one of them is deaf) also participated. There was agreement of participation and the use of images from the parents or guardians through an statement of Informed Consent Form (ICF). Two researchers in human-computer interaction conducted the activities.

### 3.2 Materials

The environment for performing the activities was the computer room of the school. One researcher acted as a direct observer, taking notes and observing the interaction between users, the other researcher acted as interpreter, since she is fluent in LIBRAS. The experiment was also recorded with images.

Two dolls of cartoon characters were used in one of the tasks of the activity. Each participant used an XO laptop version 1.0, with the installed version of Sugar 0.98.2, build 36.

### 3.3 Procedure

For each activity session in the computer room were present only one participant and the researchers. Immediately upon entering the room, the researchers presented the XO laptop and objectives of the activity. Following the explanation, we applied a pretest interview (in a playful way and LIBRAS) in order to obtain some information about the participants, such as age, school year (grade), how long the student attends the school, whether the participant have computer at home and who uses it.

After the completion of the tasks a post-test interview was applied to determine whether the children and the teachers enjoyed to use the XO, what else do the XO liked and what they did not like regarding the laptop.

The activities involved performing simple tasks (because it was a first contact with the device) that are relevant to the process of teaching and learning supported by the XO laptop. Furthermore, it is noteworthy that the choice of the applications involved in the tasks is related to activities that may be attractive not only to deaf children, as well as other children, such as the use of images and the ability to paint and draw.

The tasks are identified by labels: open the XO laptop (T1), turn on the laptop (T2), take pictures of the doll (T3), and open the drawing application and insert the photo taken in the previous activity and draw on it (T4). The activities T3 and T4 are also related to the use of the hardware, such as the action of handling the laptop's touchpad. In addition, the tasks in this sequence were prepared by the understanding that, in this way, the complexity increases gradually.

4 Results

This section first presents the results of the pre-test interviews, followed by the findings from the participants’ interaction with the XO laptop and, finally, the results of the post-test interviews.

4.1 Pre-test Interviews

The responses for the pre-test interview questions were obtained primarily by participants mediated by the interpreter. Table 1 shows the responses of the pre-test interviews about the students.

Table 1. Students’ responses for the pre-test interviews

Student	Age	Gender	School year
1	7	Male	First Year
2	7	Male	First Year
3	8	Female	First Year
4	8	Female	Third Year
5	12	Male	Fourth Year
6	8	Male	Third Year

It was also noted during the pre-test interviews that all students have computers at home. The Student 2 said that despite of having a computer at home, he does not use it. All the students have weekly activities at school and involving the use of computers for word processing, Internet research, paintings, drawings, and games. The school’s computers use Microsoft Windows® operating system.

The Teacher 1 is 28 years old and is deaf. She is fluent in LIBRAS and is a professor of early childhood education until the fifth year of school for 4 years. On the use of computer, the teacher said that at home she uses it to plan lessons, record videos and access the Facebook®. The Teacher 2 is 40 years old and is not deaf and teaches classes for childhood education until the fifth year and, at the time of the activity, he has been also the principal. The Teacher 2 said they use the computer at home to write texts, view photos, and access the Internet and Facebook®.

4.2 Interaction with the Laptop

The average length of the interaction was 25 minutes. Figure 1 shows some relevant moments during the execution of this activity, which will be detailed in the following paragraphs of this section.

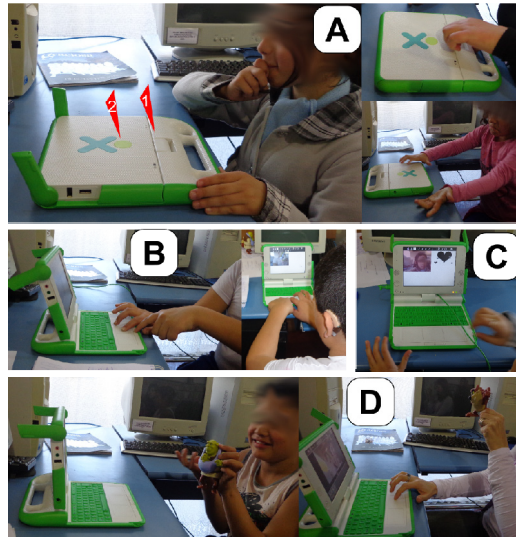
**Open the Laptop (T1).** All the students experienced difficulties in opening the device. Except for Student 6, all other participants (including teachers) were able to open the laptop only after the intervention of the researchers. Some of them tried clicking on the hinge between the body of the laptop and the monitor (see Figure 1a,

arrow 1 and the rightmost photo), others tried clicking on the green circle of the XO logo (see Figure 1a, arrow 2). Student 3 came to employ certain strength in trying to open the laptop, however, as the locks were still closed, he could not open it. The Student 4 (see Figure 1.a, leftmost photo) came to get unlock the laptop, but could not open it. The two teachers tried to open it by clicking the green circle of the XO logo (see Figure 1a, arrow 2).

