Enhancing Interaction through Visual Interfaces in the design of Hypermedia Games for English learning at Preschool

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Abstract: As the presence of technologies becomes more apparent in every corner of our lives, interaction and user-centered design can be a vital tool in addressing target groups with special needs. Within the realm of education, this research proposes enhanced, user-friendly hypermedia applications for young children so they can be proficient enough to handle web-based interfaces and easily interact with content. The issue of how graphic content and visual design can be tailored for both the user and the content will be dealt with by examining the implementation of enhanced computer games interfaces for children. Research will be centered on the interaction design applied in creating instructions (referred to as intros) in gaming, the navigation icons needed by early learners while moving through hypermedia tasks and the understanding of the different backgrounds to recognize the type of game they are working on (e.g. matching, click and color, drag and drop, and the like). Evaluation through recorded observation of young learners´ interactions during class sessions detects trouble spots which consequently lead us to rethink navigation and interaction elements for the purpose of improving communication on the final product.

Keywords: interaction & graphic design, games, English, hypermedia, young learners

Resumo: À medida que a presença de tecnologias se torna mais aparente em nossas vidas, a interação e o Design centrado no usuário podem ser uma ferramenta indispensável na abordagem de grupos alvo com necessidades especiais. Dentro do campo da educação, esta pesquisa propõe aplicações hipermídia aprimoradas e fáceis de usar para crianças pequenas, para que possam ter proficiência suficiente para lidar com interfaces baseadas na Web e interagir facilmente com o conteúdo. O conteúdo gráfico e o design visual podem ser adaptados tanto para o usuário quanto para o conteúdo é tratado examinando-se a implementação de interfaces de jogos de computador. A pesquisa será centrada no Design de interação aplicado na criação de instruções (chamadas de intros) nos jogos, nos ícones de navegação necessários para os aprendizes iniciais e nas tarefas hipermídia, e na compreensão dos diferentes históricos para reconhecer o tipo de jogo em que estão trabalhando (por exemplo, correspondência, clique e cor, arraste e solte, e assim por diante). A avaliação através da observação gravada das interações dos jovens aprendizes durante as aulas detecta pontos problemáticos que conseguintemente nos levam a repensar elementos de navegação e interação com o objetivo de melhorar a comunicação sobre o produto final.

Palavras-chave: interação e design gráfico, jogos, inglês, hipermídia, jovens aprendizes

1. Introduction: Computer interaction at early ages: Posing the question

Each technology period has brought important changes, from the rise of the personal computer and the Internet, to the emergence of mobile and ubiquitous learning and social networks. Aligned with such developments, newer educational experiences

and opportunities have incrementally appeared at all educational levels and ages. In this sense, technologies have given way to novel forms of media expression, forcing innovative types of graphic communication to adapt and keep up with new consumers of visual language (Fitton, 2015). Our focus is placed on a specific target group and market segment in need of greater attention as for as visual communications is concerned: the design of appropriate graphical interfaces for hypermedia games for English learning at preschool (3-6 years old children).

Technology has allowed children to learn in ways their parents and, even their teachers, never had through a great deal of resources, apps and tools. Regarding how devices best suit to children´s needs and capabilities, in the last years touchscreen devices like tablets, smartphones and iPads are considered to be less expensive, more portable, versatile and user-friendly versions than desktop and portable computers.

For authors such as Chiasson & Gutwin (2005) who claim that children cannot successfully handle computer equipped with a keyboard and mouse, since they cannot surpass the hurdles they encounter when attempting to use it, the arrival of touchscreen devices has made technologies accessible to young learners. In this line of thought, the prevalence of tablets is also supported by those claiming the advantages from natural gestures used to handle objects on touchscreen devices, movements which can resemble those used by children on physical objects in the real world (Hiniker et al, 2015).

An opposing view is held by authors such as Luckin et al (2003) who state that children are indeed capable of mastering multiple interfaces of toys and screens if an appropriate design is provided. Thus, the type of interaction required, that is, dexterity with the input device, the mouse in this case, is examined in depth by authors like Pariente-Martinez et al., (2014).

In this sense, and considering that touchscreen interactivity, adaptiveness, and dynamism enable children to engage in independent learning activities and to transfer knowledge quickly, using input devices such as a keyboard or mouse can enhance the learning of skills and abilities which can help children to develop newer relevant competences at this age. Using a mouse to complete a task requires the development of fine motor control and coordination of actions such as looking straight ahead, holding the mouse steady while pressing buttons, choosing the correct selection and the like (Hsin, Li, & Tsai, 2014; Lane & Ziviani, 2010).

