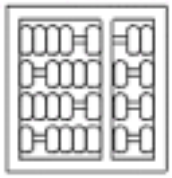

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Design Principles for Affectibility

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Abstract. The design for (with and by) children in learning contexts faces challenges to bring children's real life experiences into interactive systems, including their affective responses – which are not often considered in design processes. In the endeavor of providing practical information on the design of learning technology that is explicitly concerned with the affective responses of children, we present our investigation on Design Principles. The principles that we present here are based on empirical data and, at the same time, supported by *a priori* knowledge. Practical application of the principles is explored in the analysis of two existing activities for children on the educational XO laptop from OLPC.

Keywords: Affectibility, Emotions and affective interaction, Design for children, Brazil, qualitative research.

1. Introduction

Researches in varied areas of knowledge have been investigating the important role played by emotions and affect in our lives. It has been suggested that "positive affect facilitates creative problem solving" (Isen et al., 1987). In the field of biological sciences, studies investigated the relationship between negative affective and weaker immune responses (Rosenkranz et al., 2003). In the area of education, as we exemplify in Section 4.1, affect has been known for long to have significant worth in children's development. A crescent interest in affect is noted in the field of Human Computer Interaction. However, little is known about the practical design of learning technology aiming at improved affective responses from users in their interaction with that technology.

In order to make it clear what we mean by 'affect', we adopted the definition from Ortony et al. (2005), who see affect as "a superordinate concept that subsumes particular valenced conditions such as emotions, moods, feelings, and preferences". Furthermore, we use the term Affectibility (Hayashi & Baranauskas, 2011) as to express the characteristics that make a system or any other digital artifact to elicit rather positive (or the expected) affective responses.

We understand affective responses as a product from the interaction of the users with the technology, considering users' surroundings, as well as users' culture and society (Boehner et al., 2007). Note that 'interaction' implies in actions, meaning that users are active in the learning processes supported by that technology (Resnick, 2004).

In order to better understand the learning environment, we have been working within a school community for over two years, participating in its daily activities, including classes, informal social events (e.g., gatherings during lunch breaks) and formal meetings (e.g., teachers meetings, parents meetings). This empirical knowledge observed from daily practices, together with theoretical studies (from the literature review of renown authors from children psychology and education), informed the Design Principles for Affectibility that we propose in this work. This report is organized as follows: in Section 2 we present

related work; in Section 3 we inform our approach to propose the Design Principles; the Principles themselves are presented in Section 4. In Section 5 we instantiate the principles in practical examples and we make a comparison of two existing applications basing on the principles. Furthermore, we assess children's responses towards those applications and we discuss our preliminary results. Section 6 concludes.

2. Related work

With the objective of helping designers, different principles for interaction design have been proposed. Some are presented in a more abstract manner, applying to interaction design in general (e.g. Norman, 1999 and Shneiderman, 1993). Others are rather specific and closely connect to a specific context, to the point to be considered guidelines (e.g., Agrawala et al., 2011). Such principles provide designers with important information and guide to their work, bringing deeper awareness to the design process. We emphasize the value of all proposals, not arguing for a single "correct one". Rather, our endeavor is to complement what has been proposed and used so far, by suggesting design principles specific to the context of design of learning technology with emphasis on the affective aspects of interaction.

Among many known and broadly used design principles from field of HCI we can mention those from Norman (1999) and Shneiderman (1993). Norman explores the psychological elements behind designs that are considered good design and behind those considered bad designs. He suggests that good products can be designed if one considers: visibility (basic functions should be visible), feedback (immediate response should be delivered to users), constraints (physical, logical and cultural restrictions should be used to avoid errors), mapping (there should be logical relationship between actions and intentions), consistency (system should adopt and follow a pattern), and affordance – or perceived affordance (Norman, 1999) (designers should be attentive to the actions that the user perceives to be possible).

Shneiderman's principles for direct manipulation of interfaces include: "visibility of the object of interest; rapid, reversible, incremental actions; and replacement of complex

command language syntax by direct manipulation of the object of interest" (p.18) (Shneiderman, 1993).

Cockton (2009) points out that the approach behind design principles – as those proposed by Shneiderman (1993) – are *a posteriori* in nature, as they rely on empirical evidence. Cockton proposes interaction design principles from an *a priori* approach – i.e., derived from theoretical knowledge.

The design principles for Affectibility in learning technology that we propose here are based both on *a posteriori* and *a priori* approaches. They result from observations from our two year immersion at an elementary school as Participant Observers (Denzin & Lincoln, 1994; Miles & Huberman, 1984). At the same time, the principles we present are also resultant from an analysis of education and psychology theory, which we revised with focus on the role of affect in children's education. This process is illustrated in Figure 1. We suggest these design principles as a starting point for designers willing to explicitly account for affect in the design process. They should not be taken as rigid rules. As Hassenzahl argues, designers can create possibilities, but they cannot guarantee that a set of recommendations will result in particular set of affective responses (Hassenzahl, 2004).

3. Research Process

Phase 1. Identify Design Principles. In this phase, we derived design principles both from empirical and theoretical data. The field notes taken during our immersion as participant observers at the school were transcribed into digital blocks of texts. Then, following a qualitative technique for data analysis known as 'coding' (Denzin & Lincoln, 1994; Miles & Huberman, 1984), the blocks of texts were coded and catheogrizedd. In parallel, we studied some of the major lines of thought in education and educational psychology, filtering and focusing on information related to the role of affect in education and children's development. The data obtained from the process of coding were in line with the information retrieved from the analysis of the literature on education and psychology. The combination of the *a priori* and *a posteriori* study (Figure 1) resulted in the Design Principles for Affectibility that we present in Section 4.

