Multimedia games for fun and learning English in preschool

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Abstract

Based on the assumption that educational software addressing Primary school learners must comprise a set of features to encourage children's creativity and development, the appropriate design of second language hypermedia adaptive games for Primary School children can pose a wide range of challenges both for the language teacher and computer specialist alike. Factors such as the educational context, cognitive abilities, linguistic constraints, conceptual and psychomotor restrictions, and so on, contribute to challenging professionals. This means they must deal with linguistic, content and technology adaptation queries.

Based on the results from multi-factorial analysis, this paper aims firstly to demonstrate that the design of hypermedia tasks can be optimally implemented by following previous phases of data collection on preferred items. In this sense, the questioning approach for the creation of a hypermedia system has led us to analyze learning factors in order to deal with the possible linguistic, conceptual and technological demands in the children's learning environment. General results in the preliminary phases of the study show the need to steer the learning path towards an effective adaptation to children's cognitive abilities. These are the findings from which we have devised a set of hypermedia tasks which provide the adaptation of the information presented to the student according to individual objectives, interests and/or knowledge.

Keywords

adaptive hypermedia systems, CALL, web-based systems, preschool and ICT

I. Introduction

Computer technology is being widely used for teaching a foreign language at all types of levels and settings (Stockwell, 2012). The key factor sought in the classroom is effectiveness in the use of resources, a search which can be especially intricate and yet rewarding in the case of young learners (Edwards, Pemberton, Knight, & Monaghan, 2002; Plowman, Stevenson, Stephen, & McPake, 2012). We believe that for very young learners, a possible solution should be input management by means of adaptive hypermedia systems (AHS), conceived and designed according to specific early age language learning needs, demands, and abilities (Prentzas, 2012).
This paper aims to present some significant data in the light of the claims above, in particular, the development of a tutoring system and games focused on teaching and researching foreign language learning at an early age. Designed under the auspices of a regional research project, our work (Agudo, Sánchez, & Rico, 2006) is applied to 3-6 year-old children whose foreign language learning development includes IT as a prime teaching tool.
To reach the objectives, the paper is divided into four general sections and starts out with a brief introduction to the combination of ICT (Information and Communication Technology) and foreign language learning in childhood settings. This section is followed by data collection through an analysis of the factors involved. Then, the design of hypermedia tasks appropriate for primary school children are dealt with, describing the architecture of the system, and the platform which contains and personalizes both the content and the interface, adapting them to each student's needs. Finally, the conclusions drawn from the information interaction found and the lines opened for further research are presented.

II. Multifactorial analysis

There is a growing agreement about the many different ways that ICT can contribute to changing the types of the activities, roles and relationships experienced by children. In this sense, the appropriate uses of ICT in early childhood education settings could be based on the minor pressure to meet educational targets and the suitability to experiment and apply children-centred practices (Liang, Yuan, & He, 2009).

Many are the possibilities by which ICT can be part of early childhood education, either by the integration of technology into children's learning process and fun -using ICT in their play or learning - or by using ICT to monitor, plan and manage children's learning -building portfolios of children's work for evaluating progress, for exchanging information with other teachers or, parents- (Sylvén & Sundqvist, 2012; Turgut & İrgin, 2009).

All planning for the introduction and use of ICT in early childhood education should be grounded in a clear understanding of the purposes, practices and social environments. In this sense, children's needs should be found and the uses of everyday technology identified, so that young learners can have fruitful chances to use ICT as a support of their learning and entertainment (Verdugo & Belmonte, 2007).

There are studies which support the need for educators to have well-developed understandings of the potential of ICT (e.g. O'Hara, 2004; O'Rourke & Harrison, 2004; Patterson, 2004), while there are other authors who claim that children's experience (or lack of experience) with ICT at home

and with their parents involvement is an important factor in planning for the use of ICT at early ages (Brooker & Siraj-Blatchford, 2002; Downes, 2002; Lee, Hatherly, & Ramsey, 2012).
On the other hand, other contextual factors to explain the lack of ICT use in early childhood education could include: teachers' limited training, insufficient equipment, absence of technical support or a lack of time to develop ICT-integrated teaching or learning activities (O'Hara, 2004).
Under any of these circumstances, an approach which could describe how children's interactions with computers and other forms of ICT takes place lies in the concept of guided interaction, a guidance supported by teachers and parents by face-to-face interactions and/or by the visual and verbal instructions provided by the computer itself (Durham, Farkas, Hammer, Bruce Tomblin, & Catts, 2007; Garrett & Young, 2009; Gjems, 2013).

