|Ae|: an e-Learning Environment with Multimodal Interaction

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***Abstract*— e-Learning Virtual Environments or Learning Content Management Systems provide tools to support teaching and learning activities by using the infrastructure of the Web to provide its functionality to users. Available on the Web, these environments are susceptible to access by a variety of devices and modalities such as touch and pen, two modalities not available on desktop computers, so the e-learning environments need to support different modes of interaction. Designing a tailored user interface for each device is not a trivial task and results in a high number of code lines that must be maintained, so we propose to apply multimodal interaction in the Ae e-learning environment to build an e-learning environment with multimodal interaction: the |Ae|.**

Keywords- Multimodal Interaction; Usability; Information Systems; e-Learning Environment.

I. INTRODUCTION

e-Learning Environments or Learning Management Systems (LMS) provide tools to support teaching and learning activities by using the infrastructure of the Web to provide its functionality to users. Their user interfaces were designed to have good usability using a desktop computer with keyboard and mouse as input devices and a high-resolution medium-size display as output device. By using the Web as a means of access, these environments are susceptible to access by a variety of devices and a variety of modalities such as touch and pen, two modalities not available on desktop computers and so not considered in their design time. Shneiderman [1] describe that "The new computing technologies would include wall-sized displays, palmtop appliances, and tiny jewel-like fingertip computers that change your sensory experiences and ways of thinking". Kugler [2], supported by reports from Gartner Group, describes one of the big challenges for the Information Technology and Communication (ICT) field in the next 25 years are non-tactile and natural interfaces, and automatic translation of speech. This challenge, coupled with the tendency to change the mouse gradually for emerging alternative interfaces for working with facial recognition, motion and gestures brings new challenges to Human-Computer Interaction (HCI).

Designing a tailored user interface for each device is not a trivial task and results in a high number of code lines that must be maintained. Therefore, our group proposes to apply multimodal interaction in an e-learning environment to allow users use the many modalities that the new devices can support instead of developing one user interface for each type of device. In this paper, we present the advances to produce a web-based multimodal interaction e-learning environment, the |Ae|. Our research goal is studying how the desktop hardware shaped the on-line courses and how multimodality can improve the teaching and learning activities.

Section II presents a literature review about multimodality and e-learning environment. Section III presents the adopted methodology and analysis of our findings, and Section IV presents our conclusions and future works.

II. LITERATURE REVIEW

'Modality' is the term used to define a mode in which a user´s input or system´s output are expressed. Nigay and Coutaz [3] define modality as an interaction method that an agent can use to reach a goal; a modality can be specified in general terms as "speech" or in more specific terms such as "using microphones". Several modalities have become research topics in recent decades; among them, we can mention the voice, handwriting recognition, touch, and gestures. Bernsen [4] says that there are no two equal modalities; each of them has its own strengths and weakness.

Bernsen [4] defined systems that use the same mode for input and output as unimodal systems, and multimodal interaction system as a system that uses at least two different modes for input or output. According to Bangalore and Johnston [5], multimodal interfaces enable the user´s input and system´s output to be expressed in the way or in the ways they are better adjusted, given a task, user´s preferences, and physical and social environment characteristics where the interaction is happening. Multimodality can aim to an increase the usability, accessibility, convenience, and flexibility of an application [6]. To Bernsen [4] the main concern about multimodality is to create something new, because "when modalities are combined, we obtain new and emerging properties of representations that could not be considered individually by the modalities".

Fadel [7] says, "significant increases in learning can be accomplished through the informed use of visual and verbal multimodal learning". Alseid and Rigas [8] say, "multimodal metaphors may help to alleviate some of the difficulties that e-learning users often encounter", focusing their studies on usability and learning of e-learning tools. In this research, the authors study the efficiency, effectiveness, and user satisfaction for the e-learning process evaluating two e-learning interfaces version: one interface with text and graphs (visual channel) and another one with sound, facial expressions, text and graphs (auditory and visual channel).

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However, the used input device was a mouse (just one modality) on a desktop computer, and the researches did not study the flexibility of devices.

Sankey, Birch, and Gardiner [9] studied multimodal learning environments that allow instructional elements to be presented in more than one sensory mode (visual, aural, written). In this case, just the output multimodality was studied. Despite the many investigations about how multimodality on content and on interaction impacts positively on learning process, no e-learning environment system with input and output multimodality was found in the literature. Online systems that support e-Learning through the Web are called e-learning environment systems or Virtual Learning Environments (VLE) or Learning Management Systems (LMS). An e-learning environment system is an application that uses the Web infrastructure to support teaching and learning activities, designed to support a variety of users and learning contexts. This environment is composed of tools that allow users to create content, communicate with other users, and manage the virtual space, e.g., chat, forums, portfolios, and repositories. Examples of e-Learning environments are Moodle [10], SAKAI [11], and Ae [12].

