

An Interactive Environment as an Ambient Learning: An Innovative Example

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This document presents a short description of the design of an interactive environment used as an ambient learning. Images, sound, text, and new media technology recreates a mystic experience of a Prehispanic Mexican culture interacting using the hands in the air. This off-line project has been designed as a portable non-formal learning environment that combines physical and virtual interfaces. The software interface displays eight interactives actions and each of them plays an animation about specific aspects of the Matlatzincas culture, using learning strategies based on Constructivism. Sensors are the crucial bridge between physical and virtual interface, as they detect physical actions (gestures) and trigger virtual reactions. This application is an innovating example on how to exploit didactic multimedia possibilities and human computer interaction to increase the user's experience, learning through an interactive environment, and using a non conventional way to display this kind of contents.

Keywords Constructivism; interactivity; non-formal education; sensors; virtual environment; user experience; ambient learning; physical interfaces

1. Introduction

We are living in the Science and Technology age. New sensors (touch, motion, etc) and output devices (e.g. large displays) may dramatically change the way we live and learn[1].

Since the 1990s, research works on artistic context, like Sommerer & Mignonneau, Fleishmann, Bohn, Strauss, or Kac [2], have been centered on the user's performance through metaphoric, symbolic and technology devices, to increase the sensorial experience. In this way, G.R. Amthor arguments that people retain about 20% of what they hear; 40% of what they see and hear; and 75% of what they see, hear, and do [3]. These arguments, are taken as reference to develop an interactive project that translates this kind of -art performance- to a non-formal educational context, also considering Piaget's constructivism principles, that are rooted in stimulating interest, initiative, experimentation, discovery, play and imagination [4]. Constructivism could inform learning about concrete aspects of the Matlatzinca culture.

The Matlatzincas was a glorious and a very important prehispanic culture that founded the cultural background of the city of Toluca, the capital of the State of Mexico. Most of what is known about the Matlatzinca culture was written in 1520 in the chronicles of Fray Bernardino de Sahagun, and currently, there are not graphics evidences of this culture.[5]. Therefore, the goal is to rescue this culture from sinking into oblivion and learn about it.

This project combines an exhaustive research on Matlatzinca's history[6] with a design process, but it does not pretend to be an historical review, instead, it pretends to become unforgettable. To reach the goal, the author decided to create a sensorial experience with the recreation of the Matlatzinca's mythical world by translating the chronicles into an -live story-, placing the user in a central active role through interactivity.

A very important phase in a process design is the conception, because it provides the background of the project. The initial work began with conceptions about the culture to develop some prototypes. The final result was developed under a wide design process[7][8].

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2. Conception

Some authors mention agriculture, the net, and the spells as Matlatzinca's features. In addition, the cult to "Xinantecatl" the divine mountain, and "Coltzin" the warped god, are also distinguishing attributes[9]. The core concept of this project, uses a "net" as a metaphor, it is the Matlatzinca's main feature. The importance of the "net" can be noted within the context of their own name: "Matlatzinca" comes from the Náhuatl dialect "matlat", which means "net"[10]. It was present in all their cultural context and in every aspect of their lives: nets to fish, nets to thresh, nets to hunt, nets to sacrifice, nets to carry, nets to lull babies... and certainly, their skills using the net gave them the attribute of "wizards", the most important rank in that epoch among the neighboring civilizations[11].

The entire cultural and everyday context of the Matlatzincas, was associated with the natural elements producing four main themes in which the net is present: Earth is related to "Valle Matlatzingo", Water is related to "Xinantecatl", Wind is related to "Sorcerers" and finally, Fire is related to "Coltzin". Thereupon, each theme describes two specific contents, as described in Table 1.

Proceedings, attitudes and conceptual educational principles[12] are the crucial point to translate "arguments" into "learning interactive actions". These actions were conceived, using principles upon Constructivism that incorporates a dynamic role, the cause-effect relationships, challenge, emotion, motivation and tutoring.

Table 1 *Project contents.* Cultural context of the Matlatzincas was associated in four themes