In either case, and beyond the debate about the suitability of an input device, the aim of our proposal is based on the need to design visual interfaces which suit to young learners´ needs and cognitive development.

The fact of the matter is that like all users, children are faced with understanding navigation, content and instructions, decoding visuals, words and many other elements presented in interface devices. Currently, graphic communication professionals are drawing from a range of design theories to meet the specific needs of children learning through educational technologies. A variety of suitable theories (Sanoff, 2016; Maxwell, 2012; Nesset et al, 2004), are thus far under discussion: 1) User-centered design, 2) Contextual design, or inquiry, 3) Participatory design, 4) Cooperative inquiry, 5) Informant design, and, 6) Learner-centered design. However, what appears an obvious common denominator in all of them is that communication should be highly visual in order to ease this particular target group through the motions and interaction required to function on their terms. In light of this premise, software implementation should pay special attention to the graphic design of the interfaces and additional multimedia components, whose main features should be based on interactivity and adaptiveness at his age.

The general aim of this contribution is to present graphic design as a tool to improve on interaction at early ages by extending this area of expertise towards the development of visual communication and usability in the development of children's interfaces. In detail, our action research (specific objective) aims to design intros, navigation icons and games backgrounds to enhance interaction.

To cover this objective, the research starts by describing the theoretical background in which the study takes place. Then, the action research (objectives and methodology used) describes the steps which conduct us to the result analysis and the main conclusions.

1. Theoretical Background

1.1. User-centered solutions for visual enhanced interaction

Classical solutions in graphic design for the enrichment of hypermedia applications are not only limited to aesthetics, but also encompass basic design axioms as defined by Norman (2002: 1) simplicity, 2) versatility, and, 3) pleasure. However, as regards the process required in the case of young children, it becomes apparent to researchers that traditional tools for the design of computer applications are falling short of achieving teaching-learning goals and, claiming that poor layout, lack of color and unclear human visual perception are the culprits which greatly contribute to a lack of communication and usability in graphic design for children (Tengku, 2007; Agudo et al, 2016).

According to Preece et al (2002), usability can be broken down into the following features: effectiveness, efficiency, safety, utility, easy to learn, and easy to remember. Thus, it is our understanding that interaction design comprises a synthesis with other disciplines such as traditional graphic design, technical specialties, and psychology, among others, for the purpose of improving the user – interface alliance. Examination of the available literature (Marcus, 2011; Harrison et al, 2013) reveals solutions in up to date research highlighting that an improvement on usability can be reached by centering on the specific user, attempting to improve the usability of the product, by understanding users' needs and then designing to meet them (Lowgren, 2009).

1.2. Interaction Design and English learning at early ages

An obvious initial assumption is admitting that adult interfaces cannot be applied to children's software and that interaction design principles formulated for older users are simply not effective for preschoolers. Hypermedia for children is mainly based on sound files supported by images or perhaps better stated, images supported by sounds (i.e. oral language). Static or dynamic imagery is one of the first elements the child perceives and tries to process. These will be the channel through which content is developed and the feedback delivered to reward success or encourage the child to make another attempt in the case of error.

In the case of foreign language learning, the dynamic character associated with hypermedia requires visual components and communicative aspects through graphic design such as chromatic, typographic and graphic codes to be broadly complemented by audiovisual and narrative language formats. Thus, components like sound, movement, narrative composition elements and graphical perception parameters are the toolbox of the interaction design to create the graphical interface to an adequate usability in hypermedia language learning environments.

Guidelines in the design of digital games for children consist of examining the target group as regards their communicative needs, while simultaneously, accounting for their specific competencies, limitations and requirements. The interaction design of the graphic environment is consequently based on pedagogical theories of visualization and perception relative to the particular group of learners under study. Heller (2005) and others (Radesky, Schumacher & Zuckerman, 2015; Sedig & Parsons, 2013; Wu & Richards, 2014) propose the utilization of almost five basic kinds of sensorial techniques to reach this goal: 1) clarity of exposition, 2) comprehension of content, 3) coherence of sounds and images, 4) attention-getting designs, and, 5) strategies which communicate to others through the senses.

Therefore, if these recommendations were followed, the hypermedia architecture should contain a built-in graphical system wherein audio-visual predominance assists youngsters throughout their learning process. Likewise, functional aspects of navigation should be simplified, comfortable and easy, while the environment created in the system ought to be attractive and intuitive in an effort to spark interest and curiosity in children about this newer learning approaches.

