Accessible Chats for Computer Supported Collaborative Learning Environments in Mobile Devices

Doctoral Consortium paper

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Abstract: The use of chats in Mobile Devices (MD) for learning environments is being increased in the last decade. However, they present many accessibility barriers that prevent people from using them. As a result, some people do not have the same opportunities to learn. This research aims to solve the accessibility barriers of chats in learning environments for its use in MDs. Thus, this paper presents the proposal of an model-based design and the strategy development process to create an accessible chat.

Keywords: Accessibility, Chats, Mobile Devices

I. INTRODUCTION

During the last decade, students and teachers use MDs as a new way of learning. They share information and communicate with each other to solve problems that they face. From the point of view of communication, students use MDs as a Computer Supported Collaborative Learning (CSCL) tool to blog, to send e-mails or to communicate among others.

Previous researchers showed the usefulness of MDs in CSCL environments (m-CSCL) [1] and the usefulness of chats as a CSCL tool [2]. However, not everybody can use chats for learning because chats present many accessibility barriers for many people. Previous studies have demonstrated that these accessibility barriers affect users with disabilities, but they also can affect people who do not present any disability. For instance, many users use them in environments which limit users' capacities like hands-free or noisy environments. As a result, people without disabilities can experience the same problems as people that have some disabilities [3].

This Ph.D aims to solve these accessibility barriers. Thus, this research provides a model-based design of an accessible chat and the strategy development process to create it.

II. STATE OF THE ART

A. Learning through Information Technologies

Each student prefers a way of learning like: traditional learning in schools, learning through computers (e-learning), learning through MDs (m-learning), etc. Thus, it is important to provide different ways of learning and each student could select the best way for him.

After the evolution of Internet to Web 2.0, the interaction between users through Internet has changed because they are considered now as active users instead of static users. This concept can be extrapolated to e-learning too. Nowadays, students are active learners and the teacher is not the only source of knowledge [4]. Teachers and students collaborate with each other and teachers can learn from their students [5]. Then, the concept of CSCL emerged. Recently, this concept was extended to m-learning environments [6] too where students and teachers collaborate, communicate [7] and share their ideas [8] with each other through MDs.

B. Standards and regulations

People with disabilities should have the opportunity to access to the e-learning environments as all students. However, some people's rights are violated because some students cannot access to these educational resources [9]. If the ITs and e-learning environments were created in an accessible way, people with disabilities would be less discriminated because they could access to all the information and there would not be any difference between people. There are different accessibility standards, guidelines and laws that normalize or regulate the access to ITs, e-learning environments and m-learning for everybody.

From the point of view of laws, some countries have created laws to protect people's right when they are using ITs. For instance, USA created *Americans with Disabilities Act (ADA)* [10], in Spain *Ley de Servicios de la Sociedad de Información (LSSICE)* [11] is the law related to these rights and Europe provided the *2005 Communication on eAccessibility* [12]. On the other hand, there are laws also to protect people's rights in education like the law *Individuals with Disabilities Education Act* (IDEA) from USA [13], *Disability Discrimination Act* (DDA) from UK [14] or the law *Ley Orgánica de Educación (LOE)* from Spain [15].

Besides, some standards and guidelines are related to accessible ITs and learning environments, which are taken into account for the chat's design, such as: the educational standards *ISO/IEC 19780*[16] and *ISO/IEC TR 29410* [17]; the ITs standard provided by World Wide Web Consortium (W3C) called *Web Content Accessibility Guidelines (WCAG) 2.0* [18]; the W3C guidelines related to MDs such as: *Mobile Web Accessibility Best Practices (MWABP)* [20] and *Mobile Web Best Practices (MWBP) 1.0* [21]; or the guideline for accessible e-learning *IMS AccessForAll* [22] among others.

C. Background: accessibility barriers in chats.

Chats present accessibility problems and they have even additional problems than other IT systems [23]. After a deep analysis of previous researches which found some accessibility problems related to chats, we propose a classification of the problems found into: Accessibility-supported technology, flow and rhythm of chats, technology used in the creation and specific problems for MDs (Fig 1).

