Teacher Education and Accessibility on E-Learning System: Putting the W3C Guidelines into Practice

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Abstract—**This article discusses the strategies for the implementation of the accessibility guidelines proposed by the World Wide Web Consortium (W3C), which is an international community that develops standards aiming to ensure the web growth. The Continuing Teacher Education Course in Accessible Communication and Information Technology has been the stage for study and research, as it shows the accessibility and usability difficulties of the Web systems for teachers with diverse needs, as well as it works as a corpus for analysis and automatic and manual validations in order to develop an accessible e-learning system. The knowledge field of accessibility and usability is present in the curriculum structure and in technical and methodological actions of the course, which puts the socio-digital inclusion theory into practice. When we promote a detailed analysis of the application strategies of the W3C accessibility recommendations, we are affirming to Web system developers that projects which serve the human diversity are viable and possible. Therefore, not only the research network that aims the expansion of the web is widen, but also the assurance of access to the services and contents is provided to everybody, with or without diverse needs.**

Keywords-component; Teacher Education, e-learning system , Web Accessibility

I. INTRODUCTION

Education is a social product/process [5]. The socio-cultural repercussions caused by pedagogical actions must be analyzed, among other aspects, for the capacity to form and qualify professionals for the Brazilian educational system, and the for possibility to respond to social demands, especially the ones that emerge from a society which is more and more globalized and technological. The Continuing Teacher Education Course in Accessible Communication and Information Technology emerged as one of the possible actions that aim to give technical and methodological tools for the educators to be used with the digital technologies. Technologies which have already been implemented in the schools through qualification programs and actions from the National Fund for the Development of Education (FNDE) [1].

A course for continuing education of teachers must be designed through processes that promote group meetings, changes, and the proliferation of events which are capable of putting together innovation strategies for the network of Brazilian teachers who work in different cities of such a large country as Brazil. During almost fifteen years of continuing distance education (EAD), one of the most important points has been the presence of teachers with diverse needs. Through the specificities of these teachers, **the Web Accessibility** has become part of the course syllabus, giving a wider sense and meaning to the relation between theory and practice as well as to social, school and digital inclusion.

The difficulties regarding access and interaction with the tools available on the traditional distance education platforms revealed the impossibility of enabling public school teachers with diverse needs to work in the Resource Rooms for Specialized Educational Service (AEE). However, this qualification became the main strategy to put into practice the national policy of restructuration of the Brazilian educational process under the inclusive aspect [3]. The teachers who were distant from the normality standards , historically imposed by the society, experienced a fragile sense of belonging, which showed the urgent need to discuss the model and the interfaces chosen to mediate the distance education process.

This article presents the strategies which have been implemented to optimize and increase the interaction/capacitation process of ALL educators, with or without diverse needs. The process resulted in the design and implementation of the accessible e-learning system PLACE, which was developed according to the accessibility recommendations of W3C-WCAG 2.0 and ARIA [12,13] . This discussion details the actions that have made the tools accessible and were performed by the team of programmers of the Nucleus of Informatics in Special Education[1] (NIEE), of the Federal University of Rio Grande do Sul (UFRGS).

II. ACESSIBILITY IN THE E-LEARNING EDUCATION

The new reality of an inclusive technological school compelled many teachers to interact with students with diverse

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[1] Team of programmers from NIEE: Eduarda da Silva Pereira de Souza, Breno Gonçalves Bragatti Neves, Guilherme Ogliari, and RodrigoPrestes Machado.

needs without having any knowledge about the inclusive approach nor digital fluency to use the high and low technology resources available in the resource room. Thus, many of these teachers worked under the perspective of differences, not knowing the Special Education research field and the technological tools which can contribute to the accomplishment of the inclusive process.

The changeability of technology and the diversity of human specificities have demanded that every educator becomes a permanent student. They have to learn new knowledge, a new reality, and the new requirements of this technology and the inclusion of students with diverse needs in the educational regular system. These are the new aspects that integrate the profile of education professionals and are necessary to serve to a new routine which is very different from the previous one in the Brazilian school community. Distance Education Programs have been offered to capacitate the educator to work in an inclusive perspective, but how can we face the problems that are naturally correlated to this challenge without guaranteeing the word and the listening powers to these educators?

The coordination team of the Continuing Teacher Education Course in Accessible Communication and Information Technology is convinced that only through listening and dialog the education strategies will become pedagogical practices based on the school, social and cultural equity principles. Therefore, the implementation process of each course edition represents the result of listening and dialog movements performed by their actors – participants, instructors and tutors – a production that made it possible to follow the development of inclusive strategies of the teachers in continuing education and, at the same time, resulted in the technological updating and qualification of each new course edition.

As a consequence of this dialogued production, it was structured a pedagogical project which follows the technological changes and the socio-digital school inclusion in harmony with the inclusive education principles. The permanent strategy put in action by the NIEE/UFRGS team, which is responsible for the pedagogical coordination of the course, is to get the participant teacher and the accessible technologies closer to each other. Among many knowledge fields brought to the course, we can highlight the applications for mobile devices, and the contemporary communication and information systems on the Web, in particular the ones which operate with the computing logic of clouds. These actions have many times anticipated the arrival of these technological configurations in the public education context.

The curriculum structure (Picture 1) of themed blocks for the Continuing Teacher Education Course in Accessible Communication and Information Technology was suggested by the pedagogical team in order to respond to one of the aspects highlighted as a qualification point to capacitate teachers: to give the participant the choice power, so that each educator is able to design their own learning program and, by doing so, to perceive and approximate the time and space of the continuing education with the political-pedagogical approach

of the educational institution and the challenges that the presence of students with diverse needs present.
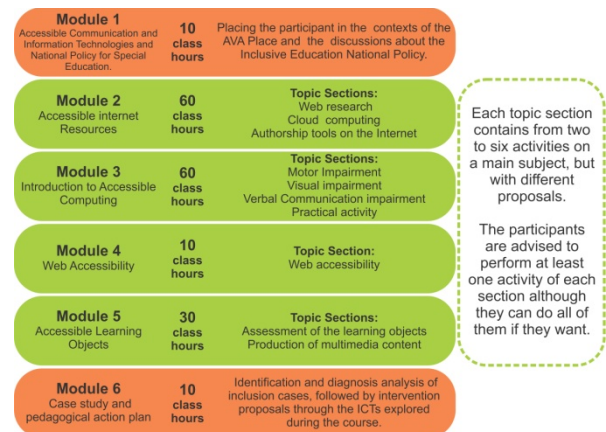

Figure 1. Curriculum structure of the Continuing Teacher Education Course in Accessible Communication and Information Technology (FNDE/NIEE/UFRGS).

