Development of Assistive Technology for Teaching-Learning History Aimed at Students With Cerebral Palsy

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Abstract: This article aims to communicate the partial results of the research entitled "Development of Assistive Technology for the teaching-learning of History", carried out at the Federal Institute of Education, Science and Technology of Rondônia (Brazil) and the Polytechnic Institute of Bragança (Portugal). This project is an unfolding of the project "History and narrative competencies: strategies for the inclusion of students with cerebral palsy" and aimed to contribute to school inclusion and to the improvement of the teaching-learning process of the History curriculum, through the development of Assistive Technology (hereinafter identified by the acronym TA), capable of expanding the functionalities of students with cerebral palsy in reading, writing and exercise resolution activities. To this end, a qualitative approach and support in the design science method was used. The main theoretical basis that guided reflections and decision-making within this project is represented by Guimarães (2012), Bersch (2017) and Alves and Teixeira (2014), among others. The results obtained indicate that applications such as that developed in this project can collaborate both in the learning of history by students with specific educational needs, resulting from cerebral palsy, as well as favor the improvement of teaching. Therefore, it can expand the process of educational inclusion and realization of learning rights.

Key words: assistive technology, educational inclusion, history

1. Introduction

The history of people with disabilities (PWD) in Brazil has been, for centuries, a history of exclusion. These people, considered "invalidated" and "incapable", were on the margins of society and the regular education system. At most, they accessed a parallel system of Special Education, frantically coordinated by philanthropic institutions. In this process, they often received an education focused merely on the performance of activities of daily living, without access to a propaedeutic or technical-scientific curriculum capable of contributing to their human development.

This scenario of exclusion only began to change at the end of the 1980s, during the re-democratization of Brazil. By force of the Brazilian movement of people with disabilities, the Federal Constitution (1988) established in article 205 that Education is a universal, subjective public right, and introduced special education as part of regular education. In this context of democratic effervescence, after 21 years of military dictatorship, the Brazilian

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State began planning and implementing public policies for the benefit of the PWD, instituting laws such as no. 13.146/15 — Brazilian Law for the Inclusion of Persons with Disabilities.

In the international context, the public debate on the universal right to education also gained new vitality with the World Declaration of Education for All (UNESCO, 1990) and the Salamanca Declaration (UNESCO, 1994), which together brought the understanding that: (1) regular education is the right of all persons, regardless of their limitations or abilities, (2) that public school should be the starting point for the construction of an inclusive society, for combating discrimination and building a culture of compression of differences, which is consolidated in an ethics of conviviality, (3) that it is schools and education systems that must adapt to the PWD and the special educational needs (SEN) that may be present.

More than 50 years after the outbreak of this process, there are achievements to be celebrated, as well as setback points and threats. Without entering the merits of the discussion about the challenges that the current government imposes to maintain the educational rights of the PWD (especially through Decree No. 10.502/20), it is considered pertinent to consider that, if, on the one hand, we have made progress in the consecration of rights and in a formal policy of social inclusion, on the school floor there are significant challenges that arise as barriers to the realization of inclusion.

Among these challenges, it is possible to point out, about Brazilian public education, the overload of teaching work, low salaries, the lack of continuous training for specialized educational care, and material resources for the realization of the adaptations necessary for the realization of the learning rights of students. It is also worth mentioning the lack of architectural, attitudinal, communicational, instrumental, methodological, and programmatic accessibility of some schools.

In the case of the Porto Velho Calama Campus, the entry of two students with cerebral palsy in the technical course of Informatics Integrated to High School brought multiple pedagogical challenges. If on the one hand there was already in the institution a culture of respect for otherness and a rigorous work of monitoring the students to curb prejudiced attitudes, which favored the inclusion and reception of these two adolescents with their respective classes, on the other hand, questions about what and how to teach, what strategies to adopt to ensure meaningful learning for these students became a concern of teachers.