Likewise, the concept of task and game performance in pre-school settings should be focused more on the process of learning than on the successful achievement of content. Most of preschool programs are characterized by raising awareness and are designed as a foundation on which more complex skills depend- e.g. recognizing symbols which will help them read, physical development allowing children to perform more complicated movements, adaptive computer interactions which will let them develop more complex functions, developments which will prepare children to deal successfully with the challenges of further school and everyday tasks (Aghlara & Tamjid, 2011; Sylvén & Sundqvist, 2012).

If one of the most critical steps of language learning at early ages is the process of picking out and recognizing words, sounds and basic structures of a language (Burchinal, Field, López, Howes, & Pianta, 2012; Ekizoglu & Ekizoglu, 2011; Sun & Dong, 2004), our adaptive set of games could make children part of an enriched multimedia environment in which the acquisition of these language components are encouraged by:

- Engaging children in vocabulary, key sentences and short conversation repetitions, which will help young learners to read, to recount a story and interact with others, important aspect of oral language development (Korat, 2010).

- Playing in a hypermedia context for children's language development. The adaptive games which will help children try out new ways of combining thought and language (Cumbreño, Rico, Curado, & Domínguez, 2006).

- Scaffolding. Children's language is enhanced when adults, older children or in our case computer games scaffold their play, making them bear in mind their roles. (Linklater, O'Connor, & Palardy, 2009).

- Interactions with multimedia environments -symbols, shapes, sounds, colors and even letters- are powerful in forming understandings about their daily life and world around them (Griva, Semoglou, & Geladari, 2010).

- Creating phonological awareness through hearing and thinking about the language itself can help children learn to read. When children are able to map the sounds of speech onto the letters they become aware that continuous speech is broken down into discrete sounds (Seker, Girgin, & Akamca, 2012).

- Development of language fluency can be based on the game instructions, the continuous interactions and the opportunities to engage children in spelling activities (Kleemans, Segers, & Verhoeven, 2011).

- Listening to short stories (and reading when older than 6) depends on vocabulary and general knowledge, skills which can be developed through the completion of the computer games. While oral comprehension may develop "naturally," reading requires instruction. It is a process in which multimedia can play a leading factor (Verdugo & Belmonte, 2007).

a. Computer within the preschool classroom

According to research experts (S. W. Haugland, 2000; Stephen & Plowman, 2008; Plowman, Stevenson, Mcpake, Stephen, & Adey, 2011), claims are made to the effect that computers should be physically introduced in kindergarten and primary level classrooms in a coherently integrated fashion with the rest of the learning resources. Opposed to the creation of separate computer rooms removed from the habitual learning area of the children, the recommendable student /computer ratio, (S. W. Haugland, 2000), maintains the suitability of students' corners, having one computer for every seven pupils, at most.

Thus, classrooms for early ages must be organized in such a way as to globally enhance knowledge-building, and specific methodological proposals of classroom organization can include activity corners that promote cooperation by means of tools like digital boards and computer stations. Furthermore, in this kind of atmosphere it seems that children activate their cognitive strategies, observe each other, play an active role in the learning process, explore and experiment with everything around them, exercise memory, develop motor skills, and so on. An added bonus is that collaborative work could also encourage the most advanced learners to behave as helpful peer-tutors of those who are not quite as adept.

b. Software at early ages

According to Haugland (2000), the appropriate use of computers, as well as the educational software implemented, may increase creativity and even self esteem in children. He also claims that children, exposed to software that tends to boost their development, may successfully increase their intelligence, verbal and non verbal skills, visual and movement-related abilities, structural knowledge, long-term memory, problem-solving and decision-making abilities, as well as abstraction and conceptual formation skills. On the contrary, the uncontrolled use of ICTs in the classroom could have a negative impact on children, causing possible rejection or frustration.