The creation of a Web Accessibility module for the course is due to the importance given to this knowledge field. This is an innovative action for a development course, as most of the college education institutions disregard this knowledge. Due to the innovation of this theme and the careful dialogued construction of the theoretical referential, the Web Accessibility module unsettles the participant teacher, which makes them analyze the "Internet Universe" through a new filter: the possibility of interaction with a person with diverse needs. The words of the teacher reveal the relevance of the discussion focus proposed by the course:

> "[...] The activities proposed for this module were very important, in particular for the fact that we still do not have any idea of how difficult it is for those who have some kind of limitation to access the web.When we do these activities we realize it is not that simple...It is not because Windows has those tools on the accessibility control panel that everything will be solved.There is much more that can be done to make sure the exclusion practices are reduced." **[Participant teacher A – 2013/2 Edition]**

The Web Accessibility module made two major movements built by the teachers possible with protagonist actions that overcame the limits of time and space of the education process.

The first movement was performed by a blind teacher when doing the evaluation activity on websites. The conquer of digital fluency by this teacher, enabled her to participate of a renowned accessibility discussion list, the **Digital Access** list. This important singular movement was noticed and celebrated by a course instructor who also takes part in the discussion list:

> Educators:
> I take part in the Digital Access discussion list. To my surprise, today I read a message from a student of the course (yes, they know where to go for help!): Friends from the list, I am taking the accessible technology course. In this module we have to evaluate a website based on a list of criteria created by them. Could someone help me understand the criteria of this list? I know that a lot of people here know about this theme. I have chosen a news website which I access daily and find problems: *www.vnews.com.br*
> I have attached the list of criteria , so who can help me, please do. There are some visual criteria which I have not been able to identify. Greetings and I hope you can help me.**[Educator Ma- 2013/2 edition]**

[...] I have just watched the video " Web accessibility, cost or benefit?", and right now the results of the course start to cross over the walls of my school.Many words called my attention, such as the ones I quote now: " the hearing is not synthetic as the vision" (Leda) "… to make pages that are accessible to everybody" (Marco). At this time I stop to think about the official city website and I am sure I will help to make it more accessible.[...][**Participant C - 2013/2 Edition]**

The search for people who are more experienced in digital accessibility subjects must not be understood as a mere transference of responsibilities. It is very difficult, almost impossible, for an evaluator with visual impairment to verify aspects related to the accessibility guidelines for the color and contrast quality of the digital content. The normal thing to do would be the blind teacher to send a message to the instructors' team, informing them about her impossibility to performed the task of the Accessibility Evaluation Chart for this criterion: the color combination between the screen background and the text of the pages is contrasting enough to allow the information to be seen by people with visual impairment or by users who have monochromatic screens? The instructors would not contest this attitude, but it was not what the teacher wanted.

The blind teacher sought for a support network in the discussion list to construct the solution for her difficulty to assess the digital accessibility and socialized her discoveries with the other course participants, which portraits a real example of a successful inclusion process. The message sent from the virtual platform of the course revealed the action of the teacher with diverse needs when sharing her knowledge to qualify the digital accessibility analysis process of a group of educators in training:

Friends, Instructor M. and Tutor M.,
 I liked the content presented in the chart for the manual assessment of accessibility on websites very much. I did not know that referential and it will be very useful from now on. I had some questions about the existence of mechanisms to evaluate the color and contrast appearance of the websites and if it would be possible for me to assess them, as I am visually impaired. So, as I participate in a discussion group about "web accessibility" I decided to share my questions with my friends from the group, considering that some people of the group also have visual impairment. I got very rich pieces of information. There is an assessment tool which analyzes just color and contrast, and we can access it on this link provided by one of my friends from the group: http://www.checkmycolours.com/. I loved it and, although the results are in English, we can understand them very easily. I have also found Ma. there, who is an instructor of our course. What a wonderful small world this is! What I learn there, I will share here. **[Participant B - 2013/2 Edition]**

The social impact of presenting the web accessibility theme in continuing teacher education programs must be also analyzed, as they become an interface for more effective actions to conquer more equity outside the school too. The message posted in the discussion forum for accessibility illustrates this important second movement shown by the participants : to know and act:

Educators are social actors who provoke changes in the society in a more direct and effective way by mediating the human development processes and altering the economical and cultural relationships. When   they make the knowledge cross over the limits of the course and the school, the teachers exercise their citizenship and interfere with the actions of the Brazilian city governments.

The message sent to the Communication Secretary by the educator reveals that the citizenship exercise is made possible when the knowledge earns the power to interfere in the social field. The consolidation and amplification of the actions to build a fairer society go through the assurance of spaces for education and development for everybody, people with or without special needs, especially for educators.

Mister Secretary F. A.
 I am a teacher in a city public school and I work in a Multifunctional Resource Room offering to the students with diverse needs a specialized educational service (AEE). As every teacher, I am always attending continuing education programs and right now I am participating via internet in a continuing education course offered by UFRGS and MEC. In this course, we are discussing and learning about accessible technologies and I feel, not only as a civil servant, but as a citizen, that it is my duty to contribute for a more inclusive society by sharing with this Secretary the information that there are international guidelines for the design of accessible websites. As I am sure it is the objective of our Secretary to make the information on the city hall website accessible to everybody, I am at your disposal for any kind of information and contribution which can make the City Hall communication process fairer. **[Participant teacher C - 2013/2 Edition]**

The dynamics proposed by the Continuing Teacher Education Course in Accessible Communication and Information Technology responds to the contemporary paradigm, which affirms that the design of Web systems, more than the improvement of the usability of the web interfaces, must have as an objective the development of a Participation Architecture [6], that is, computing systems that incorporate interconnection and sharing resources of technologies and, mainly, knowledge. The course coordination team, which has as a process/product the qualification of the development of people with diverse needs, reaffirms the premise that "the technology is always provisory" [9], as all the digital educational resources always crystalize and represent a socio-cultural development stage of humankind. Through this premise, we highlight the supremacy of the man over the technology, for the technological and methodological choices made by the coordination team during the structuring of the course were under the certainty that: (1) the mutability of the technology cannot be disregarded, since the fast technological

updating makes the resources obsolete very quickly; (2) the socio-cognitive advances project a growth in the set of new abilities and competences which cannot always be valued and explored through traditional educational resources; (3) the transformations produced from the interaction of man with technology institutes processes of subjectification impelled by the imbricate relationship man-technology; (4) the permanent reconfigurations of socio-cultural time and space in primitive societies, industrial society and, contemporarily, in the informational society, are products and processes of technologies which emerged and forged individual and collective subjectivities.