2. Action Research: Designing intros, navigation icons and backgrounds for hypermedia games at early ages.

To cover our objective, an action research probe was undertaken on the design of intros, the navigation tool bar (icons) and game backgrounds of computer games for 3-6 year-old children learning English. Because of the age frame, our study aims to present the description of the instructional language needed by young learners who do not yet read but need to understand a set of instructions and directions via visual and oral communication in order to interact with a hypermedia environment in a foreign language.

2.1. Methodology: sample and metrics

A sample of 55 preschool Spanish children took part in the research distributed as follow: eighteen students aged 3-4; seventeen from 4-5; and twenty 5-6 years old students. Following the design stage, observation and in-class assessment were made of the children during four sessions of 40 minutes each. The research was divided into three main phases: (phase 1) two sessions -40 minutes each- to assess children´s understanding and interaction with intros, navigation bar icons and game backgrounds; (phase 2) a lab session to perform UX visual improvements from the results obtained in phase 1 and; (3) two additional in-class sessions to assess children´s interaction with the redesigned interfaces (intros, icons and backgrounds).

Table 1. Intros, Navigation Icons and Game backgrounds. Evaluation Parameters

Interfaces Evaluation Parameters (EV.P)	
EV.P1	Does she/he understand the game instructions (through Intros)?
EV.P2	Does she/he recognize the use of the navigation tool bar (navigation icons)?
EV.P3	Does she/he recognize the game content through the understanding of Intro background and stages?

The metric applied for in-class evaluation (phases 1 and 3) and lab improvement phase (phase 2) was done according to three evaluation parameters -EV.P.-, criteria which could be described as follows: (1) visual understanding of Intros; (2) Visual recognition of the navigation bar icons; and (3) Recognition of the games types through the settings and backgrounds applied to each type of game (see table 1).

From the evaluation parameters comprising the three interfaces under study (EV.P1- EV.P3), a group of 10 assessment criteria (table 2) was set during the whole experiment, both in-class and at lab work. The metric was applied from the initial design and assessment of intros, icons and background (phase 1); used also as a guideline to enhance the visual interfaces described in the second phase, and were the evaluation criteria through which the final in-class assessment was conducted as well (phase 3).

Table 2. Evaluation Criteria to improve User Experience Design

Evaluation Criteria to improve User Experience Design		
Evaluation Criteria	Used for	EV.P
1 Simple and closed shapes	Visualization of the contents	2
2 Limited number of elements	Clear organization Avoiding confusion or distraction	1,2
3 Minimum number of steps in interaction	Understanding of directions. Easy to use and not boring	1,2,3
4 Bright and lively colors rather than light or soft tones	Attracting attention towards the action	1
5 Exploitation of colors and movement	Guiding the line of vision and presenting new information	1,2
6 Colors in conjunction with shape and size	Reinforcing user interaction	1,2,3
7 Sounds + graphical design	Reinforcing user comprehension	1
8 Discrete background composition	Capturing the main graphic information	3
9 Balance of elements with equal visual aspects	Creating coherence with the entire structure of the system and contents	2,3
10 Customization of every piece of Instructional language	Improving the comprehension to reinforce the interaction	1,2,3

The right hand column (EV.P) shows the correspondence between the ten assessment criteria (left hand column) with the three interface types: (1) intros, (2) navigation icons and (3) game backgrounds.

Notations of children interaction with the audio-graphic understanding of instructions in English (intros), manipulation of the navigation icons and recognition of games types though backgrounds and settings were digitally recorded in-class phases (1 and 3). The results were viewed and thoroughly analyzed by the researchers at the end of each experimental in-class phase by applying the ten evaluation criteria (table 2) over the three interfaces under study (table1).

2.2.Research Phases and Results

2.2.1 Phase 1. Sessions one and two: in-class assessment before interface improvements

The 55 preschool children comprising the research sample were exposed to a couple of 40 minutes sessions which were recorded to gain insights into children´s interaction with the prototyping interfaces for intros, navigation icons and backgrounds (figure 1 and 2).


Figure 1. First menu: Navigation bars and game icons

Figure 2. First navigation menu to choose level

From the results (graph 1), the major problem arises when analyzing children´s understanding of the icons designed to move through the navigation bar (figure 1), being the youngest, those aged 3-4, who find it more difficult and challenging, only 7% recognize the navigation icons to go through the games.

The older students become, the better the movement implied by the icons is understood, getting to 42% and 65% of success in the case of 4-5 and 5-6 years old respectively.