The target students of this project are intelligent, organized, very dedicated to studies and have excellent family support. They were diagnosed with cerebral palsy early and were able to benefit from multidisciplinary help, therapies and surgeries that ensured considerable improvements in their health and development.

They attended the common school, in common classes, were literate at the right time, socialized and were able to enter Professional and Technological Education. They are from the generation in which special education is no longer a parallel education system to consolidate itself transversally in the general context of education (BRASIL, 2002). Fruits, therefore, of the national policy of special education (BRASIL, 1994) and the new national policy of special education from the perspective of inclusive education (BRASIL, 2008), which despite presenting limitations have achieved positive results regarding the schooling and school inclusion of People with Disabilities (PWD) (Rebelo, Kassar, 2018).

These students have spastic cerebral palsy marks with diplegia (neuromotor limitations of the lower limbs). According to the Brazilian Ministry of Health (BRASIL, 2013), cerebral palsy describes a group of permanent disorders of movement and posture development attributed to a non-progressive disorder, which occurs during the development of the baby's or child's brain, which may cause limitations in the person's functionality profile. Silva Afonso adds that "brain injury can affect functions other than motor functions; with some frequency, motor

problems may be accompanied by language changes; hearing; vision; mental and intellectual development; personality, attention and perception problems" (Silva Afonso, 2012, p. 7).

For these characteristics, Correia (2008) classified students with cerebral palsy in the group of permanent special educational needs (SEN) of motor character. Although permanent, lesions resulting from cerebral palsy are not progressive and do not necessarily affect the cognitive capacity of the subjects.

In the case of the student with cerebral palsy participating in the project, in addition to the symptoms of cerebral palsy, he presents atrophy of part of the fingers, which hinders fine motor coordination, grip and handwriting. His cognitive ability has been preserved, the language is well developed, the diction is excellent, and he talks with resourcefulness in both Portuguese and English, having excelled in Spanish classes. To walk, it is used by the help of crutches and to see better he use eyeglasses.

The student, in turn, when she started the course also used a crutch, but gradually developed confidence in walking without the device. It presents hearing deficit that affected her diction a little but did not affect her communicative capacity. Likewise, her cognitive ability was preserved.

In view of these specificities, we set out to collaborate with the improvement of the teaching-learning process of the discipline of History, through the development of an Assistive Technology (AT) capable of assisting in the learning of this curricular component, of reinforcing the contents taught in the classroom and of favoring the recording of activities.

2. Materials and Methods

This is a research focused on technological development, conducted in a qualitative approach with the support of the design science method, which captures the needs of the "business" and builds solutions for it, having the scientific support both as a basis for the development of these solutions and for it to be backed with the results achieved with the research (Hevner et. al., 2004). By "business" we understand here the opportunity to generate pedagogical and social benefits about teaching-learning (it is not, therefore, business in marketing conception, in capitalist terms).

This method aimed to go beyond the diagnosis or description of the problem, generating answers capable of contributing to the solution or improvement of the problem. It represents a step-in science towards innovation. The focus, therefore, was the production of an artifact that contributes to the improvement of the teaching-learning process of History. To this do so, we carry out the following actions:

1) Survey of the needs presented by the History teacher regarding the teaching of this curriculum for students with cerebral palsy;
2) Survey of the educational and motor needs presented by students with cerebral palsy, as well as their social expectations in relation to the application that we set out to develop;
3) Presentation of 03 applications available in the market for testing by students and the teacher;
4) Content collection (adapted texts and activities) prepared by the teacher to make up the application;
5) Preparation of the application documentation;
6) Study on the technology used to develop the application;
7) The following steps planned for the application: making the prototype available for testing, functionality fixes, source code registration, and social product transfer.

3. Theoretical Framework

In this topic we will point out some of the main concepts and concepts that converge to the study of the problem of school inclusion and the development of AT for this purpose.

3.1 Assistive Technology

Assistive Technology (AT) is a term used to identify all material or resources that aims to develop skills in the disabled person and provide independent life and inclusion. In this sense, the AT will allow the development of a deficient ability and enable the accomplishment of some task that has as impediment disability or aging.