Haugland (1997:134) devises a ten criteria scale to determine whether young learner software could foster effective learning and claims if obtaining a score of 7 or higher such software may be considered suitable for the child's educational integration. Criteria could be summarized as follow: (1) adaptation to learner's age, (2) ability of child to pay attention and be able to control the process, (3) clear instructions, (4) progress of difficulty levels, (5) self-access and work possibilities for child, (6) non-violent content, (7) orientation on learning process, (8) capability in program for real world modeling, (9) technical features in the program, and (10) capability of program to undergone adaptation and further developments.

However we think that using educational software based on high quality rates does not necessarily guarantee success in the classroom. Our claim is that the optimal assessment of a learning application is actually made by the teacher within the classroom.

As for the content presented, educational software must be open and invite exploration in order to increase the child's creativity as well as enhance motivation, commitment and curiosity. At this level, in which children do not yet have sophisticated reading and/or writing skills, the auditory presentation of instructions plays a leading role. For these reasons, all activities, the interface, software structure, vocabulary, and all the other ingredients must be tailored to the age of the potential users of the product. Scaffolding, the hierarchical building of sequential activities, is another key element for calibrated involvement through computer support. Scaffolding could enable young students to reach objectives and educational goals, and make children progressively integrate into the social environment, promote their autonomy, and build new competencies in an expedient fashion.

c. Children and computer interaction

Of special interest in our analysis is the question of dexterity with the computer mouse and interaction with the computer itself. Children's motor abilities, as we know, develop over time. For this reason they may encounter difficulties in controlling the input device chosen, have trouble selecting specific areas on the computer screen within the application, find holding down buttons on the mouse too hard at first, need development in skills like pressing keys on the keyboard, and so on.

Input options must be efficient and easy to operate in order to create a user-friendly environment. The device selected for interaction with the system is the mouse since it seems to be the most efficient device for this age (Wood et al., 2004). As children are learning to use the mouse and considering that one click, for example, is easier than dragging, drag and drop or double-click, operations like double click or drag and drop require repetition and extended practice. In other words, we need to adapt the use of the mouse in the activities and games to the dexterity children possess.

Thus, according to our in-class research, we can state that.

1. Children should be able to interact with the mouse as easily as possible, as a simple interface usually becomes more accessible. They can manage one-click actions better than dragging, drag-and-drop, and double-click actions. Consequently, the lowest stages should have more operations such as click, and point and click. Nonetheless, at this lower level, more difficult interaction types such as dragging and double click (albeit being deferred to higher levels) can be conveniently adapted, e.g., by clicking on the object to attach it to the pointer (click-move), and clicking again to drop it at the desired location (click-move-click).

2. Considering young learners have problems selecting small areas on the screen, objects should be large enough and clearly distinguished. The same criteria should be applied to navigation buttons which, in addition, should have the same or very similar functionality for younger users.

d. Cognition, mental development and L2 acquisition at early ages

Although a number of child developmental theories have been used in the literature to speculate whether (or how) the computer would affect very young learners, either positively or negatively, (Brady & Hill, 1984; Elkind, 1987; Clements, Nastasi, & Swaminathan, 1993; Schetz & Stremmel, 1994), most of recent studies conclude that the adequate use of ICTs at these ages can improve children development (Plowman & Stephen, 2005; Clarke, 2006; Stephen & Plowman, 2008; Mangen, 2010; Anders et al., 2012; O'Hara, 2011; Peng, 2012; Plowman et al., 2012).

As stated, young learners have difficulties in understanding abstract concepts since they have not yet acquired most of the basic knowledge required for complex conceptualization and intricate information. They in turn, understand visual icons and relate to recognizable items which help them to extend knowledge and meaning. Within cognitive abilities at this age, imagination is instrumental and plays a leading role. Children are clever at associating learning situations with situations in real life, a quality which can be exploited for learning purposes. In this sense, most metaphoric proposals should be reserved for higher levels, since at lower stages children tend to expect all the objects to present the same proprieties as their real-life counterparts which does not mean that abstract content must be altogether omitted. In essence, the principle rule of design for content and levels of difficulty is that the software be fully adapted to children's features and cognitive abilities.

