Adaptive Hypermedia Usability for Language Learning at Preschool

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Abstract
Software developers assume that users in general, regardless of their individualized features, are proficient enough to handle web-based interfaces and that they can easily engage in content, tasks, interaction and the feedback provided by multimedia applications. Based on our experience in the development of educational software, it is our belief that research on usability should take as primary as well as active part in the methodological process of hypermedia development. In addition to this, if the hypermedia system addresses very young learners, the whole application requires a graphical sensory-enhanced format [8]. In this sense, our government funded 3-year research project (2004 / 2007) aims to demonstrate that the design of a hypermedia system should necessarily suit the purposes of usability by accommodating the particular learning needs, patterns and preferences of 3-6 year old children.

Introduction
Previous research [5] concludes that children cannot properly master most technology presently on the market and that they are incapable of overcoming many usability obstacles in navigation, content, interaction, interface design, wording and the like. Departing from these premises, our proposal is based on the creation of an adaptive hypermedia system which properly adjusts to the learning suitability of young learners [3] and conveniently applies a set of various pedagogical aspects that have been taken into account in the design.
- Knowledge, level and content
- Interface design.
- Tasks and games.

All these aforementioned factors have been combined in this research project in order to provide adaptive hypermedia usability for language learning for specific users, namely youngsters in preschool.

1. Knowledge, level and content considerations in the design of AHS for children
For the design of hypermedia activities according to children’s cognitive levels, at a preliminary stage, we directly approached three to five year-old children’s educational and social features in our region to cope with actual demands, needs, and preferences for learning. Such were observed, processed, and analysed in order to determine the type of suitable computer tool that may effectively adapt to educational traits and patterns at early age [7].

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Hypermedia capabilities (video, audio, images, links...) allow for the integration of resources in the form of sequences which the student can manage at his / her own pace. Such are special traits needing exploration and adaptation to age levels. The tool must be used to accomplish specific verbal / non-verbal functions which the learner should exploit without being aware of big efforts. In other words, the material should be appropriate, based on actual surveys conducted in the schools for the determination of both graphical and content preferences for the SHAIEX lessons. The key point in this respect is the search for consistent motivation in order to foster learning incentives, in agreement with [9].

Brusilovsky [2] notices that adaptive hypermedia applications are different from ordinary World Wide Web sites and multimedia software, having the goal of guiding learners toward the paths that are considered optimal for learning. In addition, such systems may foster children's effective learning and knowledge development by enhancing cognitive and social perspectives, including games, interactive project tasks, child-to-child interaction, immediate feedback, collaborative projects, etc [3]. In AHS, the conjunction of multimedia activities and hypertext environment allows teachers to integrate different media and key information, explored and presented through different sequences and according to users' needs and levels. Also, the AHS lessons should include key language that enables both understanding and challenge for the child according to his / her own age level.

Thus, we believe that, in addition to the learning context, media traits, and teaching preferences, the linguistic content in the lessons should be interpreted and based on our analysis of real language data, derived not only from actual teaching material (e.g., textbooks) used, but also from corpus study of communication among three-, four-, and five-year old speakers (e.g., interacting with other children, adults, parents, etc). As regards this naturally occurring language for the system, we follow claims by [1], among others, who stresses the need to rely on corpus material containing the type of target language data that needs investigating.

All the above factors (i.e., adaptiveness, hypermedia graphics, content, and language) interact and play crucial roles in the determination of adaptability and flexibility traits for the learner. Statistical analyses have been applied to two different levels in our context: 1. the institutional plane (schools surveyed in our region to obtain information on teaching and learning traits); 2. the language and discourse stage (by means of textbook material and oral corpora).

Key characteristics appear in the early age learning environment in terms of pedagogical traits and graphical priorities, specified for the orientation of verbal and non-verbal elements in the AHS. Other means, such as textbook material, corpus data, and children's preferences, have also lead to setting up the type of content and visual displays established. Data analysis, by providing such significant findings, allow for consecutive contrastive studies of graphical and content items, interaction preferences, main skills to develop, etc. During the design of the SHAIEX lessons, all the verbal / non-verbal features must be kept in mind and followed as directly as possible. The nexus in the design is essentially software suitability, a fact stated by teachers as one of the main concerns. This issue involves not only flexibility on the part of the tool (i.e., ease of use, attractiveness, etc), but also adaptability, which means that the system has to adapt to learners' pace and manner of learning.