Phase 2. Explore Design Principles. In this phase we further investigated the proposed design principles by examining two existing educational applications. We reviewed the main characteristics of each application, searching for elements that could be related to the ideas behind each of our proposed principles. In this phase, our hypothesis was that, the higher the rate of compliance of the application in regards to the proposed design principles, the higher positive affective response could be expected from children when interacting with the applications. In order to assess children's response towards the applications, we conducted informal interviews with children that were regular users of the applications.

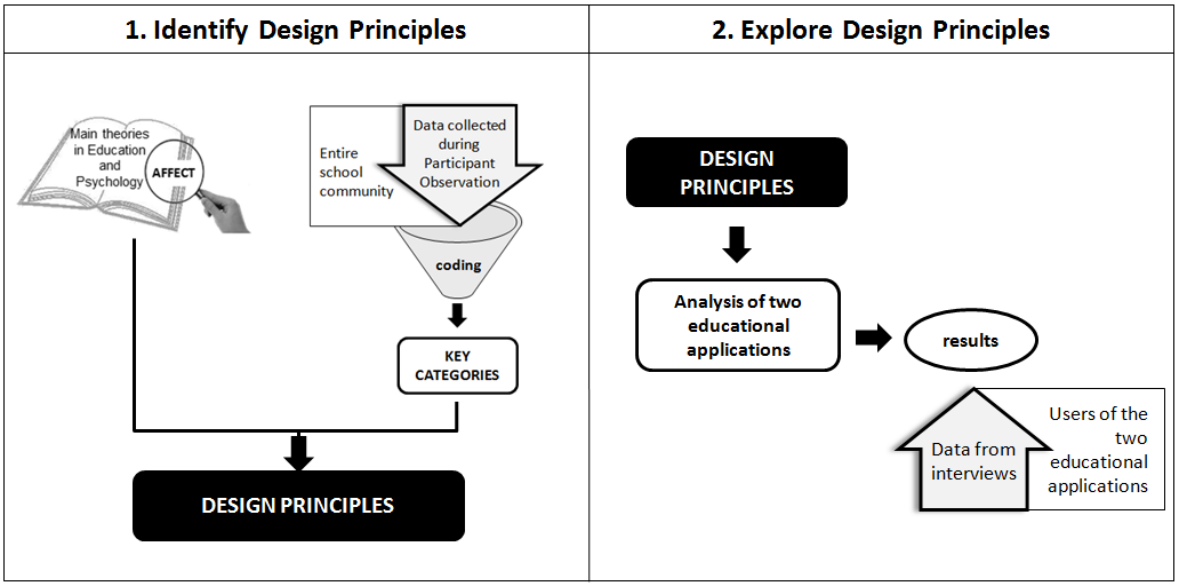

Figure 1 – The research process: phases 1 and 2.

3.1 Materials and participants

During Phase 1 of our research process we were engaged within the daily activities of a public school, located at a suburban area of a major city in Brazil, in a low income neighborhood. The school had a population of about 500 children, with ages varying from 7 to 15 years old (from the first until the ninth grades of the elementary years of the Brazilian educational system); and around 40 other people including teachers, principle, pedagogue, cooks, cleaning staff, security, door keepers, maintenance, and a few representatives of

children's parents. All participants (and/or their parents) agreed in taking part of the research. All related documents and procedures were approved by the Ethics Committee of our University.

While Phase 1 involved the entire school community over almost 2 years of constant interaction, in Phase 2 we selected a smaller group of participants. We conducted informal interviews with the children from two groups of second graders (around 8 years old). We chose these two groups because they are the target users of the applications analyzed. Moreover, these children had been interacting with the applications since their previous year at that school.

The two applications are native from the XO laptop from OLPC: the "Speak" and "Write" activities (OLPC). The characteristics of these applications are further detailed in Section 5. The XO laptop is not focus of this paper; more information on the XO laptop can be found in (OLPC).

3.2 Method

In Participant Observation (PO) (Denzin & Lincoln, 1994; Miles & Huberman, 1984) the researcher is immersed within a group, participating in its activities while observing the behavior of people in the group and gathering information about them. PO is considered a key method in ethnographic research and it demands from the researcher both the involvement of a participant and the detachment of an observer. As an ethnographic method, PO does not assume an initial hypothesis. Rather, usually hypotheses emerge during the collection and analysis of the data (Denzin & Lincoln, 1994; Miles & Huberman, 1984).

Our field work as participant observers resulted in text documents with field notes, which were transcribed, coded and organized, together with pictures and informal interviews, using the computer based tool for qualitative data analysis Atlas.ti (http://www.atlasti.com). Our objective in PO was to observe and understand the manifestations of affect in daily interactions, without any particular hypothesis or assumption made.

The constructs associated to quality in qualitative research differ from the constructs associated to quality in quantitative research. In quantitative research the Validity is an important concept, and it presupposes the achievement of: Internal Validity, External Validity (or generalizability), Reliability and Objectivity. These constructs provide the base for the evaluation of the quality of the research. On the other hand, qualitative research approaches can be evaluated on their Trustworthiness (Denzin & Lincoln, 1994). Trustworthiness encompasses: Credibility ("believability" of the findings), Transferability (application of the findings to a different situation), Dependability (findings are reflective of data) and Confirmability (findings can be substantiated by participants) (Denzin & Lincoln, 1994; Maul, 2011). Different tactics – or techniques – have been proposed to establish the achievement of these constructs in qualitative research. To provide Trustworthiness for the findings from the PO that we describe in this work we adopted the tactics presented in Table 1.

Table 1 - Goals and tactics (Denzin & Lincoln, 1994; Maul, 2011; Miles & Huberman, 1984).

Goals towards Trustworthiness	Tactics adopted to achieve the goal
Credibility	Prolonged engagement; Member checking
Transferability	Thick description
Dependability	Inquiry audit
Confirmability	Audit trail

Prolonged engagement. In Prolonged engagement researchers are on the site of the study for long periods of time in order to build trust with participants and overcome the variations that might occur due to the presence of the researcher in the site. Moreover, in Prolonged engagement researchers can experience the different attitudes and changes that might occur throughout different periods of the year. As mentioned before, we have been engaged within the school for two years.