Bersch (2017) states that AT can be divided into categories such as: aids for daily life and practical living, increased and alternative communication, accessibility features, environmental control systems, architectural projects for accessibility, orthotics and prostheses, postural adequacy, mobility aids, aids for visual function enhancement and features that translate visual content into audio or tactile information, mobility in vehicles, sport, and leisure.

Often, AT is confused with the equipment used in rehabilitation conditions in the therapeutic area and in specific cases of medicine. Assistive Technology is, in fact, a "user resource" and not a "professional resource", just as the cane is for the blind, as the features of reading aloud are for dyslexic and intellectually disabled, the AT is for the resources that promote independence and that will serve at different times of the everyday life of the disabled person.

What can also cause some confusion is the fact that not all educational technology is an Assistive Technology. Educational technology can be inserted in the context of content seen in the classroom and used to reinforce the teachings, regardless of whether a student has some type of disability, all will be inserted in the same context. For example, if a teacher uses some digital platform to assist content learned in the classroom, and there is a wheelchair in the room that will use in the same way as other students who are not wheelchair users, this platform is not assistive, but only an educational technology. As Bersch (2017) describes, in AT, the tool will cross barriers that limits or impedes the development of the proposed skills, for example: alternative communication software, text readers, enlarged texts, etc.

3.2 Cooperative Learning

Cooperative Learning, according to Bryant, P. and Bryant B. (2014), is a method used by teachers to promote academic achievements and social acceptance of students with or without learning difficulties. However, this method becomes even more attractive for students who need extra assistance, because it provides greater instruction and feedback among students than if the teacher taught each individually. Some recently pointed studies indicate that the use of an adaptation of assistive technology can help students with learning difficulties in specific areas.

Cooperative learning, according to Johnson et al. (1994), can be understood in three phases: planning, implementation, and evaluation. The first is divided into six points: academic and collaborative objectives, group functions, activities, and elements. These topics are linked in ensuring the development of activities together following some metrics. The first, aims to separate students into small heterogeneous groups of different skill levels, to promote approaches to discussions and approximations between them. The second topic, roles aim to

include responsibilities, the student performs functions such as: listening to the group, explaining to colleagues their point of view, while managing the development of their activities based on the defined time. Students are assigned situations that increase their involvement with the groups, so that one member depends on the other to complete the activity and at the end, realize that everyone must collaborate for the success of the group.

3.3 Gamification

Gamification, although its concept has existed since the mid-1970s, as the organization In Practice (2017) says, the popularization of the term occurred around 2010, the name "gamification" is associated with the act of user interaction through games in non-playable scenarios. An example of this is the gamification associated with education. Gamification is not limited to explicitly playable scenarios, but also as resources aimed at encouraging during certain activities. In the classroom, when the teacher recognized the student's work with reward, be it stamping with relaxed texts, starlets, or a role as "the helper of the day", gamification was already being carried out unconsciously, according to Silva et. Al. (2014).

Gamification is linked to Mihaly Csikzentmihalyi's Flow Theory (1990), cited by Alves et al. (2014), in which it is investigated the reason why a person when he is involved in a particular activity, to the point where nothing that happens around him is relevant, is like a state of ecstasy, in which his only focus is on what is done and proceeds in this activity in order to satisfy himself, even though you have no material or financial return.

Alves et al. (2014) mention that the researcher Csikzentmihalyi during his research, cast seven characteristics in common in people who were in a state of Flow: Focus and concentration, ecstasy, feedback, skills, growth, loss of feeling of time and intrinsic motivation. The author also describes that to achieve Flow, there is no ready recipe.

The combination of these elements mentioned above can result in an "optimal experience". However, the combination of the Skill and Challenge factor at the right time and time can greatly influence to achieve Flow. To illustrate how Flow happens, Csikzentmihalyi (2004) uses the example of a tennis player. When you start learning the sport, challenges increase according to the player's skills, at this point the player is in a state of Flow. However, as the player begins to acquire skill, interest decreases because their abilities no longer match the initial challenge. When another challenge arises that requires another level of skill, the player feels challenged again, as he now tends to overcome a new challenge and consequently reaches flow once again.