III. Data collection for user modelling and content

a. Contextual research

It is necessary to examine some of the learning variables involved in the creation of digital tasks, a questioning process which recommends quantitative analysis in order to study the influential factors at this level. For that purpose, initial research thorough questionnaires has been conducted in all the Primary centres in Extremadura (south-western Spain). This exploratory approach includes a set of questions regarding the number of students and teachers per class, hours per week dedicated to the teaching of English, the material and skills being practised in class and the like.

The first questionnaire was answered on-line by most teachers though it was also handed out in schools in paper form. The main information relevant to our study from this questionnaire is summarized as follows:

1. There is an average of 71 primary students per school and 17 students in the English classes.
2. 38 percent of the teachers using English in class do not have a specific degree in English.
3. The average time dedicated to English per week is one hour and 15 minutes.
4. More than 50 percent of the schools offer English as an extra-curricular activity in afternoon / evening classes.

5. As a result of regional governmental policies and funding encouraging computer literacy, starting in Pre-School on up, our community, Extremadura, has become a leader in Europe with regard to implanting ICTs at this early level.

6. Likewise, one of the main purposes was to find out exactly what kinds of resources were being used in the early language learning classrooms in Extremadura. In addition to the traditional resources used and measured by percentage from left to right in Figure 1 books, audio material, and flashcards, the use of computers reaches a 42% in the foreign language classroom of primary schools.

7.

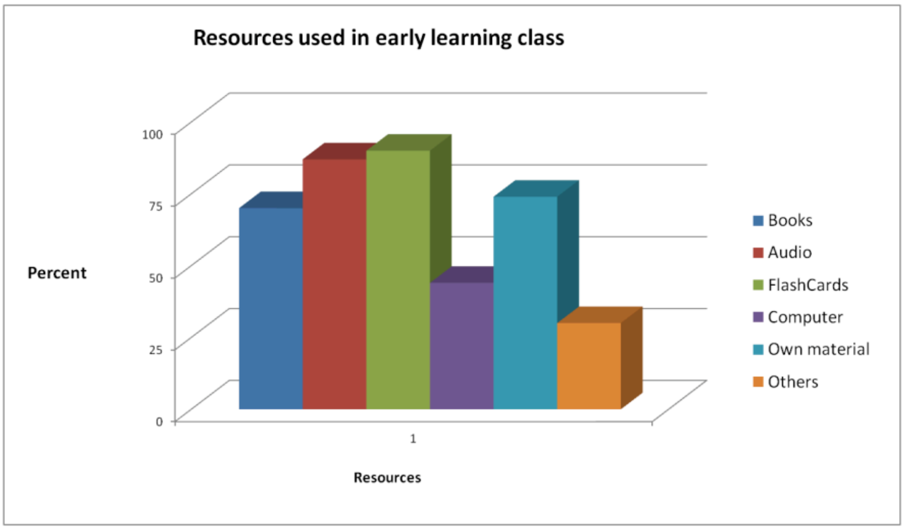

Figure 1. ICTs in Early Learning classes

In this sense and though almost 50 percent of the English teachers use computers in class as either a supporting tool or for games, more than 60 percent of the teachers recognise a demand for software that adapts to the students' levels and age.

b. Pedagogic domain

For the development of the pedagogic domain (nodes of information, content and links), the design of the hypermedia proposal is based on four main sources: (1) the European Portfolio for pre-school education (http://www.edupa.uva.es/portfolio/); (2) regional and national legislation regulating the implementation of English teaching in pre-school; (3) questionnaires and surveys on the teachers' observations of classroom preferences and curricular interests in the preschool classroom and (4) corpus-based linguistic information.

The European Portfolio of Languages (ELP) is a customized document designed to foster the recording of foreign language learners' individualized experiences with the learning process. The ELP proposes activities and tasks to be developed both in the classroom and at home so that children may become familiarized with the languages that surround them and begin to acquire specific content and skills. The ELP establishes learning marks by means of positioning specific skills that the child should have according to the levels.