Member checking. In the process of Member cheking the data collected, the analysis and interpretations made by one researcher are reviewed by the participants from whom the

data was collected. In a slight variation of this method, in our approach all data were continuously collected and interpreted together with representatives of the target community of the school (e.g., the teachers and students that were mostly directly involved with the Participant Observation). In this process, we were able to know that the interpretations and conclusions reflected the participants' view as they were built together with them.

Thick description: Vast and detailed information from the target community is needed in Thick description. The broarder project – *Projeto XO na escola e fora dela* (Projeto XO) – in which this research was inserted opened possibilities for a deep understanding about the context and involved parties. This information can be found in (Baranauskas, et al., 2012).

Inquiry audit: Also known as External audit, this process involves the participation of a different researcher to examine the steps of the study and its results. The activities from the Participant observation and the analysis of the findings were performed by one researcher. Another researcher followed from distance all the steps, guiding and advising the process and reviewing the findings.

Audit trail. This tecnique consists of a transparent description of the rationale of the research. Tables 2 and 3 (next section) present information that allow other researchers to trace back the process of coding of the collected material that lead to the results.

4. Phase 1: The Design Principles

As mentioned before, Phase 1 consisted of two main approaches to derive the Design Principles for Affectibility: the review of the literature on psychology and education, and the Participant Observation at the school.

4.1 Revisiting theories with affective lenses

In the search for more solid basis to support the design of learning artifacts that is concerned with affective factors of interaction, we reviewed some classical theories from education and psychology. Here we present a summary giving especial attention to the authors' remarks regarding emotion and affect.

Piaget greatly contributed to the understanding of children's intellectual development and he is known, among other contributions, for his theory on the stages of development (Sensorimotor, Preoperational, Concrete operational, and Formal operational) (LaTaille, 1992). For Piaget, affectivity is an energetic source, like a fuel that makes the motor of intelligence run without modifying the motor's structure (LaTaille, 1992; DeVrie, 2006); and while affectivity provides the fuel that motivates actions, cognition provides the structures that support all behavior (DeVrie, 2006). For Piaget, there are no innate cognitive structures; such structures are constructed by the person from his/her interactions with the world – a concept that forms the base of Piaget's Constructivism. Wadsworth (1996) points out that Piaget has attributed to the social relations among children a clear importance for their affective and intellectual development.

In Constructivism, knowledge is actively constructed and not passively received from the teacher or environment. According to DeVries, Piaget "argued that feelings are structured along with the structuring of knowledge and stated that 'there is as much construction in the affective domain as there is in the cognitive'. This is illustrated by his discussion of the development of affectivity through six cognitive stages." p. 6 (DeVrie, 2006).

According to LaTaille (1992), Piaget's works emphasizes that the development of the intellect that considers only the cognitive aspects – without taking affectivity into account – is incomplete. Also Vygotsky, according to (Oliveira, 1992; Wertsch, 1985), explicitly criticizes the distinction that traditional psychology used to make by putting intellectual aspects to one side and affective ones to the other.

One of the fundamental precepts of Vygotsky thinking, according to (Oliveira, 1992), is the idea that higher mental functions are developed throughout our social history. That is, it is our relationship with the physical and social worlds – which are mediated by tools and symbols developed in the social life – that creates and transforms our modes of action in the world. Vygotsky proposed the Zone of Proximal Development, which is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers" p. 86 (Vygotsky, 1978).

For Vygotsky, according to deSousa (2011), it is important to understand the cultural aspects behind the language adopted by children and parents. Words have meaning and senses. While meaning is objective and can be shared among members of the same cultural group, the sense is the unique result that each person constructs from his/her experience. In this direction, Vygotsky, relates meanings to complex and superior cognitive processes; and sense, to emotions. Therefore, it is in word (and in the construction of the meaning and senses of that word) that affect and intelligence meet, according to the Vygotsky's perspective (deSousa 2011).

Wallon views the relationship between intelligence and emotion in terms of causality and interchange (Veer, 1996). For Wallon, emotions have social functions: they "serve to link the person to social others" (Veer, 1996). Similarly to Piaget, Wallon puts in evidence stages in child's development (Wallon's stages are: Sensorimotor and projective; Personalism; Categorical and Adolescence). In each stage, either intelligence or affect prevails (intelligence, affect, intelligence, and affect, respectively). When affect prevails, the focus lies on the construction of the self – which is achieved by the interaction with other people (deSousa 2011).

From an analogous social perspective and in the context of Brazilian education, Paulo Freire argued for a revision of curricula and programs of educational systems (Jackson, 2007). Aiming at deeper social changes, Freire presents visionary critiques on pedagogical approaches; "Freire viewed education as a political act. Teaching, he believed, can never be divorced from critical analysis of how society works, and teachers must challenge learners to think critically about the social, political, and historical realities within which they inhabit the world." p. 203 (Jackson, 2007). It is from the context where people live that teachers and students should find their examples and base for learning activities and motivation, since the person (together with his emotions and cognitive capacities) cannot be disconnected from his/her world (Freire & Freire, 2007).

Like Freire, Papert also argued for a change in the educational system's structure. He proposed a radical change in the school as it is seen today. Papert, who worked in collaboration with Piaget at the University of Geneva (Papert, 2004), developed a theory of

learning based upon Piaget's Constructivism: the Constructionism (Papert & Harel, 1991). While Constructivism and Constructionism share many similarities (in both, "learning occurs within a context of use, learning is frequently collaborative, learning as authentic, learning as inquiry-based not transmission-based"), Constructionism stands out mainly by "the degree of active learner engagement as well as the assumption that learners have the ability to create meaning, understanding, and knowledge" (Papert & Harel, 1991). The programing language Logo and the XO laptop have their roots in the Constructionism theory of learning.