3.4 Gamification: Dialogue in Education

The gamification process is increasingly present in the different scenarios of everyday life. This culture began with the popularization of the Atari 2600 video game in 1980 and continues to this day with the constant expansion of this market through the evolution of technology, considerably improving the audiovisual experience, with increasingly affordable costs, thus enabling the increasing popularization of this leisure and entertainment to the public, now called Gamer.

Although the word Gamer still has a meaning, for the most part playful, gamification transposed the rooms with televisions and sofas: the Ministry of Culture of Brazil grants video games the definition of audiovisual product and the Ministry of Education of Brazil, used Gamification for high school graduates to study for the National High School Exam (ENEM), through Geek Games, a fully digital platform that uses mechanics and game dynamics for the student to practice the content applied in the exam.

The positive results of the platform brought some questions to the MEC, which considered "gamify" the Prova Brasil and the International Student Assessment Program (PISA).

Gamification is a set of mechanics in which the focus is on people, in contexts that are not necessarily games,

using reward logic, and challenging the participant to continue interacting more and more. Many companies use this dynamic to train their employees. Many television stations also use these logics to increase their audience according to the challenges proposed in TV shows. Using Gamification as a facilitating element of learning, the planning of this AT also includes this method to instigate the use by students.

Figure 1   Thematic Axes — Application

Dividing the didactic contents into "Thematic Axes", an allusion is made to the 4 (four) natural elements: air, earth, fire, and water as a way of entering the historical themes. For example, to reference the great maritime navigations, which led to the discovery of Brazil, the thematic axis "water" is used; the outbreak and improvement of the use of firearms in World War I are brought to the "fire" axis; and the evolution of aviation, which was one of the hallmark features in World War II, can be found on the "air" axis.

4. Results and Discussions

Since the late 1980s, Brazil has been making advances in the school inclusion of students with disabilities. The number of special education students enrolled in the public school system increased in all regions of the country from 2007 to 2014, according to a study by Rebelo and Kassar (2018). In 2018 this audience was already 658,518 in Basic Education, of which: 637,797 were in common classes; 20,721 in exclusive classes; 106,827 in the ESA; 70,857 in Early Childhood Education; 463,359 in elementary school; 76,992 in high school and 8,155 in Technical Professional Education of secondary level (INEP, 2019).

Baptista (2019) attributes these results to the success of the Brazilian State in the policy of universalization of public education. For the author, however, it is necessary to analyze the conditions of schooling, considering

aspects such as student participation, support, and school performance, which permeates the issue of teaching.

Most students who make up the target audience of special education need AT to have secured their rights to education. Although there is no updated quantitative data, it is known based on the last demographic census that, in Brazil, people with disabilities (who require ED) represent the percentage of 23.9% of the national population (IBGE, 2010), which shows a significant increase, compared to 14.5% recorded in the 2001 Census. It is essential, therefore, investments in the area and consolidation of a perennial public policy for the production of these technologies, the reduction of costs and their social transfer.

For some students, the existence and availability of such technologies is a fundamental condition for them to study, live and perform day-to-day activities.

In the case on screen, the need for an application that favored the teaching-learning of history was identified by both the teacher and the students with cerebral palsy – which challenged us to undertake this development allocated research.

We understand that the prototype developed (soon converted into product) will be able to collaborate for historical learning and literacy construction in the area.

The teaching of history is relevant to broaden the horizons of citizenship, to consolidate in students with cerebral palsy the understanding of themselves, of their situation in the world, of the trajectory of struggles for rights, and to consolidate the competencies related to this field of knowledge.