The plasticity and dynamicity of the fast and changeable technological world imposes the updating of the mediation and communication tools, especially the ones related to the educational context. If the technology is always provisory, the digital platform has also been redesigned by the coordination team of the Continuing Teacher Education Course in Accessible Communication and Information Technology in order to make it an interface that displays the processes of essential inclusion but also elective inclusion, as they were named by Rodrigues [7].

[...] The essential inclusion is the dimension which ensures that all citizens have access and participation to all levels and services, with no discrimination. Therefore, the essential inclusion assumes that nobody should be discriminated because of personal conditions to have access to education, health, job, leisure, culture, etc. It is an issue connected to the human rights and to the basic acceptation of social justice. [..] That is why it is necessary to develop the elective dimension of inclusion. This dimension assures that, regardless any condition, a person has the right to relate and interact with any social group according to their interests [7] (own translation).

When the Brazilian Inclusive Education Policy affirms the right to access to different educational levels and services available in the society for all teachers, which is a basic prerequisite of social justice, it shows the essential inclusion dimension. However, the act of teaching and the participation in continuing education programs for teachers with or without diverse needs must not be reduced to a mere access assurance. They must provide effective belonging conditions, including those programs which are through Distance Education (EAD).

III.   PLACE: AN ACESSIBLE E-LEARNING SYSTEM[2]

The socio-cultural inclusion movements cannot delimit positions nor determined time and spaces for the interaction of teachers with diverse needs in the distance education practices. This thin line that separates inclusion from exclusion must be carefully observed when designing the continuing teacher education programs through the interface of digital platforms, The possibility of dialog among everybody – instructors, tutors and teachers with or without diverse needs -, will only be

assured when the digital platforms impel actions of technological and methodological mediation based on the belonging concept. If the distance education course interfaces disregard this conceptual knowledge, they might be designing "ghettos" when attributing positions and determining the possibility conditions for each participant to trace their learning trajectory, which inevitably puts the human diversity under the risk of exclusion.

The technological configuration of the traditional Distance Education platforms exemplifies the fragility of the dimension of the essential inclusion discussed by Rodrigues [7]. All teachers, with or without diverse needs, are entitled to register for the continuing teacher education courses , either distance education or through digital platforms. However, the researches on Web accessibility reveal that the information and communication resources available in the distance education courses do not offer the important belonging sense exercise to all the participants.

The technology homogeneity of the Distance Education courses makes the development and learning processes of the participants with diverse needs not possible, which results in exclusion processes. The Continuing Teacher Education Course in Accessible Communication and Information Technology values and wants the participation of teachers with diverse needs. Therefore, the several editions of the course gradually constructed adaptation strategies for the digital and methodological resources so that the essential inclusion could lead to an elective inclusion.

The team of the Continuing Teacher Education Course in Accessible Communication and Information Technology took into serious consideration the concept of difference when constructing the organizational and management strategies. It is obvious that a course which has as the main goal to train teachers under the inclusive education perspective considers the elective dimension of inclusion for the curriculum organization, didactic material selection and the evaluation process. Moreover, the presence of participants who are deaf, blind, with low vision and with physical impairments led to the promotion of actions of elective inclusion: (1) the creation of a tutoring system in which the instructors and tutors know the Brazilian sign language to provide a more specific mediation for the participants with hearing limitations; (2) the use of specific technologies to solve the particular accessibility issues of each need, for example, video lessons with sign language detailing the directions of each activity for the participants with hearing impairments, and audio description for the ones with visual impairments; (3) the material available on the course platform was organized according to the recommendations of the universal design – texts with short sentences and accessible vocabulary, image description, glossaries and encouragement to use the online sign language dictionaries; (4) tutorials in different formats – text, audio, video, and dynamic formats – to make it easier to understand the methodology and the techniques.

For the participants who are blind or have low vision the adaptation of the resources was focused mainly on the description of the image and/or video. All the didactic

resources made available are in sync with the requirements established by the national and international team of researchers and registered on the guidelines of the World Wide Web Consortium (W3C) [12]: (1) labeling and description of the images, content validation by screen readers; (2) use of alternative communication resources, such as the synchronous communication tool (chat) accessible to blind users from Saci Network, and resources for instant communication such as Google Talk, Hangout, and Skype; (3) texts available in the .doc or .txt formats, allowing the access to the information through the screen reader; (4) the reorganization of the activities when the technology under discussion shows to be inaccessible to the blind participant.

The preparation of the course material, printed or digital, takes into consideration the usability principles, as it: (1) uses simple language, presenting the information clearly and objectively; (2) speaks the "language" of the participant , translating the computing knowledge into the universe of the Basic Education teacher, which allows conceptual appropriation; (3) minimizes the cognitive load through intensive familiarization of the participant with the course virtual platform, with the functions of the digital resources; (4) establishes a support network through tutorials in different formats and through the discussion forums that help answer the questions about the installation and the use of the accessible technology.

However, all the adjustments of the course didactic material made in order to ensure and qualify the presence of the participant with diverse needs were not enough due to the non- accessibility of the digital platform on which the course was mediated. For the paradigm of the Participation Culture to be able to operate at full potential also in processes of distance education, as adverts O'Reilly [6], it would be necessary to increase the number of people benefiting from the resources.

The conceptual matrix on which the course is structured, the respect and valorization of human diversity, cannot accept the previous exclusion of any social group and the restriction of any rights from people with diverse needs. For these groups, which were until recently invisible for humankind, to conquer spaces for sociability, education, and work, the developers and programmers of NIEE faced the challenge of implementing an e-learning accessible system – PLACE -, an interfaced adjusted to the specificities of teachers with diverse needs (Picture 2).