This brief review on the main theories from the fields of education and psychology, with emphasis on the presence of emotional and affective aspects, is summarized in Table 2.

Table 2 - Some authors from education and psychology: their main contributions to the fields and how they see affection.

Author	Fields	Main contribution	Role of emotion/affect
Freire	Education	Critical (social, political, historical, cultural) view of pedagogy; method for the alphabetization of adults.	Freire speaks of pedagogy and educational environments as embedded in affect (Jackson, 2007; Gadotti & Torres, 2009)
Piaget	Psychology and education	Constructivist theory; stages of development.	Affectivity is an energetic source. The fuel that makes the motor of intelligence run, without changing its structure (DeVries, 2006; LaTaille, 1992).
Vygotsky	Psychology and education	Zone of Proximal Development; cultural-historical psychology.	Affect and intellect should be considered simultaneously in the process of making sense of things (deSouza, 2011; Oliveira, 1992).
Wallon	Psychology	Dialectic and genetic perspective of the theory of emotion.	Affectivity as an eminently social activity (Galvão, 1995). In order to evolve, affectivity depends on conquers made on the intelligence level and vice-versa (Dantas, 1992).

4.2 From Participant Observation

Our presence in the school was rapidly assimilated and accepted by students, teachers and staff. Younger children seemed more curious, especially during the first days of our presence inside their classrooms. They were also the ones to display affection more often, receiving us with hugs, kisses and kind compliments. Within one week, they all seemed already used to our presence. The 'participant' approach to the 'observation' helped this

familiarization process: as we were immersed at the school helping teachers in their tasks, children soon started to identify us as members of the school. That was noticed when the children started to refer to us as 'teachers'.

All the field notes from PO were transcribed and coded. Table 3 informs, as an example, the coding of some extracts from the field notes, which led to our design principles. The design principles were derived from different moments of our observations.

4.3 Converging theory and observations into design principles

Observations made during the immersion at the school, together with considerations from the theoretical literature led us to a preliminary set of principles for the design of learning systems.

The first column of Table 4 presents quotations from the literature. Observations of behavior (column 2) are matched, corroborating the quoted theory. Together, both suggest the design principles (column 3).

5. Phase 2: Exploring the Design Principles

In this section we detail the Design Principles, providing practical examples and further support on the literature from the field of computer sciences (HCI, CSCW, computers in education, etc.) Moreover, the proposed design principles were used to analyze two applications that are native from the XO laptop: "Write" and "Speak".

"Write" (OLPC) is a simplified word processing application that allows children to write and edit texts, and insert images and tables. "Speak" has a simple interface and it uses a speech synthesizer to speak anything that the child types. It shows a customizable face that moves the mouth and eyes according to the children's input. Both "Write" and "Speak" (Figure 10a and c) have been used as powerful tools in alphabetization classes. Both applications were analyzed in terms of compliance with the design principles for affect in learning technology. An overview of this analysis is presented below. Additionally, as examples of concrete application of the principles in learning applications, we provide examples for each principle; however the examples were not always used with the explicit

Table 4 - Converging theories (first column) and observed behaviors (second column) into principles for the design of educational technology.

Quotation	Key category (from table 2)	Design Principles for Affectibility
"A complete understanding of human thoughts can only be achieved when there is an understanding of the affective-volitional base." (Vygotsky's view according to Oliveira,1992).	Commun., Expres. and interpretation of affective estates	**PAf.1 Support expression and interpretation of affective states.** The system should allow the communication among users, especially encouraging the expression (and perhaps therefore the comprehension or awareness) of emotional responses.
"(…) values attributed to people are the starting point to feelings. (…) all behavior is dictated by an interest, which is related to a goal towards action. Such interests are represented in the form of values and they are constituted, in essence, by affectivity." (Piaget's view according to deSouza, 2011.	Context, culture and Social values	**PAf.2 Design for social values and motivation.** The system should allow the presence or representation of associated values that are of interest to the user. Such values might change over time, or according to user groups or age of the users. The designer should strive to understand users' social values.
"(…) Why not, for example, take advantage of the students' experience of life in those parts of the city neglected by the authorities to discuss the problems of pollution in the rivers and the question of poverty and the risks to health from the rubbish heaps in such areas?" Paulo Freire (1998).	Tailoring/customization	**PAf.3 Allow tailoring** with use of students' own material. System should allow groups of users to insert learning material that are specific to and reflect their community/culture
"(…) to say that a child can do more when collaborating with an adult does not mean that the level of potential development may be arbitrarily high. (…) the child can operate 'only within certain limits that are strictly fixed by the state of the child's development and intellectual possibilities'". (Vygotsky's view according to Wertsch, 1985).	Collaborative construction and participation of adults	**PAf.4 Strive for collaborative construction and adults' participation**. The system should allow learners to collaborate by helping and supporting each other. The system should allow (direct or indirect) action/participation from adults (i.e., teachers, parents, elderly, etc.) who might contribute to the development (of the intellect or emotion) of the user.
"Affective exchanges are entirely dependent on the concrete presence of other partners." (Wallon's view according to Dantas, 1992).	Social awareness	**PAf.5 Promote social awareness**. The system should let users be aware of the presence (and actions) of other children and/or the teacher (especially in the case of virtual presence and actions).
"The highly contagious nature of emotion comes from the fact that it is visible, that it is open to the exterior by the modifications of mimics and facial expression (…)" (Wallon's view according to Dantas, 1992).	Media contamination	**PAf.6 Enable contamination by media**. As the use of sound, images, rhythms help create certain moods, the system should support multimedia formats.

purpose of improving affective responses. Notice that the principles aim for interactivity, meaning that users have active roles in the interaction with the application, rather than passive receivers or consumers of a product.