**Turn on the Laptop (T2).** Students 1, 5, and 6 turned on the laptop without difficulties. However the students 2, 3 and 4 attempted to press other buttons that are next of the screen and are intended for games; however they also succeed in turning on the device. Teacher 1 turned on the laptop, but she initially tried pressing the right button of the touchpad. Teacher 2 was able turn on it without difficulty. Both teachers commented that the device was slow at startup.

**Take a Picture of the Doll (T3).** In this activity, participants were first invited to open the application to take pictures, and then they were given the option to choose between two dolls to take a picture and, finally, close the application (see Figure 1.d). Not all the students were able to find the application to take pictures and for these cases the interpreter signaled an eye, which is the icon of taking pictures in order to facilitate the identification of the application by the students.

In the moment of taking the picture, students 1 and 4 clicked repeatedly in the icon that has an image of a photo that is located in the top bar of the application (indeed, it is the selector of media to be recorded). The button for taking pictures is a circle at the bottom of the screen. The Student 2 was excited by the activity and took several pictures. Student 4 chose to take pictures of herself, because she found it difficult to hold the doll and use the touchpad at the same time.



**Fig. 1.** Interaction with the laptop: (a) opening the laptop, (b) using the touchpad, (c) using the taken picture in the application Paint and (d) student (left) and teacher (right) taking pictures

Teacher 1 initially thought the application to take pictures was Fototoon, because of its name. Entering in the correct application, she did not find problems to take pictures. Teacher 2 easily found the application to take pictures, but she confused, as students 1 and 4, the button to take a picture with the media selector.

None of the participants were able to close the application. Student 5 tried to press a button that resembles the icon for closing applications of traditional operating systems (*i.e.* letter X) that is located in the upper left corner of the laptop keyboard. Teacher 2 clicked on the text “stop”, which is the text hint of the icon for this function. However the visual appearance of such hint is very close to a sub-menu.

One difficulty faced during the interaction with the hardware was the use of the touchpad because it does not have the click function by tapping. Consequently, clicks must be made only by buttons located just below the touch area. This resulted in unsuccessful and frequent attempts, by all the participants who tried to access the functions by touchpad (see Figure 1b).

**Import the Taken Picture into the Paint Application and Draw on it (T4).** In this activity the interpreter invited the participants to open the Paint application. After opening the application, the interpreter signaled to participants the task of “insert the taken pictures”. Then the participants were invited to draw on the picture. Except for Student 5, all the participants opened the Paint application without difficulties. Student 2 took the opportunity to play with the dolls while waiting for the application to load. Student 5 initially opened the application Writing.

Students 2 and 3 found the option to “insert picture” without difficulty. However the students 1, 4 and 5 failed to identify it without the intervention of the researchers. After selecting the button for inserting picture, students found it difficult to select the desired picture, because the browsing window (*i.e.* Journal) does not show thumbnails of picture’s contents. Student 4 explored the options “forms” and chose the form “heart” (see Figure 1.c).

Teacher 1 thought that the Paint application was the Portfolio application. The teacher argued that the icon application looks like the physical apparatus that she uses in her classes. Teacher 2 opened the application without difficulty and also imported the picture. Both teachers encountered problems to select the desired picture. Teacher 2 was the participant who most explored the application; she clicked in all the icons to verify their functionality and also inserted text on the picture.

In general, we verified that children were reticent of clicking the buttons. They frequently questioned the researchers whether icon they pointed out was the correct before trying it. Student 4 was excited by the activity and, even after the researchers had informed him that the activity had ended, the student wanted to continue using the device.

### 4.3 Post-test Interviews

The post-test interview aimed to identify whether the children and the teachers liked to use the XO laptop, what they liked to do and they did not like.

Except by the Student 6, the other participants affirmed they enjoyed interacting with the XO laptop. Student 6 considered the laptop is too hard to use. The researchers noted, in some moments of the activity, when he was not able to complete a task, he was nervous. The teachers reported that this student had some behavioral disorders previously diagnosed at the school.

When asked what they had most liked to do on the XO laptop, two of them answered to draw, a student answered to paint, the other answered to take pictures and the last said he liked everything. Next, when asked about what they had not liked, two of them said the delay in loading applications.