In the 2014 edition of the Continuing Teacher Education Course in Accessible Communication and Information Technology the started to take its first steps to assure a belonging feeling for the teachers with diverse needs by providing a context of education that seeks to minimize the barrier for the access to and interaction with the resources traditionally available on distance education platforms. Three groups consisting of participants with or without diverse needs learn the concepts regarding accessible digital technologies and , at the same time, live the experience of an inclusive educational interface on the e-Learning Place system.
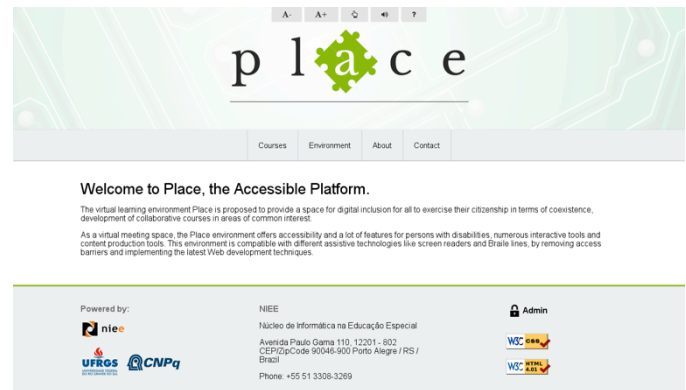

Figure 2. Enter screen – Place e-Learning System

The e-Learning Place system was implemented with the basic proposal of making a virtual space of digital inclusion available so that all users can exercise their citizenship by participating and developing collaborative projects in areas of common interest. In comparison with other platforms, it is different due to the fact that it was projected strictly following the usability and accessibility guidelines from W3C.

The accessibility principles of accessibility and usability that guided the design of the e-Learning Place system outline the actions to make its interface and tools accessible: (1) the resizing of the text is presented through the resources for enhancing or reducing the fonts, regardless the use of Assistive Technology; (2) the labeling with a text alternative for non-textual content; (3) the guarantee of access through different entries: keyboard, simulators, activators, mouth sticks and head wands;(4) the descriptions of the shortcut keys and the instructions for their use on different Web browser versions; (5) the proposition of consistent navigator mechanisms, easily identified and which operate in a predictable way; (6) the possibility of keeping the same order and location for the access to the functions to help the user instruction; (7) help mechanisms sensitive to the context, which provide information related to the resource that is being used. The instructions for the use of the functions of the Place e-learning system are presented on video with Brazilian sign language translation and on audio to make the access easier to blind or low vision users; (8) the possibility of maximize the compatibility with user agents through the validation of the interface with screen readers and real users with visual and auditory limitations [10]; (9) through automatic assessments, with robots of accessibility evaluation - validator W3C (https://validator-suite.w3.org/.) and Access Monitor (http://www.acessibilidade.gov.pt/accessmonitor/.)-, and manual, following the validation with users with different impairments, which is one of the most important precepts for the evaluation of accessibility.

All these strategies implemented for accessibility resulted in a graphic project with a minimalist design with friendly and intuitive interaction, which provides a low cognitive load to the users. The accessibility bar of the Place environment represents an application of the concept of cognitive ergonomics, as it empowers the interaction between human beings and socio-

cultural systems, which is guaranteed to everybody, regardless their sensory or cognitive needs. The accessibility bar is located at the top area of the interface and it is always available to the users. The bar is one of the differentials of the e-learning system and it aggregates the following functions (Picture 3): (1) the interaction and communication resources can be accessed through shortcuts of the keyboard. This implementation strategy allows the users with visual limitation, who use screen readers, or the users with motor impairments to move with more agility among the three areas of the environment: menu of tools (key F), accessibility bar (key A), and content area (key C); (2) the options to enlarge or reduce fonts make the use of the environment easier for people with visual limitations; (3) the link for the video files in Brazilian Sign Language (Libras) describe the main information (similar to a help) about the tool the user is on;(4) the link for audio files, which presents the same content of the video, aims to make the access of users with visual limitations easier.

The functional architecture of the Place e-learning system was projected to respond to the weaknesses of the previous platform pointed out by teachers with or without diverse needs. The traditional mediation tools for distance education were developed under the criteria of usability and accessibility and, at the same time, new resources were implemented so that the Participation Culture was empowered also in a teacher education context, for example, the White Board tool for the synchronous and collaborative production for the Web.

The teachers who are going through the continuing education process now benefit from a new set of functions offered by the Place e-learning system:

- Production Space : a place in which all the participants can insert work and material, which can or cannot be shared with other users.

- Media library: it works as a storage place for the material which can be shared with other participants of the course. The material can be in many different formats: audio, video, image, text, or other kinds of files.

- Blog : a tool of asynchronous and accessible production, which allows posts to be shared with participants and also with external internet users.

- White Board: a tool of synchronous and accessible production, which allows the development of documents collectively and has the support of video and audio communication as well as design resources.

- Chat: text communication among the participants of the course. The chat sessions can be created by any of the students.

- Mail: a tool for traditional internal electronic mail which also allows messages to be sent to the users' external e-mail services.

- Forum: internal environment for discussions among the participants. They can be open by any participant of the course.

- Logbook: a tool that works as a daily log for the participants to demonstrate their opinions and feelings in relation to the course.

- Profile : a tool on which all the participants include their personal information, allowing the other participants to know a little about their preferences and professional experiences. It is shared with all the participants of the environment.

- Notice Board: It works as a board where all users can posts notices.

- Reports: A tool that allows the coordinator and instructor of the course to check through charts and graphics the access frequency of the participants to the project.

- Urgent Information : a tool on which the support material is available for the accomplishment of the task: tutorials, video-classes, useful links, etc.

- Schedule: A tool on which the schedule of the course is displayed: the themes, discussions, modules or courses and when they will happen.

- Activities: A tool that presents and organizes a set of educational tasks and strategies which are supposed to be accomplished by the participants during the course.

- Administration: A management tool which allows the coordinator and the instructor to alter information about the e-mail and course, as well as to send the passwords to the participants.

The 2014 edition of the Continuing Teacher Education Course in Accessible Communication and Information Technology accomplishes one of the most important phases for the implementation of an accessible web system – the validation with real users. In addition, there is the advantage of this process to happen in a real teacher distance education context. In order for this to be possible, 75 articipants and six members of the group of instructors and tutors are building their fluency in accessible digital technologies which gives the opportunity for the NIEE development team to receive a direct feedback from the target audience of the project.