5.1 The Design Principles for Affectibility (PAf)

PAf.1 - Support expression and interpretation of affective states. Users should be able to communicate their feelings and emotions. Designers could make features available that allow users to express that. Rather than making systems that automatically recognize emotions, designers concerned with affect responses should leave to users the immensity of possible interpretations that the expression of emotional and affective responses may suggest. Boehner et al. (2007) explain that affect and emotion are interpreted and produced culturally: the experience of a feeling (e.g., anger, lust) is grounded in a cultural context that makes that feeling (of anger, lust, etc.) meaningful. Socio-cultural aspects will determine the type of emotional responses those feelings might evoke (e.g. something to be proud of, ashamed of, etc. (Boehner et al., 2007). Sengers and Gaver (2006) argue that multiple interpretations can be fruitful in design and design solutions should not promote only one single interpretation. We suggest that designers should provide users with opportunities for open expression and interpretation through the system or application.

At the online page of Scratch – an educational application in the form of "a visual

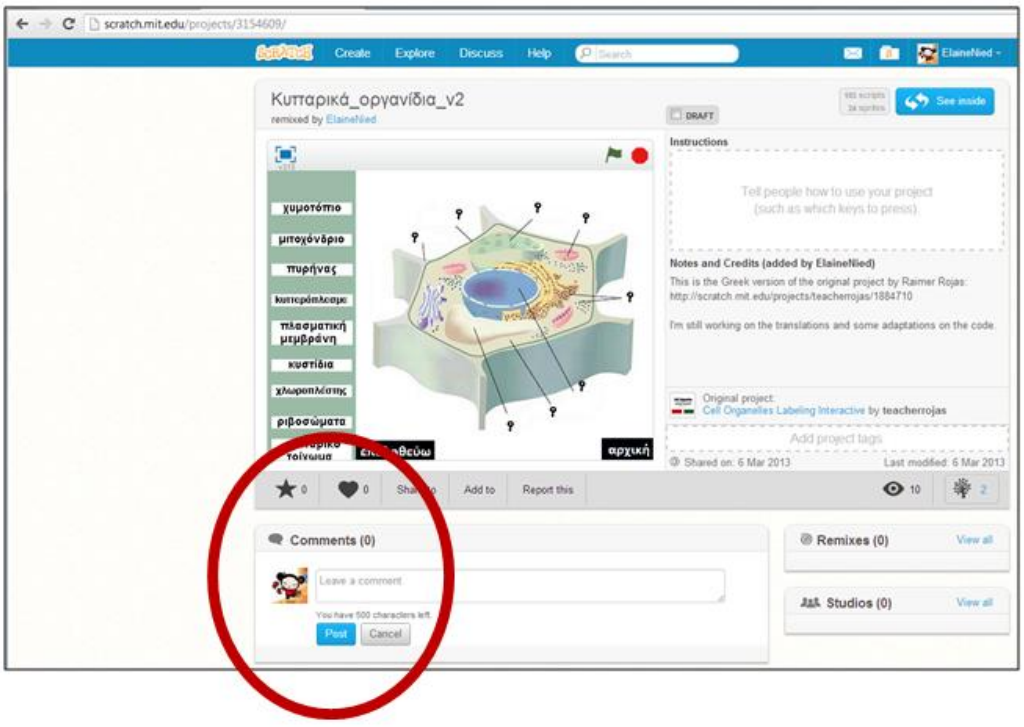

Figure 2 - Example of a Design Principle for Affectibility: features that allow communication of affect are highlighted in the red circle.

programming environment that allows users (primarily ages 8 to 16) to learn computer programming" (Maloney et al., 2010) – users can leave their written comments about the activity. Users may also quickly indicate that they liked an activity by clicking at an icon that has the shape of a heart. The page displays how many people have clicked that icon. Those features are highlighted in the red circle in Figure 2.

At the application proposed by Thomas & DeRosier (2010) for the development of social skills in children, the player can choose the responses of the character of this adventure game. The choices for response include affective expressions. Figure 3 was extracted from the paper from Thomas & DeRosier (2010) and it is reproduced here to illustrate another possible way to implement the principle of supporting expression and interpretation of affective states.

Figure 3 - Image reproduced from the work of Thomas & DeRosier (2010) to illustrate another possible way to implement a Design Principle for Affectibility: feature that allows manifestation of affect.

Both "Write" and "Speak" present features that allow children to express themselves, by writing, listening (only "Speak") and/or reading what they have to say. With "Speak", children can change the rhythm and accent of the voice. Also, they can make the eyes look at different directions. With "Write", children can compose any kind of text or art. Another

example of affective expression through art in learning technology is found in (Kim & Choi, 2010).

PAf.2 - Design for social values. Designers should consider users' social context, including their values and culture. Elements from users' culture and values should be taken into consideration and their presence should be made clear in the designed application. This can include associated values that are of interest to the learners or that are specific for their context. In order to understand what would be of interest to the users, socio-technical and participatory approaches can be used by designers.

An example of the application of this principle is the digital storytelling proposed by Lu et al. (2011) – Figure 4. The authors intentionally consider the Chinese cultural heritage and create an activity that lets children create and interact with puppets from the traditional Chinese shadow puppetry.

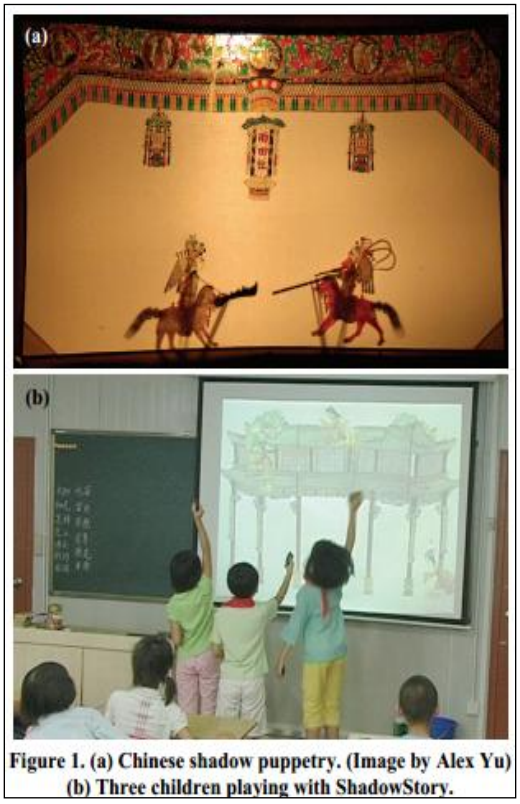

Figure 1. (a) Chinese shadow puppetry. (Image by Alex Yu)
(b) Three children playing with ShadowStory.