In general, the layout and arrangement of the lessons should awake interest and even increase motivation, according to the results and answers by learners. Verbal content (i.e., vocabulary, dialogues, topics, concepts, etc) should activate a large amount of positive reactions; likewise, in the graphical layout, there are some aspects of the setting and design features that can and should be consistently reviewed to be improved for pedagogical purposes.

2. Interface design

In hypermedia systems, the term usability refers to the degree in which the interface allows the user to navigate and interact with the content in the most appropriate way. Thus, when we talk about graphic usability we mean both the degree of ease in navigation and the user interaction with the interface; in other words, we refer to the visual elements which compose the graphic design as a whole. However, the term usability is a much broader concept that includes, not only interactivity and navigation, but also all the forms of presentation of hypertext data, the tools for their comprehension, the type of technologies used and the like.

2.1 Graphic design to get usability in hypermedia systems for 3 to 6-year-old children

The interdisciplinary approach of this area as a main communicative function with specific
creative aspects, make graphic design the primary focus of every project as images are the meeting point for both the user and the content. Nowadays, this perspective gains new importance since the image (or better yet, “the good image”) assures drawing the attention of its audience while it communicates via the wealth of visual information it offers.

If, in addition to this, the user of a system is a 3 to 6-year-old child, the design will be one of the main elements of software development. Images are essential due to the fact that they make up virtually the sole source of visual communication with such young learners, as evidently, text is reserved for later on in order to be functional. Usability is closer to hypermedia systems and, more specifically, to the adaptation of the user model. The designer must carefully guarantee an effective communication in terms of the design of easy reading and comprehension of the content as well as the characterization of an intuitive interface. In this sense, usability can be measured both by its functional utility and by its design style, being this concept even more crucial when the users are young learners (see Figure 1).

Children are a heterogeneous group different from the average user type, with different interests, needs and cognitive abilities. We might also take into account that at their age gender differences and the use of new technologies are greater than ever. [8]

The innovative learning space has become a computer screen where information is presented in a whole new format containing images, multimedia elements, form, colour, movement, sound, and so on. The child can learn in a non-sequential way by navigating through the various options of information and interacting with the elements that appear on the screen which merely suggest rather than oblige taking established paths leading to the fulfilment of previous objectives. Therefore, the designer should create a system tailored to this type of user, and the teacher - tutor will determine whether the system is easy to use and adjusted to the pre-established purposes of the pre-school curriculum.

Interface design must be effective, intuitive and easy, and the resources and tools used should serve to facilitate specific functions with the least possible number of steps. Graphical intuitive systems reduce effort and motivate the user, developing the child’s positive attitude towards interaction and navigation, but the functional aspect is not what determines the preferences of this kind of user. It is decidedly the offer of an attractive design and a familiar interface that which motivate the youngster and sparks, keeps and drives his/her interest and curiosity.

As the system we are designing focuses on educational purposes, the environment is determined by this objective. Therefore, the navigation elements should be intuitive, simple, and of an optimal size for the motor capabilities of the child. The number of steps involved should be kept to a minimum to facilitate navigation in the system. In this sense, the system underwent changes in shape and size from the initial proposals designed. The problem spots detected in
test runs with small children caused us to rethink certain navigation elements and strive for improvement.

2.2 Characters
Due to the importance of the characters in the design of preschool software, mainly because “these represent pattern, motivations and real users behaviour, by means of a descriptive narration” [6], we carried out a field test where children directly participated as character evaluators. The methodology consisted in locating a sample group of children in the age bracket under research with the express purpose of selecting the most attractive characters from the point of view of this selected group. Taking into account among the children’s characteristics, they have limited abilities in figuratively defining a character, we directly offered them five drawings of possible characterizations from which we requested they choose just one, and subsequently participate in its visual development by colouring. Those who turned out to be the most popular among the children would then be the main characters starring in SHAIEX. In order of preference the children’s favourites were: a snake, a turtle and an elephant (Figure 2). This cooperative creation methodology with the potential user seemed to be successful as well as useful so it was determined that it would also be used in the forthcoming occasions in which decision-making was imminent. Specifically, before christening the animated characters, we once again turned to a field experiment with representative members of the target age group to help us select their names.