For Guimarães (2012),

> Thinking about the place and role occupied by history in basic education today requires considering the transformations that have occurred in educational policy and in the teaching of history, conquered in the process of struggles for democracy in the 1980s, embodied in the new institutional legal frameworks: the Federal Constitution of 1988 and the new LDB. The curricular reforms expressed in the academic debates produced within democratic governments, both at the federal and state and municipal levels, are revealing objectives, political and theoretical positions that configure not only the formative role of history as a school discipline, strategic for citizen education, but also the ways of thinking, building, and manipulating school historical knowledge (Guimarães, 2012, p. 61).

The teaching-learning process of this curricular component in the context mentioned was marked by challenges that led the teacher to adopt a new approach and methodology and demand the prototyped tool.

In the list of these challenges, it can be mentioned to consolidate a basic vocabulary concerning this area of knowledge, clarify elementary concepts, and seek, from the previous knowledge of students, to problematize and expand this knowledge, increasing the degrees of complexity to favor the formation of a historical consciousness, as well as to provide instruments for transformation, for social liberation.

The teachers' expectations are therefore in line with the understanding of Schmidt and Urban (2018), who claim that historical learning can not only be thought of as the acquisition of cognitive skills, but also as a formation of historical consciousness. Its objective, therefore: "is a critical-genetic consciousness, where the relationship between past and present is based on more complex narratives, which lend themselves to a temporal orientation to the present life, based on some principles such as freedom, democracy and human rights" (Schmidt, Urban, 2018, p. 27).

In this sense, the development of an AT capable of assisting students in the study of history should contribute both to the expansion of specific vocabulary, as well as to the formation of historical consciousness, and also to be accessible, functional and intuitive, in order to meet the needs of students with cerebral palsy.

One of these particularities concerns language and specific levels of knowledge, because although history uses an everyday language (Bloch, 1998; Magalhães, 2002), capable of representing a certain familiarity to students, this can be a trap with regard to the need to overcome common sense towards the elaboration of new knowledge and historical skills. In this sense it was necessary to stimulate reading in order to build a specific vocabulary, not only to expand the repertoire of knowledge about words and meanings, but about their applications at different times and contexts. Magellan (2002, p. 50) clarifies that,

> The mastery of a specific vocabulary implies, in this case, not only the ability to know the meanings that a given word may have, but, what is much more complicated, the ability to understand the meanings that such a word may have had for the actors who have spoken it, that is, implies the development of a specific sensitivity to recreate past situations and experiences that the testimonies at its disposal can evidence.

Another particularity found and which proved challenging was the issue of historical consciousness, which is essentially narrative competence (Rüsen, 1992, 1994, 2004). When we understood, with Rüsen, historical awareness as the ability of human consciousness to perform procedures that give meaning to the past, concretizing a temporal orientation in the present practical life, it was fundamental to design situations that allowed exploring the domain of temporality, consolidating the competencies of experiences, interpretation, and orientation Rüsen (1992).

To do so, we started the development of the application, as described below.

5. Technologies Proposed for Development

The application began its development with the Yii Framework, which uses the PHP-Hiper text preprocessor programming language and other tools such as composer, and database techniques such as Migrations. The Yii framework uses a bottom-up approach, that is, it is necessary that database modeling be created first, and later the generation of source code using Yii technology itself, so that basic features such as: create, update, and delete are automatically generated. Therefore, classes, templates, and controllers are generated based on relationship entity diagram (DER) tables when defined by the programmer within the application.

However, throughout development, it was observed that the Web application would not meet all the requirements for use of the platform by students, mainly because the type of application developed with the chosen framework is intended for computers and not mobile devices. Thus, the application was initially redone using Flutter and Firebase technology.

About the platform proposed for development, this was prototyped using the MarvelApp tool, in which it is possible to design layout, layout, layout usage flows according to the intended platform, such as desktop, mobile or web. The use of tools for prototyping at the beginning of development, is a practical planning facilitator regarding visual identification and implementation of techniques such as UX — User Experience and UI — User Interface.