Figure 4 - Image reproduced from Lu et al. (2011) illustrating the Design Principle on social values.

Also Kam et al (2009) were explicitly interested in the values and context from their target users. The authors first analyze village games that are traditional in the rural areas of India. Comparing their annotations with characteristics of Western video games, the authors propose a video game for India children. The authors argue that, due to the fact that the game is culturally meaningful to the rural children of India, the game is found to be more intuitive and engaging.

"Write" shows no evidence of design made considering specific social values, other than those derived from their educational purposes. "Speak" lets users adjust the accent of the voice according to different languages. Other examples of social value in learning technology can be found in (Kim & Choi, 2010; Pereira et al., 2010; Anacleto et al., 2010).

PAf.3 - Allow tailoring. Users should be able to tailor the application. An example of application that complies with this principle would be one where users could adjust the interface in ways that they feel more comfortable. Users could add their own personal media or educational content, according to their needs or preferences. Designers could leave space for teachers and students to include their own material. Material from learners' specific contexts composes more meaningful learning opportunities. In the quest for more interesting and motivating learning environments, applications should be flexible to allow insertion of users' own material, like their media (pictures, sounds, etc.) or educational content.

Barab (2002) comments on the need of promoting more realistic learning instead of the traditional schooling practices: they are usually artificial or consist of experiences from other environments. Information out of context, indirect and abstract knowledge, can only contribute to less motivated learners and other rather negative affective responses (Barab, 2002).

The Ely doll is a learning tool proposed by Africano et al. (2004). One of the features of this system is a camera, which, according to the authors "allows children to explore real-world phenomena by creating digital content to be brought into the play" (p. 858).

Other examples of tailoring in the design of educational technology include the

customizable avatars proposed by Given et al. (2010); the personalized search interface from Azzopardi et al. (2012) – Figure 5; and personalized modules, which are based on the learners' previous achievements or based on their explicit choices (Ananian et al., 2012).

Figure 1: Maddie's search interface using MaSe.

Figure 5 - Image reproduced from Azzopardi et al. (2012), representing the Design Principle on Tailoring.

Both "Speak" and "Write" allow children and teachers to work with their own content. "Write" allow students to choose the color and size of the fonts of the text. However, this feature might not be considered an actual tailoring feature. "Speak" lets students choose the number of eyes that the face has. Also they can choose the format of the eyes and mouth.

PAf.4 - Collaborative construction. The application should support users to work in collaboration in the construction of group learning. The participation of adults (teachers, parents, other relatives or professionals) can also be valuable in this process (see section 4.1).

An example of application that allows collaboration is Mobile Stories from Fails et al. (2010). Mobile Stories is a mobile technology that empowers children to collaboratively read and create stories. Figure 6 was extract from the work of Fails et al. (2010) and it

illustrates the application of this Design principle in educational technology.

Figure 1. Children using Mobile Stories; bringing mobile devices together to work collaboratively in a collocated situation.

Figure 6 - Image reproduced from Fails et al. (2010) illustrating the presence of the Design Principle of Collaborative construction.

Another possibility of application of this Design principle of Collaborative construction involving peer support would be in the form of virtual guidance. This could be achieved via (online or offline) participation of more experienced peers, or help systems made available in the system. In Figure 7 we highlight in the red circle an example of guidance present in the system proposed by McKinley & Lee (2008).

At Livemocha (Livemocha) – an online community where people support each other in the task of learning a foreign language – native speakers of a language can help other participants who are now learning that language by correcting their exercises and giving advices on their pronunciation. Participants can rate each others' contribution to the community, both as learners and "teachers".

Figure 7 - Image reproduced from McKinley & Lee (2008) illustrating another possibility for the presence of the Design Principle of Collaborative construction.

"Speak", via its chat interface, allows for collaborative practices. "Write" does not present such feature. Other examples in the field of learning technology that presents collaborative work are found in (Apiola et al., 2010; Resnick, 1996; Soloway, 1999).

PAf.5 - Promote awareness. Awareness in interactive systems has been investigated in diverse contexts. For example, Erickson et al. (2002) present their approach to make the online presence and activity of others visible. Their motivation was to foster collective activities, as it would make it easier for people to express themselves using social conventions and engage in collective interactions. Similarly, architectures have been proposed to support awareness in systems user interfaces (e.g., Almeida & Baranauskas, 2010).

As shown in Section 4.1, Wallon supports that affective exchanges are dependent on the presence of others (Dantas, 1992). That is because affectivity is an eminently social activity. In this sense, applications should make the presence of others noted, providing feedback to the users. This feedback can also serve users to understand his/her own role within the activity, application or community.

Lee at al. (2011) examine the mediating role of social presence in the context of educational games. They compare three groups: online educational quiz game vs. off-line educational quiz game vs. traditional classroom lecture. The key difference among the groups was that participants in the online condition were able to see the performance of other users on a real-time basis, whereas participants in the off-line conditions played the game alone without monitoring the performance of other users. This study showed positive results in relation to sense of competition, satisfaction, and perceived efficiency of the learning method.

In the application proposed by Tanenbaum et al. (2010) for a tabletop game for sustainability, trees change color and facial expression to show the levels of environmental damage during the game. Moreover, different trees change colors to show each player what his/her individual contribution to the game is. Figure 8 shows some images that were extracted from the paper from Tanenbaum et al. (2010) that illustrate these features.