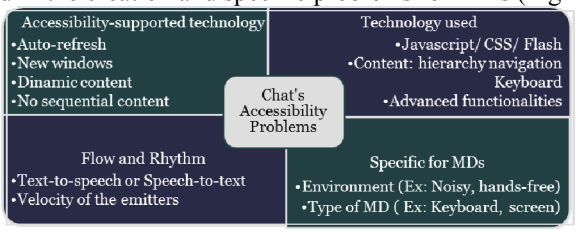

FIG 1. CHAT'S ACCESSIBILITY PROBLEMS

1) Accessibility-supported technology

Some people need to use assistive technology to access to IT systems. However, it can suppose an additional handicap for them because their use can make that some chats do not work properly. For instance, screen reader users face problems when the website is auto-refreshing continuously because the screen reader restarts [24] and the screen reader reads the whole content sequentially again [25]. Moreover, the use of AJAX technology in live regions could cause problems when the content is updated and not tagged properly [26]. Besides, if a new Window is opened or Java technology generates new buttons, then the user can be disoriented if they are not tagged properly [27]. Furthermore, some chats do not provide support for text-to-speech or text-to-braille which is useful functionalities for screen reader users [28].

2) Flow and Rhythm

The main accessibility problems that users experience are related to the flow and rhythm of the conversation and the existence of parallel threads in the same conversation. For instance, the convert of text-to speech or speech-to-text in real time is complex depending on the velocity of writing of the emitter. Besides, if one of the emitters is not able to write quickly or if the person has cognitive or learning disabilities, he could not be able to follow the conversation [29].

3) Technology used

If chats are implemented with an inaccessible technology or in an inaccessible way, users can have problems to use chats. For instance, some web-based chats present accessibility problems because the implementation of Java inside the Web browser is not accessible [31]. Moreover, there are other accessibility problems related to how developers use the technology because they do not use it in an efficient way. For instance, they do not use CSS appropriately, they use Flash, Java or Javascript in an not accessible way or they do not follow accessibility guidelines [32][31].

Moreover, there are some problems related to the use of some HTML tags elements improperly. For instance, developers use hierarchy navigation [28]. Another problem is related to the use of advanced functionalities or the use of functionalities which cannot be accessed by keyboard [30].

4) Specific for MDs

The accessibility problems of chats in MDs are similar to the problems that chats have in a desktop computer but they can be increased because of the MD. For instance, people without disabilities can have the same problems of accessibility as people with disabilities can have when they use a computer [33]. For example, some people have problems to recognize colors which is similar to the problems that a person without disability can experience when they are using a MD with a screen that do not support all the colors.

D. Existing solutions in chats

There are previous approximations which have solved some of the specific accessibility problems of chats. These solutions are summarized in Table I. It shows if the chat is adapted to learning or mobile environments, which problems are solved (Fig 1), if it is focused on specific disabilities (visual, cognitive, speech, and learning) and if it follows standards and guidelines.

TABLE I. PREVIOUS CHATS APPROXIMATIONS

Chat	Learning	Mobile	Problems				Disability	Stand. & Guid.
			Assistive Tecnology	Flow & Rythym	Technology	MD		
Reef Chat[26]	✗	✗	✓	✗	✓	✗	Visual	✓
Google Talk IM[34]	✗	✗	✓	✗	✗	✗	?	✓
Moodle's Chat[1]	✓	✓	✓	✓	✓	?	✗	✗
Atutor's Chat[2]	✓	✗	✓	✓	✗	?	✗	✓
Blackboard's Chat[3]	✓	✓	✓	✓	✓	?	✗	✓
eCollege[4]	✓	?	✓	✗	✓	✗	✗	✓
Clap[35]	✗	✗	✗	✗	✗	✗	Visual	✓
Alt. Met.Int.[36]	✗	✗	✗	✗	✗	✗	Older user	✗
Messenger Visual [37]	✓	✗	✗	✓	✗	✗	Cognitive	✗
AssistiveChat	✗	✓	✗	✓	✗	✗	Speech	✗
PictoChat[38]	✓	✓	✗	✓	✗	✗	Literacy	✗
✓ Yes; ✗ No; ? unknown.								

Reef Chat uses Rich Internet Application (RIA), AJAX live regions and follows WAI-ARIA and WCAG 2.0 [26]. Besides, the study [34] adds WAI-ARIA for the Google Talk IM and translates the content generated in Chinese to English. The Clap chat is developed according to WCAG 2.0 guidelines, the user can personalize it to his/her necessities

[1] Moodle Chat. https://moodle.org/ (February 2013)
[2] Atutor's Chat http://atutor.ca/achat/ (February 2013)
[3] Blackboard's Chat. http://www.blackboard.com/ (February 2013) [4] ECollege. http://www.ecollege.com/ (February 2013)

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and screen reader users can use this chat because it includes WAI-ARIA technology [35].