Both teachers said they enjoyed interacting with the XO laptop. Teacher 1 positively highlighted the physical aesthetics of the laptop and she said that would like to use the laptop in his classes. Teacher 2 said she most like the Drawing application, the possibility of coloring, drawing, and writing. In contrast, Teacher 1 put the Paint application as one of the items that she did not like in the XO laptop. The main criticism is the need to drag using the touchpad to draw. The Teacher 1 also pointed that the colors of icons, both the Sugar and the others applications do not facilitate viewing. Both teachers said the application icons are not very significant (*e.g.* an icon of an eye for the take pictures application). Teacher 2 indicated that it is difficult to see when an icon is selected in the Paint. Finally, Teacher 2 also said that she would include the XO laptop in the classroom.

## 5 Discussion

This work investigated the initial contact of deaf children and teachers (one deaf) with the XO laptop. While being expected that children be guided during the use of this device in the classroom, one of the expectations is that the OLPC laptops could be taken home by students. Therefore, autonomy in using the device is an important feature to the learning process.

**Influence of Deafness in the Interaction.** Although this is an occasional activity and of short duration, it is possible to verify that a significant part of the results obtained are consistent with those obtained in research with children without this disabilities (*i.e.* [8]). However, it is worth emphasizing that the choice for activities that are primarily not dependent of text, influence positively the results of the interaction of deaf children. An interesting fact is that the only participant who used text in the Drawing application was just the teacher who does not have hearing loss. It is still necessary to investigate what are the reactions when interacting with applications containing more texts.

**Reticence During the Interaction.** A fact that caught our attention during the activity was the children's reticence during the activity. During a considerable part of the activity the children consulted the interpreter and/or researcher before performing actions. As the activity reported here had an average duration of 25 minutes is not possible to say that this reticence would be persistent when in longer interaction scenarios. However, we should emphasize the initial insecurity and also is necessary future researchs to verify this behavior in situations of prolonged use of the device.



**Physical Aspects of the XO Laptop.** During the execution of the tasks T1 and T2 it was evident the initial difficulty of use of the hardware device. As already identified by [12], [5] and [2], the opening mechanism with two locks is not intuitive and difficult the initial contact with the device. Despite the button to turn on the laptop uses a common sign to electronic devices, some of the participants did not identify it initially.

The tasks T3 and T4 involved the use of the touchpad and most participants reported difficulty in using the device, especially because it does not offer the option of click by tapping the touch area. Problems with the touchpad had been pointed by [5] although those authors did not have provided information about the specific problem with the touchpad.

**XO Laptop Software.** Two of the main characteristics of Sugar are the focus on iconic representation and in the children audience. However, in this activity was noted that some of the icons in the Sugar environment do not have the expected representation. In the task T3, some of the children did not relate the icon of the Record application, which is an eye, with the function of taking pictures. Still in the Record application, the metaphor of the circle button, referring to the “record” of the electronic devices to recording audio and video did not make sense to some of the participants, for the function of taking photos. The Stop button’s icon used to close applications also did not make sense to the participants.

Another identified issue is in the task T4, while using the Journal application for the inclusion of the taken picture on the Record applications. As already reported in [8] the lack of thumbnail images makes the selection of the required resource more difficult. Still about the task T4, in contrast to the results reported by [10] – in which participants reported usability problems resulting from the extensive use of the Paint application – in this activity the children just used few resources of the application. Although, in the post-test interview, some participants have mentioned the application as the activity they most liked.

**Early Impressions.** In general, the reaction was very positive of practically all participants (except for Student 6), which motivates future researches about this theme. And the school also demonstrated interest for the inclusion of XO laptops within the context of the school classroom.

## 6 Final Considerations

The use of computer technology for educational purposes is a reality. However, the design of technologies to support the use by children and adolescents still has many barriers of use that are currently being studied by several researches. This work presented an activity of evaluation of the XO laptop for six deaf children and two teachers (one being deaf) in a Brazilian school that focuses on bilingual education. The evaluation involved aspects of hardware and software, considering the initial contact with the XO laptop. Therefore, this work was based on the guidelines for evaluating applications for deaf children [11] and the guidelines to user testing proposed by [15].

The activity results indicate a consistent scenario with the problems already identified by earlier works with children without this disability. Therefore, we conclude that such problems are faced during the interaction by different user profiles, what makes these users (in all their diversity) face interaction barriers that may impair their social inclusion, digital inclusion and even interfere with the learning process of students. Furthermore, we consider that the proposed design solutions for the problems here reported can potentially solve the barriers of interaction of different user profiles, including deaf and not deaf children or adults. However, the reticent behavior during the interaction and the use of applications that are dependent on textual resources still require further investigation. Possible future works involve the use of the XO laptop in the classroom for an extended period of time, aiming at observing the changes in the interaction behavior, and its possible effects on children's learning as in the didactic techniques used by the teachers of the school.

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