Figure 8 - Different figures that were extracted from the work of Tanenbaum et al. (2010) to illustrate a possible application of the Design Principle of Promoting social awareness.

At Livemocha (Livemocha) users are aware of the online presence of other users who might help them in their language practices. They also know how many friends they are

connected with in this community. Knowing the online or offline status of other people is another example of the Design Principle Promoting Social awareness. Figure 9 displays a printscreen of LiveMocha, with the online status and friends highlighted within the red circles.

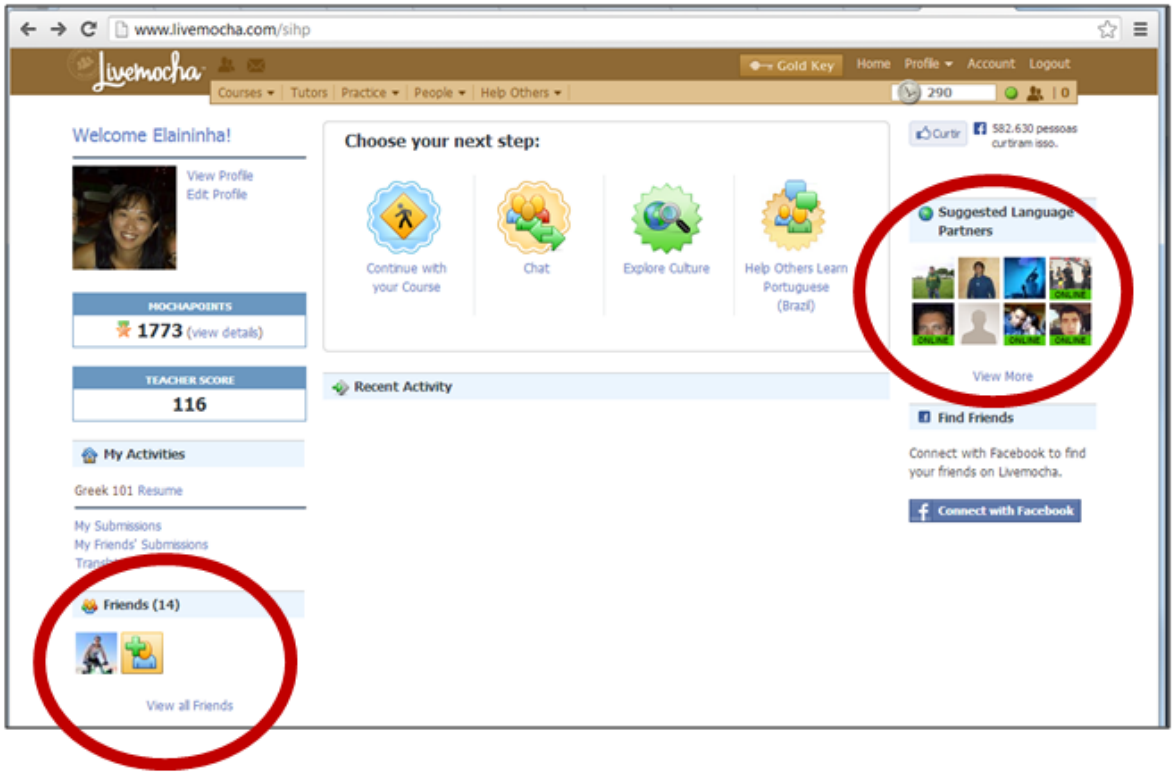

Figure 9 - Printscreen of Livemocha, with online status and friends highlighted in the red circles. These features are examples of the Design Principles of Promoting social awareness.

"Write" does not support awareness, while "Speak" allows it via its chat interface. Other examples of awareness in other learning technology can be found in (Koushik et al., 2010; Zhang & Yang, 2009).

PAf.6 - Enable contamination by media. According to Norman (2011) "Emotions are contagious". When people are happy and smiling, others around them tend to be also smiling, whereas when people are nervous, it might be that those around them will follow. In the game design field, it is already known how moods can be created by means of appropriate use of images and sounds. Like in movies, the narrative, together with camera

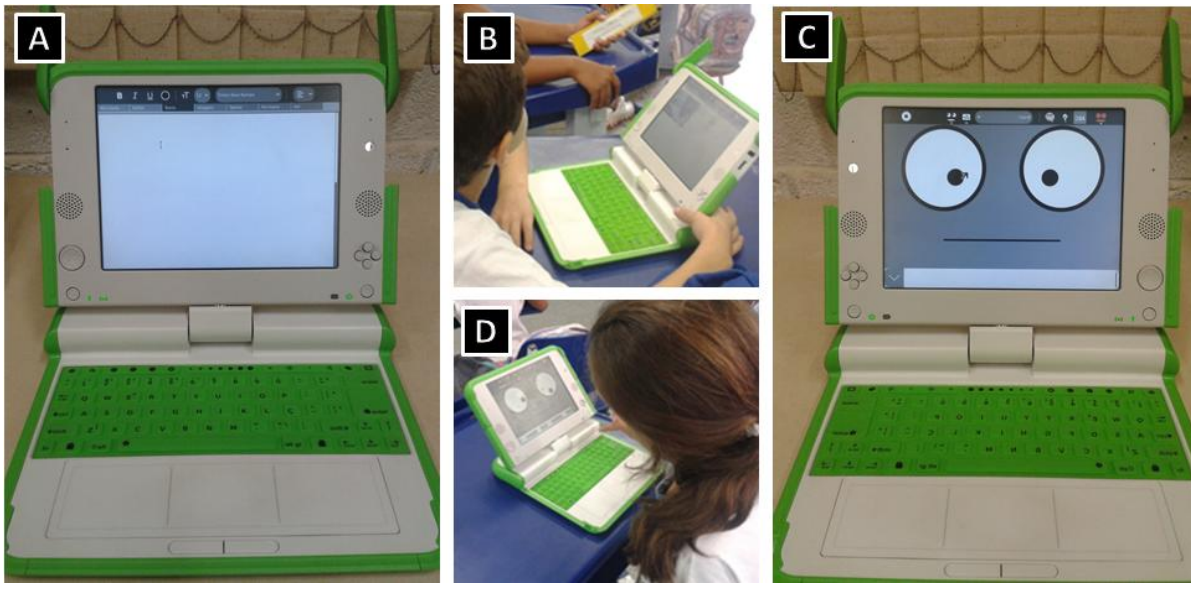

Figure 10 - A) The XO laptop running the "Write" application; B) Student interacting with "Write"; C) XO laptops running the "Speak" application; D) Student interacting with "Speak".