Focusing on the interface, the study [36] proposes an adaptation of the chat's interface for being used by older adults which includes a user representation using more lifelike characters. From the point of view of cognitive disabilities, the Messenger Visual supports pictogram-based communications [37]. Moreover, *AssistiveChat*[5] provides features for people with speech disabilities such as: suggestion words, predefined sentences or conversion of text-to-speech. Besides, PictoChat allows users to write or draw on the screen and communicate with their colleagues [38].

E. Discussion of prior research

Previous chat approximations solve five types of accessibility problems. TABLE II summarizes these types of problems

TABLE II. ACCESSIBILITY PROBLEMS AND PREVIOUS SOLUTIONS

Classification	Solution
Acc. Supp. Tech.	Provide AJAX regions to updated content.
Flow and Rhythm	Allow refreshing the messages.
Acc. Supp. Tech and Technology	Do not use Javascript or create html-based interfaces
Tangential problem	New solutions to speech literacy problems, visual impairments or older people.
Technology	Accomplish with some standards and guidelines like WCAG 2.0 or Section 508 to create accessible chats.

However, although some of previous chats try to improve the user experience; none of them try to improve the interaction from the point of view of accessibility which is really important in a UCD environment. Moreover, most of them do not accomplish with the standards and guidelines related to ITs and m-learning in a complete way. Besides, they are designed for a specific technology and their design cannot be extrapolated to other environments; thus, they are not designed taking into account methodological model-based approaches that allow separate design from technology of Final User Interface (FUI). Furthermore, they do not solve the accessibility problems that applications of MDs present. Finally, to the author's knowledge, there is not any previous research which provides a SE approach of a chat.

Considering all these problems, a solution to them was proposed as a research which is part of the thesis presented in the next section.

III. RESEARCH METHODOLOGY

According to our research domain, the research method follows in this Ph.D. is based on the action research method applied to IT[39]. The methodology comprises the next phases which are iterated: diagnosing, action planning, action taking, evaluating and specifying learning. A deep literature review has been done and the problems have been specified in the previous section. Currently, this Ph.D research is in the action taking phase. Next, the phases are explained.

A. Diagnosing: Domain and Problems

In order to obtain a good solution proposal, a specific domain has been chosen to elicit accessibility requirements. Thus, following a UCD approach, we analyze the needs of users who use a chat as a m-CSCL tool and specify the problems that they could face (See Fig 1).

There are different tools used by teachers and administrators to manage and create learning environments. One of these tools is named Learning Management Systems (LMSs) which are divided into different modules needed to support a course. Specifically in mobile LMSs, the study [39] specifies the main modules that a mobile LMS should have. This doctoral thesis is based on this study because up to the author' knowledge, there is not any other study which specifies the main modules of a mobile LMS. We consider that this study could be improved if it included a CSCL module[42], because it is an important module in learning environments nowadays. Thus, we have added a CSCL module to this mobile LMS environment [42]. There are different authors who specify the main components of a CSCL module [42][43][22]. This study is based on the IMS [22] specification which divides the CSCL tools into: asynchronous or synchronous. This research is focused on one of these synchronous tools, the chat. Moreover, it is important to emphasize that this tool can be used also as an asynchronous tool if the user writes the messages when the user who receives the message is not online. However, this thesis is centered in the synchronous way. Besides, the chat is enshrined in the two types of interaction, learner and instructor and learner and learner. They, teachers and students, are the stakeholders and users of the system, they can interact with each other and instructors do not conduct the way of learning. Thus, they will be able to execute the same functionalities.

B. Action Planning: Doctoral Thesis Goals

As it has been explained before, chats present many accessibility barriers for many people. This research aims to solve the problems of accessibility providing a model-based design of an accessible chat for MDs which improves the user experience interaction when they use chats in MDs and a strategy development process to create an accessible chat. Next, the main doctoral thesis goals are explained.

1) **Fulfill with standards and guidelines**. This research will follow the standards and guidelines related to accessibility, e-learning, m-learning and MD's to reduce the accessibility barriers and to increase the quality of the chat.

2) **Solve identified accessibility barriers**. Previous researchers brought out some accessibility problems, which are summarized in the Fig 1. They are mostly specific of desktop computers but they can be extrapolated to MDs. Thus, this doctoral thesis has as objective to provide solutions to the accessibility problems of interaction found previously. For instance, there are some solutions to improve the flow and rhythm problems such as: Improve the Addition of Files or Stop the Conversation Auto-refresh. The first one allows providing alternative text to the sent file and the second one allows stopping the reception of messages when the user feels overwhelmed.