Graph 1. Results of evaluation before improvement (Phase 1)
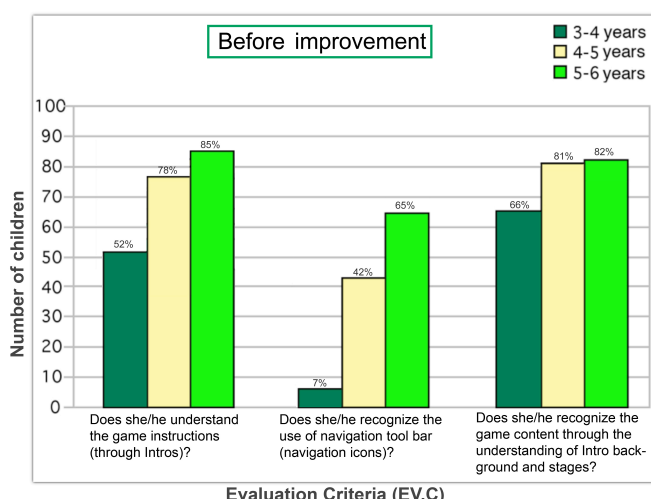
Results on understanding instructions (intro) are also noticeable, only half of the students aged 3-4 can follow the visual/verbal instructions, whereas an approximate 80% of children above 4 can properly do. The best results are found on the recognition of the game type by the visual understanding of settings and backgrounds. The design of visual interfaces resembling objects that belong to the children natural environment, scenes full of iconicity, show positive results at all ages.

In general terms, the age seems to be a key factor when assessing interaction, mainly, the youngest group (3-4 year olds), are those that experiences the most difficulty in each of the evaluation criteria (EV.C).

3.2.2. Phase 2. Interface improvement

In this phase, we will go into improvement of the interfaces from an user experience design approach to solve the trouble spots detected in the evaluation run in phase one, whose results indicate the need to rethink certain navigation and intro elements and strive for improvements in product appropriateness.

3.2.2.1 Navigation environment and tool bar icons

The figures below illustrate the practical application of the table 2 parameters on the design of the navigation menu, i.e. brilliant shapes over a dark background were implemented (figure 3).

As illustrated, the icons selected were a) a house, a well- recognized symbol for children, meaning to go back to the main menu, b) the pink arrow for moving ahead, and, c) an orange spiral circle signifying to repeat the action. The latter shape (orange spiral) was in fact the most difficult for the children's reconnaissance. Nonetheless, they quickly caught on to its significance after clicking on it twice.

Figure 3: Screen of the Unit and Navigation Menu

Figure 4: Screen of the Level Menu

Likewise, in the navigation main menu (figure 4), floating balloons, as familiar, simple shapes were used to represent the content levels marked with huge numbers. Although some written text is present (i.e. the words "level" and the name of the system "Shaiex") it is not expected that the youngsters read. On the contrary, these few written words are for teacher orientation and for identity purposes of the brand name Shaiex. The remaining information consists purely of images and sound complemented by movement. Movement is of prime importance in Interaction Design. By way of example, on the balloons menu when a child chooses a level the balloon flies up.

3.2.2.2. Intros: Improving the game introductions

Instructions, referred to as "intros", are the verbal and visual steps followed to start playing each game. Intros give directions for tasks that should be succinct in order to promote the children's concentration on information, but at the same time avoid boredom, a specific potential set back considering most young learners' limited attention spans. Over two dozen different kinds of audiovisual instructions were designed for the various types of interactive games involved in the system.

A few examples are as follows *"Pick and choose. Then click on and watch what happens; Pick, move and click (figure 5); What's this? Do you know? Match the pairs; Hi there artist! Click on your favourite colour and colour in the drawing (figure 6).*

Furthermore, customization of every piece of instructional language is fundamental for children to understand the interaction games. Thus, special care is taken to assure that each of the intros is supplemented with a miniature demo modeling the type of interaction activity.

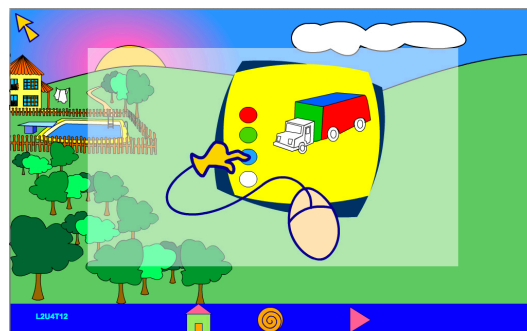Figure 5: Visual Intros for an interaction activity: Pick, move and click

Figure 6: Visual Intro: Hi there artist! Click on your favourite colour and colour in the drawing

The same kind of images and exactly the same visual organization was used in each intro. Our purpose was two-fold: for coherence in the entire structure; so the children recognize the part of the game s/he is in at all times. Note that the central focus of information contains bright colors and movement (figures 5 & 6) while the background remains discreetly faded in comparison. The background of each intro does not vary to make sure the children notice the data provided as well as guarantee their attention on the screen. Then, the children need only to repeat the sample action with the successive elements presented to them.