III. METHODOLOGY AND ANALYSIS

We adopted the Ae learning environment to develop our work. This environment is developed by the TIDIA-Ae Project (TIDIA-Ae is the acronym for "Tecnologia da Informação para o Desenvolvimento da Internet Avançada – Aprendizado Eletrônico", in English "Information Technology for Development of Advanced Internet – Electronic Learning"). This project was initiated by FAPESP (the State of São Paulo Research Foundation) with the main goal of developing an e-Learning environment that can explore the potential of Advanced Internet and can provide support to different educational context needs. We chose this learning environment due to our experience in its development and the layered component-based software architecture [13] with specific layer for the user interface.

We started our work with a literature review and investigation of the interaction problems that occur when accessing e-learning environments with modalities that have not been considered in the design process, e.g., accessing the learning environment with touchscreen devices [14]. We noticed that some usability problems happen and need to be corrected so users have a better interaction experience using a touchscreen device. One example of identified usability problem occurs when users have to choose a tool in the Ae environment browsing with a touchscreen device like a tablet or smartphone. Because the touched area is usually larger than the area pointed at by a mouse click, the users might have a problem triggering a certain tool; they might select something that is outside the desired selection. This problem is known as the fat finger problem [15]. Due to the several modalities available nowadays and our expertise, we are focusing our research on touch, pen, and gesture modalities.

After the investigation about usability problems, we developed a tool that takes the benefits of pen input modalities and multi-touch: the InkBlog [16], a tool to handwrite or to sketch posts in pen-based devices by adding features to manipulate electronic ink into a blog tool. Figure 1 shows a handwrite resolution using a smartphone with pen-sensitive screen where the user use the recursion tree technique to demonstrate the complexity time of an algorithmic.

We noticed that the system architecture must change to include components to receive data from new modalities and to treat the multimodality, so we proposed an architecture for e-learning environments with multimodal interaction [17]. Besides the client-server architecture model, a Web application can adopt another architecture model to define and structure the client or server components. Usually the e-learning environments have functionalities to manage data about courses and users, so it is necessary to have components for course management, user management, user authentication, and session management. We considered too the W3C Multimodal Architecture [18], Web-Accessible Multimodal Interfaces architecture [19], and the architecture of multimodal systems [6] to define our architecture. So components to treat the multimodality have been added to the environment (input recognizers, fusion and fission machines, output synthesizers and others). In this in-progress research, we are codifying these components related with the multimodal interaction and their connection with the e-learning environment components, to perform tests and study the impact of multimodality over the learning activities. The first implemented component was to treat electronic ink; this component was developed using part of the InkBlog code.

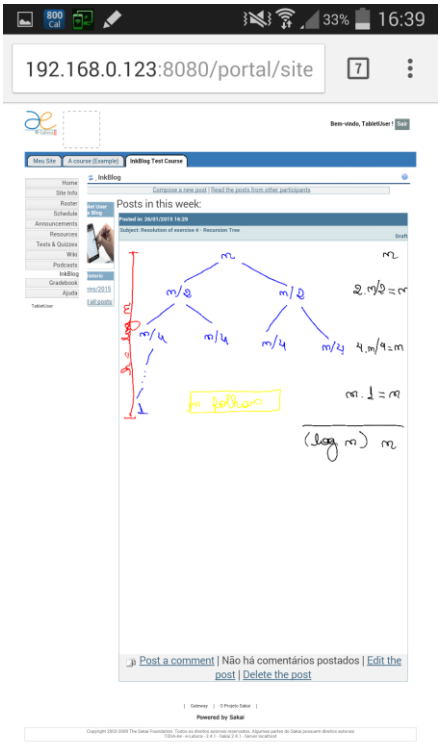

Figure 1. Using InkBlog to handwrite a post using a stylus in a smartphone with pen-sensitive screen and Android version 4.4.2.

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After user tests, we developed a second version of the InkBlog tool adding some features to improve the InkBlog to allow users to write messages in touchscreen devices. This changing generated another component that treats input data from touch interactions.

About the identified usability problems due to the modality change, we are applying Responsive Web Design techniques and investigating its limitations. We are facing the following problems: send input data from more than one modality due limitations of Web architecture and actual browsers implementation; dispose available fusion and fission machines on a Web architecture; develop a framework to build easily tools for the environment with multimodal interaction; determine which course characteristics influence a modality and its adoption.

We believe that the modalities (mouse, keyboard, and high-resolution medium-sized screen) shaped the activities done in the environment. Embracing new modalities can delivery other benefit: support a large number of educational contexts. Gay *et al*. [20] suggest that the introduction of wireless computing resources in learning environments can potentially affect the development, maintenance, and transformation of learning communities. We believe that the same can be said about multimodality and when the e-learning environments are employed.

IV. CONCLUSION

Multimodal systems are present in the HCI literature to allow users to interact with more than one mode, supporting multimodality. We believe that multimodal interaction can be a solution for the necessity to allow the environment to be accessed by a variety of modalities, so we are developing an e-learning environment with multimodal interaction called |Ae|. In this paper, we described how we are developing this e-learning environment. We noticed that the impact of multimodality can go besides enabling access for various peripherals interaction and may emerge new functionalities that support the production of content that were difficult before, or impossible, in the environments. We perceived the needs in changing the architecture to treat multimodality and in the user interface to get a better usability in devices with modalities not considered in the design process. Supporting new modalities allows having new tools in the environments, perhaps affecting the learning activities. We want to analyze these on future works.

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