3) **Follow a User Centered Design (UCD) approach**. Previous chats do not consider the user in the software life cycle because they are not following a UCD approach. Chats present many accessibility barriers, especially interaction

[5]Assistive Chat. http://www.assistiveapps.com (February 2013)

barriers. As a result, many users find problems when they follow the conversations. Thus, this doctoral thesis will take into account the user in the whole life cycle to elicit the interaction requirements for a mobile chat that a person with disabilities needs. This requirement elicitation is carried on through a methodological way which analyses the interaction of different user groups with disabilities in scenarios or platforms, etc.

4) **Provide technology independence**. All the chats included in the survey are designed for specific technologies, so they cannot be used in other platforms or environments. Nowadays, there are many MDs and technologies, so any mobile application should be adapted to each MD and technology. Then, the cost of implementation of the application increases. Therefore, the research follows a Model-Driven Development (MDD) approach of User Interface which allows the independency of the technology, platform or MD.

5) **Support the design process**. To our knowledge, there is no support or resource which helps chat's designers to create chats in an accessible way, including accessibility requirements related to the interaction and use in MDs. Thus, this Ph.D research will provide a strategy development process following the proposed models. To achieve it, a FUI is created which allows us the model's validation. Then, developers could use the provided models and strategy development to create their own chats for specific technologies or platforms.

Considering all these essential issues, the main objective of this Ph.D. work is to provide a model-based design and a strategy development process to create an accessible chat for m-CSCL.

C. Action taking : Proposed solution

The context of the doctoral thesis is framed into two different computer science research disciplines: SE and HCI. It is enshrined in the SE discipline because Model Driven Engineering (MDE) methods are used to provide a formal design solution based on models. On the other hand, it is a HCI Ph.D. research because some usability techniques are used in order to follow UCD approach in the chat design.

A spiral model [44] in the software development process is followed. This software process has been chosen because the application requirements will be elicited continuously during the software development and, therefore, the design of the tool will be improved with the new requirements in each iteration. Furthermore, from the point of view of HCI, this life cycle is chosen because the user is involved in each phase of the software development and the iteration is the key principle of the UCD approach [45]. Each iteration of the life cycle is divided into the next phases [46]: 1) Enumeration of the problems; 2) Suggestion; 3) Development; 4) Evaluation to confirm the solution; 5) Decision on a solution to be adopted. For our research these phases will be extrapolated to: Requirement Engineering, Conceptual Design, Strategy Development Process, Validation and Feedback.

1) Requirement Engineering.

This process is divided into three phases which are: elicitation, specification and validation of the requirements [47]. SE and HCI techniques and methods are combined to obtain, formalize and validate the accessibility requirements. In the elicitation process techniques like Brainstorming, Personas, Scenarios and some Standards and Guidelines are considered. The accessibility requirements are considered as tangential requirements and are extended to all the categorized requirements which are: Functional, Data, Environment and User requirements [48] from the point of view of the HCI approach. After that, the requirements are formalized with HCI and SE techniques and methods such as: Use Cases Diagram, Sequence UML Diagrams, Use Cases Descriptions, Scenarios and Prototypes. These requirements are represented in Use Cases Diagram shown in the Fig 2, which bolds the new or improved requirements which try to improve the accessibility of the chat. Some of these requirements are: *Stop Conversation Auto-refresh* (the user can stop the conversation and do not receive more messages)*; Time refresh* (the user can control when the messages will be shown because he could configure the time of auto-refreshing)*;* or *Number messages* (the user can configure how many messages he wants to show per second).

Finally, the requirements will be validated by users and experts to confirm if the proposed requirements are useful for users. The users' evaluation will consists on the execution of some tasks like *Add File* or *Stop Conversation Auto-refresh* by users to catch their experience with the chat. On the other hand the experts' evaluation will be centered on the Walkthrough method proposed by Giorgio Brajnik [49] to evaluate the accessibility of a Web from the point of view of known problems classified into different user categories.