| THEME | ACTIONS | ARGUMENTS |
|-----------------------------|-------------------------------------|---|
| EARTH <i>Matlatzingo</i> | Cosmology | The Matlatzincas considered the Sun and Moon as creators of the cosmos. They had the belief on being born from the corn core, and in their rite of birth they had to bury the child's belly button into the birthplace to have a deep-rooted life |
| | Net | The Net was present in all of their life. The Matlatzincas distinguished feature |
| WATER <i>Xinantecatl</i> | Candles Procession | They organized Candle Processions to the Xinantecatl, to attract the rains into their temporal crop |
| | "Scare-cloudy" (Espantanublados) | A wizard becomes a "Scare-cloudy" to perform a rite: he must wield to shoo away the storms and save the crop from the flood |
| FIRE <i>Coltzin</i> | Sacrifice | A man is sacrificed in tribute to Coltzin God. The rite is to wring a man into a net until spraining him up all his body |
| | Dead | They believed in life after death. The Death takes the hearts of the sacrificed men to the Sun, whom after four years become birds and return to earth. |
| WIND <i>Sorcerers</i> | Licker-illness | A witch doctor licks the person's body to extract the bad illness and heals him. |
| | Wizard | A Wizard eats -toloache- to become an animal. He sucks blood from a victim and blows a bad spell on him. |

Each action sets up a situation that must be analyzed. The role of the user changes in every action. To pay attention and control the situations, the user has to discover by himself which character is representing. For example, in *Sorcerers/Licker illness*, the user becomes a *tongue*, but in *Matlatzingo/Cosmology*, the user becomes the *Sun and Moon*.

3. The Design of the Interactive Environment

3.1 The virtual interface

The software interface uses the core concept of the “net” as a metaphor. Therefore, the user “goes through themes using the net into the earth, into the water, into the wind, into the fire”. Each theme displays the interactive actions, and each one play an animation in order to start interacting. The actions are completed with prehispanic music and a professional anchor’s voice that tells the textual phrases.

The fundamental layout concept in which are conceived the visual aspects of this project, is based on a particular vision and a personal interpretation with a mystic-aesthetic structure of the expressionist models from ancient America[13]. As shows Figure 1, the graphic screening is spontaneous, like a children doodle, being specific manifestations from ancient drawing that can be seen in Prehispanic codex. The program was written in DirectorMx, FlasMx and Xtra DirectComm.



Fig. 1 *The software interface layout.* On the left, a screen theme from: Fire/Coltzin. On the center, a zoom of “Arbol de las Manitas”. On the right, the “Wizard” becoming an animal.

3.2 The physical interface

The physical domain uses a circuit with seven sensors: four pulsers and three Infrared Sensor Kit # 28019 PARALLAX, connected to a Basic Stamp II Microcontroller, as shown in Figure 2. The sensors are hidden into a metaphorical interface that could be used into a 5 x 4 m. close space to restrict all the distracting elements through darkness and isolation, with a projected screen about 4x3 m, and two speakers to transmit audio .

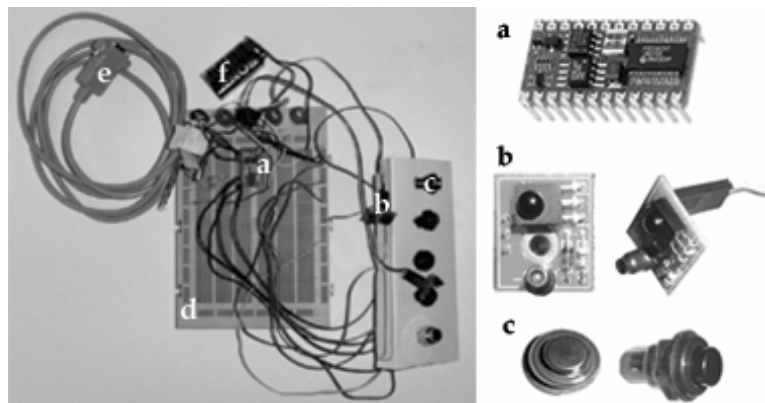
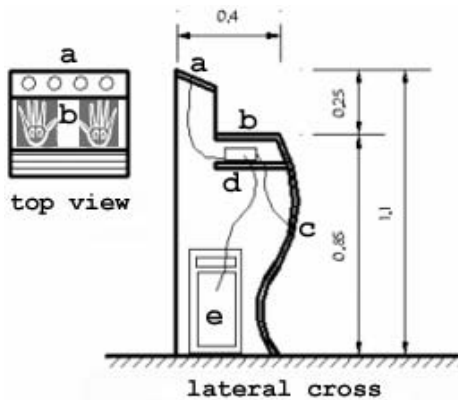


Fig. 2 *The physical interface circuit.* (a) Basic Stamp II Microcontroller, (b) infrared sensor, (c) pulsers, (d) interfacing board, (e) serial cable, (f) 9- volt battery

1 The metaphorical interface, represented in Figure 3 in accordance with anthropology measurement[14],
 2 admits one user at once, it captures the “presence” of a new user through one hidden infrared sensor,
 3 creating an environmental reaction to the presence of a user, it means, the environment “wakes up” with the
 4 “user’s contact”. This contact between “user” and “culture” produce a step from the initial screen to the
 5 menu screen. The menu screen display the four themes. The user can “go in” by pressing the pulsers
 6 that are on top of the external interface. This menu allows access to the first navigation level. Each theme
 7 represents one of the four natural elements related to one activity from Matlatzincas life. In each theme,
 8 the user can access to the second navigation level: the “actions”. These are represented with “hands” in
 9 which infrared sensors are positioned the infrared sensor to allow interaction with the hand suspended in
 10 the air. Sensors are used as a bridge between physical and virtual interface, as they detect physical actions
 11 and trigger virtual reactions.