Aiming the optimization of the validation process of the Place e-learning system, a group of participant and tutors who have physical, visual and hearing impairments analyzed and reflected upon the graphic project and functionality of the interface. To make sure the practice was truly inclusive, the validation team also had participants without diverse needs. Graphic 1 presents the profile of the validation group.

- Teachers with visual impairment
- Teachers with motor impairment
- Teachers with hearing impairment
- Teachers without any impairments

63% **19%**
51 **7%** 15
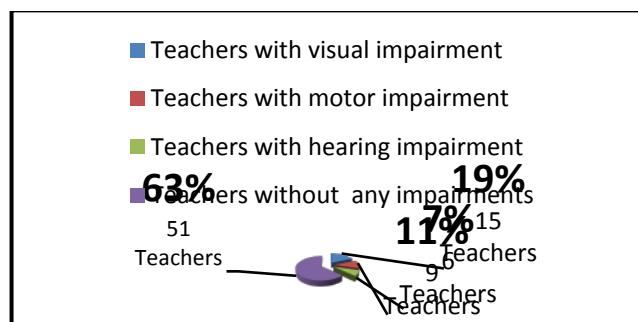Teachers **11%** Teachers
9
Teachers
Teachers

Figure 3.   Profile of the validation group.

Methodologically, the validation protocols of the Place e-learning system are in a research context with qualitative approach, as it values the dynamic relationship between the technological resource and the research subject and confirms the unbreakable link between the resource objectivity and subjectification practices, a movement which cannot be translated or reduced into figures.

The words of a blind teacher qualify this reflection because they come from a user with a double profile, who experienced the possibilities and limitations of two different digital contexts – as a student, he used Teleduc and later, as a tutor, the Place e-learning system. From the dialogs built with Valdir Dias de Moraes,   former student of the course who has visual impairment and has been working as a tutor in the 2014 edition, we present an extract of his feedback about the validation process:

> [..] I have not noticed any incompatibility between the screen reader I use, NVDA, and the Place platform.I navigate safely using the navigation keys, which allow me to move from one area to another faster and make it possible to access and interact with the resources in a very peaceful way. When I was a student of the course, I used the tools of Teleduc platform and, comparatively, I can see advantages with the Place Platform.**[Tutor VDM -2014 Edition]**

After the development of the Place e-learning system, the distance education format now can count with an accessible digital resource for the accomplishment of the essential inclusion. The Continuing Teacher Education Course in Accessible Communication and Information Technology, by training groups of teachers with or without diverse needs with accessible tools available on the Place e-learning system, creates possibilities to build capacitation processes in which the educators' diversity can interact without the projection of ghettos.

With the Place e-learning system, the NIEE technologic development team ratifies Castellano and Montoya's observations [4], researchers who, when investigating the interactions of people with diverse needs with computing resources, reveal the need to rupture the logic of the exclusive software for Special Education. Programs labeled as deficit-centered reveal their weaknesses, even when they do present advantages, as they are easy to operate and seem to solve the problems, but, actually, they do not follow the development of the user and do not empower the interaction with other users.

IV.   PLACE: APPLYING THE W3C GUIDELINES

The Place e-learning system has been developed following an incremental methodology, parts of the system are designed in parallel and integrated after being finished and validated. The iterative methodological character is expressed through the complementarity of the actions of planning, modelling, coding, and verification, which inflict a continuous re-work process with revision and qualification deadlines predetermined in the chronology of the tool implementation project. In order to comply the accessibility requirements,   we followed these instructions established for the development of accessible systems [2]: (1) to verify patterns for the Web; (2) to adopt the accessibility guidelines, and (3) to verify the system accessibility manually and automatically .

The first document consulted for the implementation of Place system was the Web Content Accessibility Guidelines (WCAG) [12], at the present in its 2.0 version, developed by the W3C consortium   from the creation of the   Web Accessibility Initiative (WAI)[13]. Due to the fact that it is an environment for the Web, which involves a larger set of functions that are gradually possible on the new HTML and CSS versions, a second document is being studied, still in a draft version, ARIA- HTML5 [13]. Aiming to make the Web environments more and more accessible to users with diverse needs, a new set of accessibility guidelines is being developed by the Web Accessibility Initiative (WAI) group, which is part of the W3C, clarifying the complementary technology for HTML5, an Accessible Rich Internet Application, known as ARIA. ARIA guidelines allow us to operate on the ontology of the functions, states and properties that are needed to make the elements of the Place tool accessible. Through this new technology, it was possible to enlarge the HTML semantic, aggregating a set of information on structures and behaviors that allow the assistive technologies to recognize and transmit the resource and content functions of the interface properly.

A. Place: the application of the accessibility principles.

Socio-digital inclusion processes are propelled by the accessibility recommendations established by W3C. The set of orientations that guide the web-content developers is organized in four categories: **perceptible**, the information and components of the interface should be perceived by the users; **operable**, the user interface components and the navigation should allow the interaction, respecting the characteristics of the user; **understandable**, the information and operation of the interface should be understood by the user; and **robust**, the content should be sufficiently well elaborated so that it can be interpreted in a concise way by different user's agents, including assistive technologies.

The first guideline of the WCAG 2.0 document, perceptible, recommends that the environment should be developed with accessible interface components and their meaning should be presented to the user. On the Place e-learning system all entry and exit data elements of the interface are components standardized in HTML 4.01.
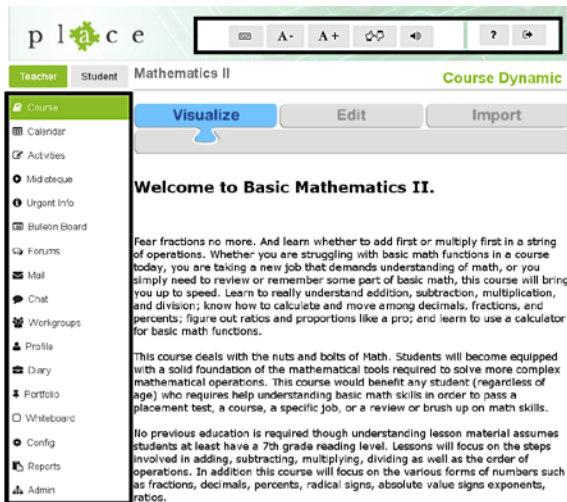
Figure 4.   Accessibilitymenu bar accessible to the screen readers.