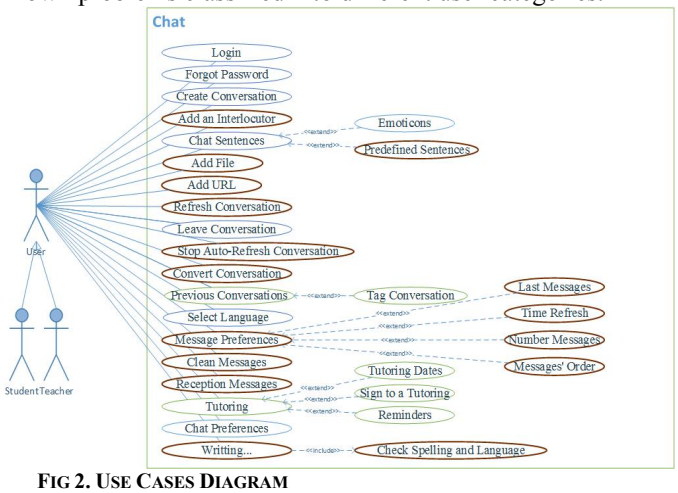

FIG 2. USE CASES DIAGRAM

2) Conceptual design approach

As nowadays the technology is evolving rapidly, the proposal will follow a MDD approach taking into account that the main objective is to create solution which is independent of the technology. This approach will be used to create a User Interface (UI) abstract model of the Chat for MDs in learning environments. To design this UI it is necessary to use a User Interface Description Language (UIDL). The UIDL selected would be based on the Cameleon reference framework [50] which proposes multiple levels of abstraction which are: task and concepts, abstract user interface (AUI) independent of any modality of interaction, concrete user interface (CUI)

independent of any computing platform, and FUI for a particular computing platform.

In concrete, this research design will provide the tasks and concepts and AUI models. These models are designed independently from personal, contextual or technical restrictions. After that, the AUI model specifies the components of the chat in an abstract way and the tasks defined in the previous tasks and concepts model are assigned.

3) Strategy development process

A strategy development process is presented following the proposed models previously. Then, an instance of the abstract models provided will be developed in order to validate the abstract design proposed. Thus, the abstract models provided in the previous milestone will be transformed to a specific technology which corresponds with the final level of the Cameleon reference methodology: FUI of the accessible chat.

Mobile applications can be implemented in three different ways: hybrid, web or native. As one of the objectives of this doctoral thesis is to follow the Universal Design approach, the application will be transformed to a hybrid implementation due to many reasons. Firstly, it will be implemented according to standards like HTML or CSS. Secondly, the design could be adapted to different environments with progressive enhancement features [51]. Then, the application's interface will be adapted to the MD. Moreover, resources like time or cost are optimized. The cost of implementation is fewer because the programmer does not need to know the Operating System (OS) language because it can be executed in different MDs regardless of the OS that they use. Finally, it takes advantage of some specific features. This application needs to access to some elements of the MD and some MDs does not support the access to execute them from a Web site.

4) Validation

As a UCD approach is followed, the FUI must be validated by users. Moreover, some experts validate it too. The user evaluation will check the accessibility of the FUI. The survey methods questionnaires and interviews will be combined [52] and will be conducted by the author of the Ph.D. to verify the usefulness of the requirements. Moreover, the expert evaluation will be carried out with the Walkthrough method [49]. It proposes different user categories; however, for this experiment some of them are excluded and the barriers proposed by Yesilada [53] for MD users will be included. For our research, this method is useful for the validation of the FUI because it evaluates the accessibility of a web and the FUI of doctoral thesis design is carried out in a hybrid environment, which simulates a web interface. After the evaluations, some statistical techniques will be created to interpret the results obtained. Then, some conclusions can be taken from the results and future work could be identified.

5) Feedback

After each iteration, some conclusions will be obtained and a new iteration will start only if it were necessary. Then, the requirements and models will be improved with the feedback of the previous iteration and the iteration will have these requirements and models as starting point. Moreover, it is important to emphasize that, despite of following a MDE approach, the users will participate in the whole lifecycle and they will contribute with their opinion to next iterations [54].

D. Evaluating

This phase will validate the Ph.D approach in order to demonstrate the practical applicability. To validate the model-based design and the strategy development process of an accessible chat, a proof of concept will carried out by Software Engineering professionals. After that, they must accomplish a survey which asks them if they could create the accessible chat following the model-based design and the strategy development process.

E. Specifying learning

After the research, it could be concluded with the practical applicability of the Ph.D research. Moreover, some developers could use this approach to create accessible chats for MDs.

IV. CURRENT AND EXPECTED CONTRIBUTIONS

The research is currently in the *Requirement Engineering milestone* of the *Action Taking Phase* research methodology. The requirements, which improve the accessibility and interaction of the chat, have been elicited considering different HCI and SE methods and techniques. Now, users are evaluating the requirements. Later, the model-based design will be created, transformed to a specific technology (FUI) and validated by users and experts to assure the models' validity and the strategy development process proposed.

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