zooms and increasing rhythm in the background music, can create strong emotional states in the viewer (Scolari & Fraticelli, 2004). The design of learning technology should also profit from those resources. While the majority of applications already make use of media, such resources are not always used with the explicit purpose of obtaining determined affective responses from users.

As an example of use of different media (images, videos, text compositions, sounds, etc.) in learning technology we can mention the interface for digital textbook proposed by Kim et al., 2010. Different media can also be explored during the design process with children. An example is reported in Tikkanen & Iivari (2011).

The voice of "Speak", with its different speed, volume and accent contribute to this mood contamination.

5.2 The preliminary study

The analysis of the "Write" and "Speak" (Figure 10) applications that were presented in section 5.2 is summarized in Table 5. We can see in this result that "Speak" complies with more Design Principles than "Write". Our hypothesis is that "Speak" would be more appealing to children (i.e., they enjoy more, are more comfortable in using, are more excited, etc.)

In order to verify our hypothesis a simple qualitative study was conducted with 43 students from a Brazilian public school. We interviewed each child individually about their opinion on both "Speak" and "Write". All children were from two groups of second graders. Most of them (39 from 43) had been using both applications ("Write" and "Speak") since they were in the first grade (the other 4 children were transfered from a different school that year).

83% of the children interviewed said they liked Speak better. This result was confirmed by their behavior, observed while we let them interact with "Speak" and with "Write" with the

Table 3 - Two applications from the XO laptop analyzed according to the design principles for Affectibility.

Principle	"Write"	"Speak"
PAf.1 Support expression and interpretation of affective states	✓Users may create compositions with texts and images.	✓Users may make the voice speak any text they type.
PAf.2 Consider users' social context, including their values and culture		✓Users may hear the voice speak with the appropriate accent and language.
PAf.3 Allow tailoring		✓Users may change the format and the number of eyes, and change the rhythm of the voice.
PAf.4 Allow collaborative construction		✓Users may establish conversations with other online users via chat.
PAf.5 Promote awareness		✓Users may see who is online via chat.
PAf.6 Enable contamination by media	✓Users may create compositions with texts and images.	✓Users can be moved by the movements of the eyes and mouth, and by the sound and rhythm of the speech.

task of writing simple sentences from a song. Among the 17% who prefer "Write" are some children who reported thoughts like: "I know <name> will say he prefers "Speak" and I don't want to be like him."

This result (Figure 11) confirmed our hypothesis: "Speak" – which is the application that mostly complies with the elements of our proposed principles – is the application that children report having more fun, liking the most or spending more time with.

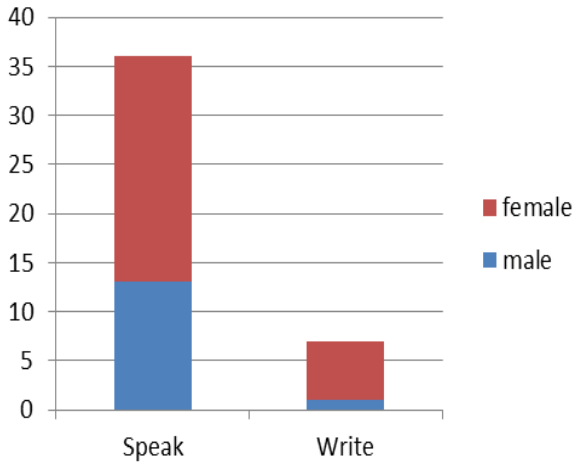

Figure 11 - Number of children and their preferred application.

6. Discussion

While some of the principles might not seem new, the new challenge lies in: (1) making affect and emotions explicit in the interaction design with (for and by) children; and (2) creating design processes and products that combine the Design Principles for Affectibility together with other recommendations (i.e., for usability, accessibility, etc.) with harmony, simplicity and beauty.

As Norman (2010) discusses: "*The new design challenge is to create true participatory designs coupled with true multi-media immersion that reveal new insights and create true novel experiences. We all participate, we all experience. We all design, we all partake. But much of this is meaningless: how do we provide richness and depth, enhanced through the active engagement of all, whether they be the originators or the recipients of the*

experience?"(p.15). We hope that the proposed design principles can contribute in this direction.

The combined use of the Design Principles for Affectibility should direct educational applications towards more interactive systems, where learning activities can not only reflect real life (more meaningful), but actively be part of it, ubiquitously. Designers should not be limited by the concrete examples provided in this report. Other uses may be further explored according to the available technology and creativity. For example, the expression of emotions can be manifested not only via textual formats; it might be interacted in body movements (e.g., strength or speed of movement) and in a collaborative and cultural rich way (e.g., traditional/typical group dances).

7. Conclusion

In this paper we presented design principles aiming at improved affective responses from children, as a result of their interaction with learning technology. We derived the Design Principles for Affectibility from both a posteriori (empirical) and a priori (theoretical) research. Furthermore, we explore the design principles by comparing two existing educational applications for children and by providing examples of how the principles could be applied in the design of educational applications. We expect to have contributed with practical recommendations to explicitly account for affect in the design process. Future work includes deeper investigation of the principles, allowing other designers to apply them in their contexts, and assessing users' feedback.

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