The item 1.1.1 from WCAG2.0 recommends that all the non-textual elements should have an alternative text that can be used by assistive tools such as screen readers, Braille displays or should be processed by tools for text simplification. The Place system had on his prototype and interface built with non-textual elements for the menus and the headings, like images and icons. These elements were substituted for plain texts in order to increase the compatibility with the standards and the assistive tools (Figure4)
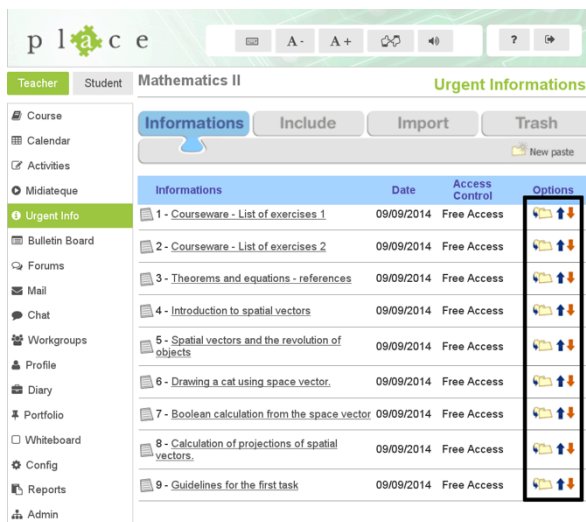

Figure 5.   Labeling of the non-textual elements.

By not using images on the lateral menu or on the accessibility bar we eliminated the labeling process and optimized the implementation ensuring the accessibility to all its elements. The icons on Place were built with Unicode mapping techniques, fonts and CSS, making them visible on the graphic interface but hidden for the screen readers and, at the same time the text content becomes invisible on the graphic interface but visible to the assistive technologies. Technically, the CSS file informs that this non-standard character and

defined font in CSS is a vector icon, putting the item on the menu or on the accessibility bar. Non-textual elements, such as the icons used on some tools of the Place e-learning system, were correctly labeled according to the guidelines from WCAG 2.0 (Picture 5).

There is a help system which enables the use of the text, video and audio resources by turning the instructions into Brazilian Sign Language (Libras) so that the perception, understanding and usage of the resources available on the Place e-learning system are increased. To allow it to be used on mobile devices, the page labeling informs the correct exhibition form through the metatag viewport attribute (Picture 6). The feedback of the course instructor about the blind participant accessing the platform through a mobile device illustrates the importance of installing a distance education system compatible with different platforms, as it is the case of the Place e-learning system:

Hi, Débora Conforto, how are you?I would like to share with you, professor Lucila, and the programmers' group what Luciane, a participant who uses screen readers, published at the end of the module 4 activity about the Place accessibility:"PS: I am notat home and I am posting via iPad. I do not have the Office package and I am copying and pasting the content here. I want to inform you that the platform is very accessible through the screen reader VoiceOver".

Figure 6.   Place e-learning system is accessible on a mobile device.

The Place e-learning system allows the insertion of HTML files without showing any problems for encoding the characters. The support for the different character encodings and idioms is not forced, which makes the documents included on the e-learning system valid and legible.

The accessibility of the forms was another aspect observed in the implementation of the Place e-learning system. All the tools that use this kind of resource for the data input present the fields to be completed connected to their respective labels, which are properly descriptive (Picture 7).
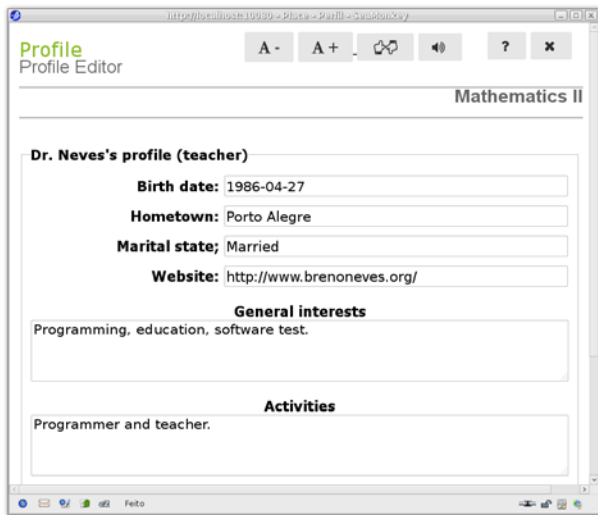
Figure 7.   Text fields present their respective labels.

The correct labeling process was also performed on the radio and selection buttons. The content of each button is a field label, which allows the user to choose through a click on the button or on the text, using the mouse, the keyboard or another entry device (Picture 8).
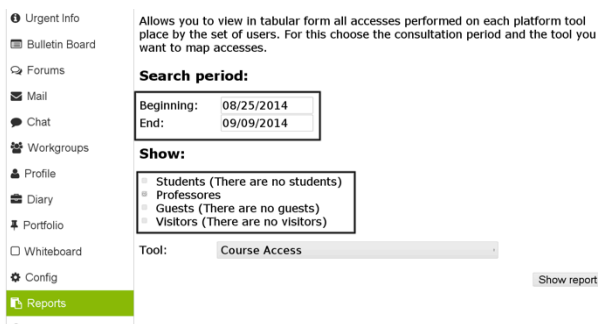

Figure 8.   Labeling on radioselect buttons.

To make sure the blind user can navigate in an optimized way, the interface of the e-learning system follows a specific order – Accessibility Bar, Tool Menu and Content Area -, and when it is rendered by the browser it can be read by a screen reader or accessed through another assistive tool. On screens that have a menu, the elements which are usually displayed in charts were substituted by semantic markers which connect the title and the descriptive text with a field to enter data.

Another accessibility action implemented was the alteration of the colors used on the prototype layout. Even though the contrast was validated in several tests, light gray background with black letters, the colors were substituted to ensure a higher contrast between the background and front colors used on the interface. The gray background with black letters offered a 2.65:1 contrast. The new color palette offers a minimum contrast of 12.5:1, a much higher value regarding the item 1.4.6 (AAA level), which recommends a contrast of at least 7:1. The Place e-learning system still allows the tool to be resized up to 200% without using any assistive technologies.

As for the second accessibility principle, operable, the WCAG 2.0 guidelines advise that the web systems should be able to be operated using only the keyboard. On the Place e-learning system, the code part which could alter the keyboard focus had been removed, such as the selection of the mail message receiver, and now it does not interfere with the object focus through the keyboard, following the recommendations.