From the adjustments made in this phase to improve the usability of the games presented in phase 1, interfaces show a noticeable upgrade on the products in terms of a better visualization of the instructions, understanding the content and recognition of the game types.

3.2.3. Phase 3. Sessions three and four: in-class assessment after interface improvements

Improvement on the elements of Interaction Design entailed controlled observation of the target group's interactions with the audio-visual elements, on parameters under study. To assess the final design of the navigation environment, intros and backgrounds, data logs of children's interactions in the last two in-class sessions were recorded after applying adjustments on the games. From the information gathered, statistical results were derived (graph 2).

From the results, a noticeable improvement across the pre/post assessment is observed in all the criteria, interfaces and ages (graph 1 versus graph 2). Intros in English are better understood by children of all ages, similarly to the increase observed in the recognition of the games types through backgrounds and settings. Nonetheless, the youngest (3-4 year olds) still experience the most difficulty in each of the evaluation criteria (EV.C), being especially significant in the recognition of the navigation icons (EV.C 2), in spite of the fact that 3-4 year old children doubled the scored obtained before the interface improvement (7% versus 13%).

Graph 2. Evaluation after improvement
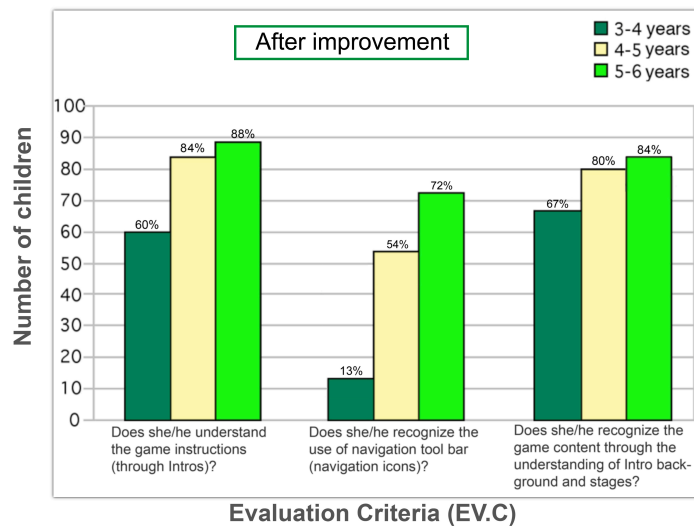
Thus, icons for the navigation design need to be rethought, an element on which we should keep on devising new models and directions to gain insights into the visual perceptions of these elements at early ages, study which could make us improve the design of the visual language and children understand the meaning implied in interfaces and icons.

In this sense, some of the perceptual problems found may not be only related with the game interface systems, factors such as the motivation at this age, the distribution of students in class, the dexterity /familiarity with the mouse, among others, represent a wide array of additional factors which should be analyzed.

4. Conclusions

The conclusions we draw call for enhanced audio-visual techniques for early learners to be able to follow instructional language because of their limited literacy levels, especially intricate in a foreign language like English. Sight and sound applications of interaction design should transmit the messages required of young learners to achieve expected goals whenever appropriate interfaces are designed.

The feedback provided by modeling prototypes for testing with the sampling of children has indicated variables to help improve on design formats. Therefore, the creation of useable products for this particular audience coupled with their gradually acquired experience in handling computer devices can personalize interaction with educational hypermedia.

The age factor is decisive in early learning advancement in the vast majority of the cases under study. Specifically, the youngest (3-4 year olds) experience the most difficulty in each of the evaluation criteria (EV.P), and particularly with recognition of the navigation icons (EV.P 2). In comparison, the older children (4-6 year olds) demonstrate extensive comprehension of intros (EV.P 1) and game recognition through background and settings (EV.P 3) skills.

All in all, data are encouraging, given rise to the analysis of other possible variables in the compression of visual environments, factors related with motivation and the potential and need of visual education at early ages. This would lead us to consider open fields of research aligned and beyond the role played by computer-children interaction through visual design.

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