Figure 2   Login Screen – Prototype

Figure 3   Login Screen – Application

6. Accessibility in Flutter Technology

According to the Google Developers organization (2020), Flutter is a Google toolkit that aims to build mobile, web, and desktop applications from a single Code base. Internally, the technology cited consists of a framework built with the Dart programming language and a rendering of a graphics engine based on the C++ programming language.

According to the documentation provided by Google (2020), Flutter has accessibility features for building applications, such as: enabling screen readers (TalkBack for Android and VoiceOver for iOS), high-contrast options, large fonts, and a semantic organization made available by libraries for use in code.

Flutter technology also has a semantic organization, in which every slice of the structure that is built means something. That is, for accessibility on this platform to be effective, it is necessary to give meaning to each part of the application interface when it is encoded. The constructor that Flutter uses to define the meanings of the interface is called "Semantics" and is composed of almost 50 properties that can be used in the development of a User Interface, Google Developers (2020).

```
Semantics(
    {Key? key,
    Widget? child,
    bool container: false,
    bool explicitChildNodes: false,
    bool excludeSemantics: false,
    bool? enabled,
    bool? checked,
    bool? selected,
    bool? toggled,
    bool? button,
    bool? slider,
    bool? link,
    bool? header,
    bool? textField,
    bool? readOnly,
    bool? focusable,
    bool? focused,
    bool? inMutuallyExclusiveGroup,

    bool? obscured,
    bool? multiline,
    bool? scopesRoute,
    bool? namesRoute,
    bool? hidden,
    bool? image,
    bool? liveRegion,
    int? maxValueLength,
    int? currentValueLength,
    String? label,
    String? value,
    String? increasedValue,
    String? decreasedValue,
    String? hint,
    String? onTapHint,
    String? onLongPressHint,
    TextDirection? textDirection,
    SemanticsSortKey? sortKey,
    SemanticsTag? tagForChildren,
```

Figure 4   "Semantic" Library And Its Properties

Source: Google Developers

7. Final Considerations

The educational inclusion of people with disabilities in Brazil is marked by material, political, cultural, and pedagogical challenges, and the country has developed a trajectory of advances and setbacks from the period of its re-democratization to the present day.

Brazil has a population of 213 million people, of whom 24% have some type of disability, which may constitute the need for one or more assistive technologies. According to Rodrigues and Alves (2013), for most of these people, AT resources are essential for mobility, activities related to learning, work, communication, and social interaction.

Despite the growing demand of the area, and advances in public policies on this sector, there is still a gap in studies and bibliographies on the subject, which has created a challenge for this research. In addition, there are specific AT deficiencies for the teaching-learning of History.

People with cerebral palsy may need specific help not only for mobility and communication, but also for participation in school life and learning processes, as demonstrated by this case study.

To meet the pedagogical needs presented by the collaborating history teacher of this project and the two students with cerebral palsy we developed the prototype of the Sasaki application, alluding to Romeu Sassaki, one of the precursors of inclusion in Brazil.

The beginning of the project was, therefore, due to the need to adapt history classes to students with specific educational needs resulting from spastic cerebral palsy, diplégic type of Integrated High School of the Federal Institute of Rondônia, Campus Porto Velho Calama, so that the idea of this project mobilized teachers, students, researchers and pedagogues, moved by the ideal of effecting school inclusion through the effectiveness of historical learning, but also that this inclusion was not limited to the boundaries of the classroom.

In addition to studies for the development of an assistive technology, through the nehli research group — Center for Historical and Literary Studies, activities were carried out with students with cerebral palsy, where they developed a scientific project as fellows, guided by Professor Dr. Xênia de Castro Barbosa, entitled "History and Narrative Skills: strategies for educational inclusion", work presented in two local scientific events, in which in one of these was given an honorable mention to the pair of young researchers.

The idea of developing assistive technology was due to the concern to apply inclusive learning in a public educational institution and to facilitate the pedagogical development of teachers regarding students with disabilities. What is expected to be left to the educational institution with the research developed, is not only software, but a legacy on the primacy of inclusive education both in the classroom and outside it.

Acknowledgments

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