As we said, the development of the hypermedia-tasks is also based on regional and national contexts. On 21 August 2001, the Council of Education, Science and Technology of the regional government (Junta de Extremadura), published an order regulating the implementation of English teaching in pre-school, becoming a part of the 2003/2004 curriculum for children aged 3 to 6 years old. Moreover, Royal Decree 829/2003 (LOCE, 2003) established as its second core objective (article 3) the need to foster foreign language learning in combination with educational technologies during children's early school years for the same age group:

Educational institutions shall foster the integration of a foreign language during Elementary and Pre-elementary stages of schooling, especially during the last year, and shall enhance the early use and application of Information and Communication. (personal translation)

In addition to the theoretical foundations derived from the educative legislation, questionnaires and surveys conducted at the schools informed us about preferences and interests regarding skills and micro-skills to be exploited with the learners (the main finding are shown in Figure 2).

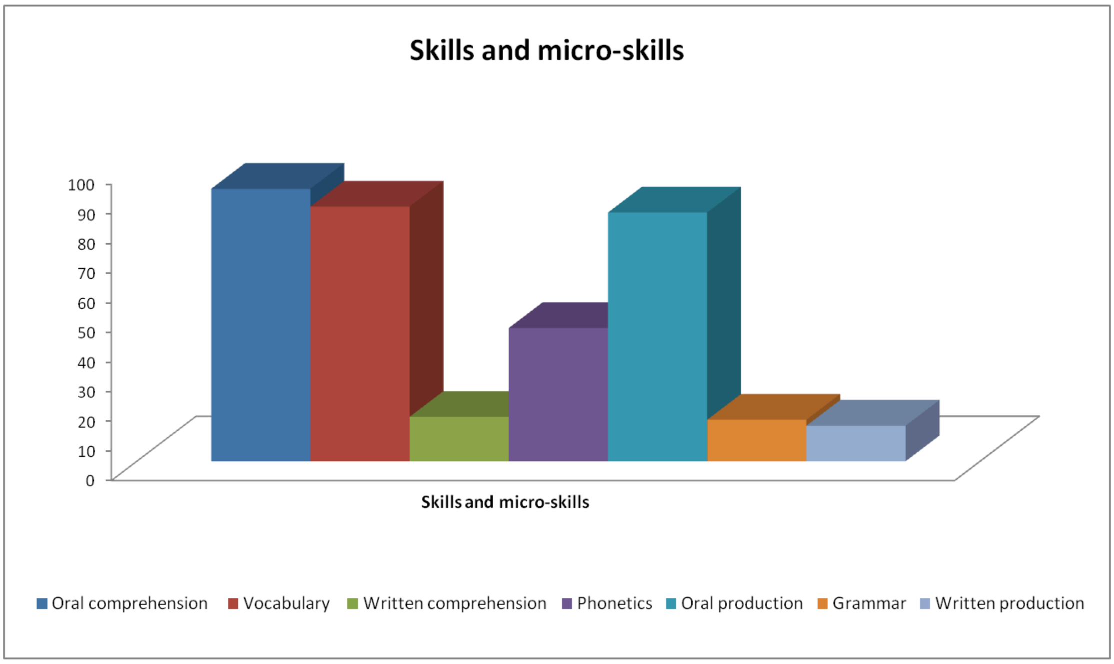

Figure 2. Skills and micro-skills for Preschool Children

As observed in Figure 2, oral comprehension and oral production are regarded as especially significant and thus emphasized in class. Vocabulary is also practised quite often by means of songs and inductive games. However, written production and comprehension are not valued as important at these early stages.

Finally, with the aim of establishing clear criteria and objectives for the empirical observation of real child communication, we integrated linguistic-communicative information based on selected transcripts from the CHILDES corpus (Child Language Data Exchange System), freely available on the web (http://childes.psy.cmu.edu/). As an illustration of our research, the use of singular first and second person pronouns by three and four year olds is noteworthy according to the statistical analysis of the corpus. In addition, there are a large number of nouns (nominalizations) in five year olds by comparison with other age categories. In contrast, in the case of English speaking children in USA, the first person pronoun is used more at three and four years of age, whereas at later stages, this use decreases substantially.