Another recommendation of the operable principle suggests that the systems should give enough time for the user to read and use the content. On the Place e-learning system, the only time limit presented is related to the course duration. All interactions with the system do not have any time restrictions and the authentication system used, HTTP Basic, does not have expiration time.

The guideline related to the navigation recommends that the web systems should allow the users to be able to locate resources and contents. The Place e-learning system has a navigation structure which is standard in the whole environment, so the user is able to see or hear where he/she is. As it is a structured environment, the system organizes the navigation in blocks, which allows the user to ignore them. The screens have titles with significant texts that inform which tool has been selected and what it is for. The links contain clear, objective texts which are proper for the context.

The interface of the Place e-learning system does not allow the user to alter the context without altering the focus and confirming the operation by clicking on a specific button. The components for entering the data do not perform any alterations on the context or focus. This accessibility strategies were implemented through the standardization of several screens for entering data. These screens now have elements, such as data-sharing selection, inserted in all the tools (Picture 9).
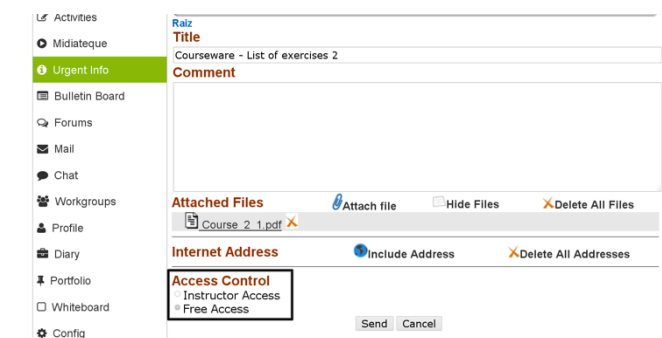

Figure 9.   Screen for sharing options always exhibits the options in the same order on different tools.

The chat tool has been the communication resource which presents the biggest challenge for the programming team, as the dynamicity in which the information is transmitted makes it difficult for blind users who rely on screen readers. To make the access easier, the enter screen displays the name of the user registered on Place, not being necessary to complete the field at each new chat session (Picture 10) . The tool settings have been changed because the traditional versions of chat software organize the message and other screen elements in charts,

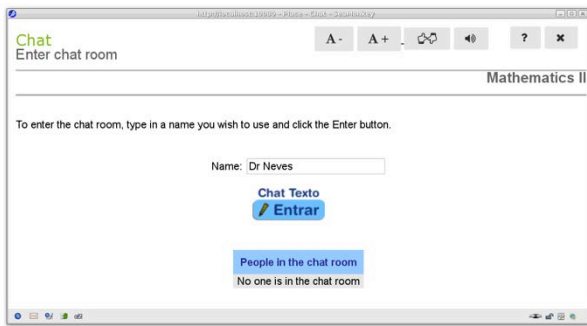which makes the access to the information difficult for the screen readers.

Figure 10. Chat room: the name of the user is autocompleted.

Visually, the chat screen is similar to the traditional chat room interfaces, but with the implementation of the right semantics, which informs the blind user about the three elements that structure the message : time, sender and message content (Picture 11).
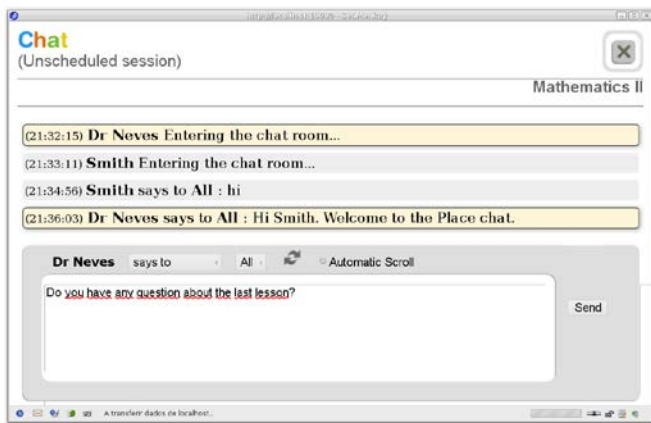

Figure 11. Chat window using the HTML semantic elements.

The future version will use the concept established by WAI-ARIA of live regions. This concept is already used with another synchronous communication tool of the e-learning system, the White Board. The words of the blind tutor responsible for the mediation of a group of participant with and without visual impairment certify the actions for accessibility implemented on the chat tool:

> [...] Another positive aspect I can point out is related to the chat tool. I perform productive mediations on the chat rooms, which have participants who are blind, as me.**[Tutor VDM - 2014 Edition]**

The Mail tool is also a resource which received specific actions to improve the accessibility and provide friendlier communication. The chart which displays the messages has been modified so that it contains status, subject, sender and date. All messages are shown on a single page, which is a strategy that makes the access easier as there is no need to go through many screens (Picture 12). The page for mail message visualization opens a new window and displays the close

button at the bottom and can be accessed through the keyboard. The navigation structure allows the blind user to go back to the previous focus, that is, to the screen which contains the message list. These modifications have also been pointed out positively by the blind tutor:

> [..] When I was a student of the course I used the tools of the Teleduc platform. Comparatively, I can see advantages in the Place mail tool, as the access to the messages is through one page only, which reduces the time spent and the difficulty to click on the button to open a new page and then have access to the other received messages. **[Tutor VDM - 2014 Edition]**

A resource highlighted in the Place e-learning system is the White Board tool, which was created to enable the production of documents in a synchronous and collaborative way. The design process started with the study of existing systems, which proved the difficulty for users with impairments, in particular visual impairment, to access these environments.
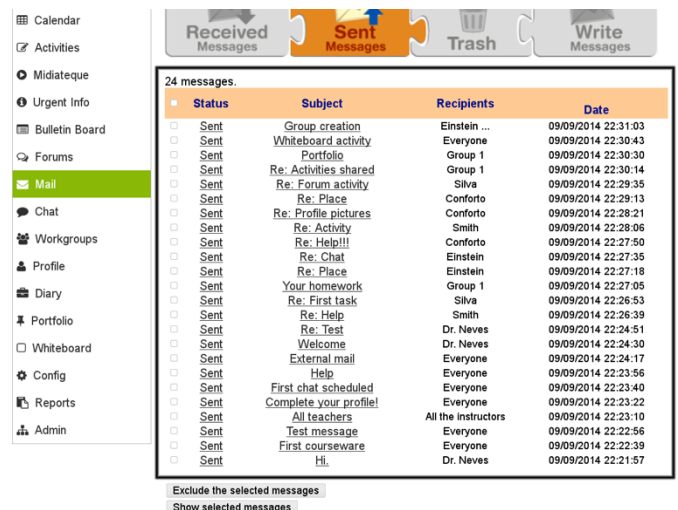

Figure 12. Mail message organization.