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14 **Fig. 3** Representation of the metaphorical interface. (a) Selective menu in which pulsers are hidden, (b) Interactive
15 action in which sensors are hidden, (c) Funnel for sensor to detect “presence”, (d) The physical interface circuit is hidden
16 into the external interface, (e) The communication among all the components follow the next process: the microncontroller
17 (generated in Pbasic), reads the seven sensors and transmits this information through a USB port. The software (generated
18 in Lingo), reads and uses this information to control the navigation and to generate the interaction. It also simultaneously
19 sends the video and audio signals to the projector and speakers located on sealing.

20 21 22 23 24 25 26 27 **4. The interactivity design**

28 There are eight interactive learning actions. In order to maintain interest , the amount of time is 2 minutes
 29 per action. The entire message plays out in about 16 minutes. The interaction has been designed to give a
 30 “unique experience”, it means, it is not possible to repeat the action, so the user must be aware in how to
 31 get the positive reactions. There is not sequence between themes, the interactor can choose using his
 32 own criteria. Moreover, there is not “good” or “bad”, the user can experiment with the sensors in order to
 33 control the situations, generating favourable conditions. All the reactions depends on the intensity of
 34 interaction. This intensity remains on the act to interact: the user must move his hand suspended in the
 35 air from up and down, over the “Matlatzinca’s hands” in which the sensors are hidden. The interaction of
 36 the actions are divided into 3 cycles, in each one, 3 levels of intensity can be reached. The intensity is
 37 measured in ranges by the sensor depending on the distance of the hand from it. In each action the
 38 software states correspond to three general conditions. For an example of a state transition, see Figure 4,
 39 in which the sick girl moves from bad to healthy state. This state transition could be reached by a level 3
 40 of intensity, caused by interaction with the Witch doctor’s licking tongue; he licks the girl’s stomach.



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51 **Fig. 4** Transition on Licker-illness action . On the left, the initial sick girl’s state. In the center, the sick
52 girl is being recovered, extracting out of her stomach worms and stones. On the right, the recover girl.

4. Conclusions

The complete product, including transitions, actions, sounds, voices, interactive script, and literary script are not displayed in this communication.

An alpha version was tested with four actions by five users, three of them were not Mexican. The results of the alpha test showed that a cultural background of Mexican prehispanic cultures is needed for a better understanding of the interplay. Moreover, Interactions with the ambient learning revealed that the design of the pictures is an important issue, illustrated conceptions cause a large amount of curiosity. The users cannot explain what they feel on his hand, but they feel immersed into the environment. The experience was described as –something different, attractive and new-. The state of this project is a demonstration version. It includes a plan for an experimental phase with a significant number of users, in order to provide empirical evidence of its contributions to the learning process and its influence in cognitive, perceptive and behavioral levels. Also, to analyze the possibilities using this methodology in the fields of mental illness or special education needs.

The final work produced an interactive environment as an ambient learning, with physical and virtual components to increase the user's experience in the Matlatzinca's mythical world. Interaction and cognitive effort imply mental activities and psychomotor abilities such as recognition, identification, interpretation, understanding, experimentation, and answer analysis. In addition, these factors strengthens an active, participative and motivative learning experience. This work reports three important requirements in ambient learning development: to find the specificity of the contents, to learn how to exploit multimedia expressive capabilities, and to understand the new technological hardware offer for designing and producing high QoE (Quality of Experience) on users.

Finally, multimedia technologies should be used to overcome adversity, to recreate what is not visible or not possible in the real world.

Acknowledgements This project was founded through Universidad Autónoma del Estado de México and developed into the context of the Master in Interactive Systems Design by Media Centre d'Art i Disseny & Escola Superior de Disseny, with Jimena's Padilla and Catalina's Jaramillo collaboratio. As main tutor: Claudia Giannetti and as a technic tutor: Eugenio Tisselli. Also, the educational methodology was developed into the context of the Postgraduate course on New Technologies and Multimedia in Education by Universidad Autónoma de Barcelona with Pere Márques as tutor. Thanks to R.Rodríguez.

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