2.3 Colour, shape and movement
The use of colour serves multiple purposes, the first of which is to guide the child with intuitive perception as semantic or abstract psychological clues are of little or no assistance at these ages. Another context in which colour will be extremely helpful is in guiding the child’s actions in order to facilitate his/her interaction with user interface. In addition, bright colours will outline objects by making them stand out. In this sense, colour cannot be considered an autonomous element by itself, rather it defines the characters and the objects that compose the graphic environment, which combined with other elements, will function to facilitate the child’s interaction. With this integration perspective of combining audio-visual elements in mind, the

Figure 2. Children favourite drawings.

Figure 3. Presentation of SHAIEX.
designer includes movement and sound when building the interface. Movement as is obvious provides actions as does sound for verbal expression. Finally, shape, colour, movement and sound should be adequate to the receptive profile of the age group under study. Graphic design for a child in today’s modern society means designing for a visually literate youngster. In SHAIEX (Figure 3), graphical design is esteemed to be a major communicative tool, not only for the transmission visual knowledge, but also as an important part of the final outcome for use of the system.

2.4 Graphic environment
The graphic environment (i.e. the scenery where the actions and interactions take place) should promote the children’s concentration on content for learning, but at the same time avoid boredom, a specific potential setback considering young learner’s attention spans. In this sense, the adequate balance was a challenge to determine. The graphical design should be a visual call attractive enough for the child, but without being too ornamental to avoid visual confusions in aspects of use and function.

Within this phase, it was necessary to start the graphical structuring of the system. It is in this phase where the development and the computer system design play a leading role. Visualization of the hypermedia adaptive system is not an easy task, mainly because the paths are not previously known as givens. In other words, it is the user who decides or, in this case, language level and cognitive abilities that actually determine the tasks and levels of advancement. Within the cognitive abilities at this age, imagination plays a major part, as does being good at associating learning situations with situations in real life. In this sense, metaphoric proposals should be carefully introduced only in higher levels of progression since at lower stages children tend to expect that all the objects present possess the same proprieties as their real-life counterparts.

3. Tasks and games
We have devised a set of hypermedia games[4] which can be adapted to the children’s level of knowledge and interaction skills. Having distinguished three educational levels according to Pre-school curricula, the contents and the type of interaction of such adaptive tasks will adapt as the child progresses along. By way of example, we will illustrate some adaptive activities in SHAIEx such as Choose, Body Identification, Stickers, Counting, Matching, Coloring, to mention a few in this section. These games are configurable and adaptable to the difficulty, interaction style and educational level corresponding to a particular child.

In the “Choose” activity (Figure 4), several objects inside floating bubbles (characters, things, animals and so on) appear on the screen. As the child listens to the name of an object, she/he is to select it according to the sound that he/she heard.

![Figure 4. Choose activity](image)

In the “body identification” activity (Figure 5) on the left of the scene a character appears with several parts of its body blocked out by grey holes. On the right, the child can easily identify the parts of the body to put in the appropriate spots. A sound clue determines which part of the body is to be dealt with first.
In the “stickers activity” (Figure 6) the child should position the objects in the corresponding silhouettes somewhat similar to doing a puzzle.

In the “counting” activity (Figure 7) the student is to count the objects that appear on the screen. A sound determines the type of object that he/she must count.

In the “matching” activity (Figure 8) the children are to find all the matching pairs of objects (real characters, things, animals etc. and their adaptive design counterparts).
In the "coloring" activity (Figure 9) a blank canvas appears on a painter’s easel with a rainbow palette of colors. The child clicks on a part of the body of his/her choice and listens to a color produced by the audio clue. The expected response is for the child to choose that color from the palette and color in the part of the body on the portrait.

Figure 9. Coloring activity

When the child makes a mistake or gets an option right in the games positive or negative feedback is received. Reinforcement of correct answers is manifested by a colorful splash of confetti, while negative responses the playful explosion of a smashed tomato (Figure 10). Feedback from the games has a dual purpose: to motivate and capture the child’s attention.

Figure 10. Top: Positive feedback, Bottom: Negative Feedback in SHAIEx games.

Conclusions
Most of the adaptive systems base their user interface in textual information because they are addressed to adult users. In our case, the users are children (3 to 5 years). At this early age, children have not reading and/or writing skills, so the multimedia content plays a leading role and adapting it to the user’s characteristics is pedagogically beneficial.

References