The White Board tool presents two user profiles: the Coordinator and the Participant. The Coordinator user is responsible for opening the communication/production room as well as sending the invitation to other participants. As the administrator of the session, he will be responsible for the control of the audio and video transmission and for opening new production pages. He is also allowed to share this control with other participants. Besides that, the Coordinator is responsible for saving the register of the interactions performed in the chat room and the audio and video transmissions, and for the publication of the final product in PDF format. The Participant user has the permission to use all the production/edition tools, as well as access to the audio and video transmissions that were made during the interactions.

The interface of the White-Board tool (Picture 13) is divided in three areas: (1) Identification and Accessibility Bar; (2) Communication Area; (3) Production Area (Picture 10). The difference in this environment is shown on the accessibility resources, which allow the users with visual,

auditory and motor impairments to benefit from a space designed for the collective and collaborative construction of knowledge.

Figure 13. WhiteBoard tool: the three interaction areas for the synchronous collective production.

In order to make the collective and individual authorship possible in the Production Area, the White Board tool displays an Edit Bar, which presents a set of edition functions programmed with a friendly and interactive configuration that does not require the user to have deep technological knowledge. On the Edit Bar, the participant/author will find icons which allow the insertion of text boxes, images, and videos. The application saves the documents automatically, which is a very important function as it respects the learning pace of the participants and, by eliminating a user action, reduces the cognitive fatigue.

The Place e-learning system is a robust environment as it fulfills all the requirements of the fourth principle of the WCAG 2.0 documentation completely. All the environment screens are considered valid by the W3C validator and, besides that, tests are performed periodically with several agents of users and assistive technologies, which makes it compatible with the accessibility level AAA, according to the criteria established by WCAG 2.0 documents. The AAA level means that the system goes beyond the minimum recommended by the accessibility standards, as it has some optional items which make the system accessible to different kinds of impairments. The source code is clean and well documented which makes it to be the support and model for the study and design of other accessible systems.

V.   FINAL CONSIDERATIONS

In the historical movement for the development of technologies for people with diverse needs, the NIEE team joins the researchers who choose to rupture with the exclusivity character. The e-learning system promotes the interaction of users with or without diverse needs and, by doing so, abandons the restrictive design, centered on the flaws, therefore, on the segregation of people with diverse needs.

If the present situation contributes for the inclusive discourse to be easily spread, as Touraine observes [11], "we

are instructed to recognize the differences and protect the minorities" (own translation), the NIEE team moves away from this established perspective for inclusion in order to make sure that the minority groups can be acknowledge as people with the right to be constituted as subject. If the constitution of a subject happens when interacting with their peers in different socio-cultural spaces, the concept that triggered the project which resulted in the e-learning system is to build this principle for the Distance Education context (EAD).

The words of Rosa Luxemburg, "for a world where we are socially equal, humanly different and completely free" (own translation), illustrate the two inclusion dimensions pointed out by Rodrigues in this important shift: from essential to elective. We have equal rights to have access to economic, social, and cultural benefits, but we are always different so that, regardless physic, social or economic conditions, the specificities that characterize the human diversity are respected.

Each action that enabled access and was implemented in the Continuing Teacher Education Course in Accessible Communication and Information Technology achieved the goals established by NIEE/UFRGS. Not only that, but these actions have even a greater meaning when they establish new elements for:

(1)   forging a new teacher, that is, designing a new professional who adopts and defends the diversity values, a keen educator and analyst for the construction of collective and cooperative teaching in sync with the Diversity Culture;

(2)   instituting a process for the teachers from different Brazilian cities to conquer the digital fluency, so that they can be the external support, not to solve the specific issues of the students with diverse needs, but to stimulate movements that transform the time and school space to construct the diversity culture. It is important to establish movements to rupture the therapeutic support configuration, centered on the impairment, so that we can design a new support network, more collaborative and with an institutional approach;

(3)   prioritizing the construction of a model of external support process, which breaks with the therapeutic intervention and promotes educational actions of a preventive and pedagogical character. Actions which are more directed to the education of the teacher than to the student with diverse needs.

The construction and use of the Place e-learning system with accessible tools and resources aim to promote an education space that comprehends the cognitive and socio-affective aspects for people with or without diverse needs. As the Place e-learning system is disseminated, the alternatives for the socio-digital inclusion of people with diverse needs in institutions which serve the human diversity will increase.

The development of the Place e-learning system empower the knowledge construction of the Computing Science field, especially in relation to Accessibility and Usability of Web

systems. This knowledge is produced through studies and investigations that are part of the researches of the Informatics in Education Post Graduation Program (PGIE) and the Post Graduation in Education Program (PPGEDU), creating a space for the development of new studies (dissertations and theses).

As beneficiaries from the implementation project of the e-learning system, we mention: (1) teachers of all levels who work with people with diverse needs, aiming their education in a national and Ibero-American level, as the continuing education that has been promoted by SECADI/CAPES/MEC and NIEE/CINTED/SEAD/UFRGS; (2) teachers and students with diverse needs who are going through education processes in all levels, especially undergraduate and graduate studies which use web systems in face-to-face, semi-virtual and virtual classes; (3) students with diverse needs who are in basic education levels (primary and secondary schools); (4) private and public college institutions which provide distance education and have students with diverse needs; (5) education institutions from English and Spanish speaking countries that use the Accessible Distance Education Platform available on the Electronic Government Portal, as free software; (6) hospitals which treat students with serious diseases and are temporarily away from school, in order to give continuity to the school education;(7) civil servants with special needs, public and private companies which participate in continuing professional education processes.

Investigations on accessible web systems are fundamental to guide educational and technological actions of the Government. Besides that, these investigations contribute to the international exchange, especially with Ibero-American countries, of digital spaces and accessible tools as assistive technology resource centers and web accessibility, aiming users with diverse needs.

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