In the analysis of the Table 1 we show how the contrastive view and itemization of such linguistic-communicative data between the terms and concepts introduced in our tasks and the frequency that appears in CHILDES, helped us in the design of the lessons.

Word	yes/no	Frequency
Head	Yes	179
Shoulder	Yes	695
Leg	Yes	552
Foot	Yes	506
Body	Yes	663
Hand	Yes	132
Look	Yes	134
Face	Yes	651
Mouth	Yes	307
One	Yes	865
Two	Yes	84
Three	Yes	146
Four	Yes	178
Five	Yes	110
Six	Yes	172
Seven	Yes	185
Eight	Yes	285
Nine	Yes	169
Long	Yes	223
Big	Yes	109
Blue	Yes	535
Red	Yes	397

Table 1. CHILDES: contrastive study

An interesting conclusion, after the quantitative analyses of legislation, questionnaires and oral transcripts, is the sequencing of topics tends to be fixed across the curricula from ages three to six. From all this information, seven didactic units are established, shaping the pedagogic domain in our hypermedia system: unit 1 Hello, unit 2 The body, unit 3 The family, unit 4 Toys, unit 5 Food, unit 6 The house, unit 7 The school.

Thus, with the information requested, we aim to elaborate charts of specific content and lessons to be programmed interactively depending on the type of learner to whom the unit is addressed (three, four, or five years old). Table 2 shows the content information that teachers answered regarding each unit that they deal with according to the different age levels.

Concepts	**3**	**4**	**5**
Colours			
Greetings and introductions			
Numbers			
Sizes and shapes			
The weather			
Feelings (love, hate …) and likes **-** (I like/ I don't like)			
Specific Vocabulary of unit			
Simple descriptions of objects, people ...			
Space /time orientation (up, down, near ...)			
Actions (read, jump, run)			
Relatives (family, friends)			
Sensations, states of mind (happy, bored, I am cold…)			
Daily routines (wash one's hands, have breakfast…) and parts of the day			
Linguistic content			
Like/ Dislike			
Prepositions			
Commands (Imperative) - Let's			
To be			

It is …			
Are you ….?			
To have			
Personal and possessive pronouns			
Can/Could - Would you like …			
Adjectives - Comparative and superlative			
These is/are			
Do/does - Yes/no questions			
Wh/ open questions - Interrogative pronouns			
Vowels			

Table 2: Content exploited according to age levels

IV. Adaptative games for primary school children

a. Arquitecture

The architecture (Agudo, Sánchez, Rico & Domínguez, 2007:3850; Agudo, Sánchez, & Rico, 2010) is divided into three different levels:

- The user interface executed by the user in the navigator.
- The Intelligent Server for the Adaptive Selection of Educational Tasks (SISATE – Servidor Inteligente para la Selección Adaptiva de Tareas Educativas) which are executed in the Server.
- The resource stockroom which holds the user data, the contents of the tasks, and the tasks themselves with their corresponding rules.

The user interface shows the learner the adaptive activities and scenes, as well as supplying the means of navigation through the contents. The intelligent Server makes the decisions on which particular tasks are those which are adequate for the individual user by calculating his/her characteristics. Furthermore, it completes the job of storing the learner's progress.

Last but not least, the resource stockroom is a database, which as its name suggests, stores all the data necessary for the correct functioning of the system, which includes user reference data, the content of the teaching units of the pedagogical domain, and the tasks and rules which will ultimately determine the content that will be visualized by each learner.

Communication on the part of the client and on the part of the Server (Figure 3) is reached via XML documents generated on the Server side in order to indicate on the client side the task which should be shown and which contents should be selected in order to build them, while the user interface takes charge of the actual construction. Once the client has finished the task, he/she will return it to the Server in another XML file, however, it should be noted that in this case, it will contain the results obtained by the learner regarding the task realization. Meanwhile the intelligent Server will fulfill the job of storing it in the user model.

This kind of architecture allows for the reuse of the intelligent Server for any type of adaptive application, since it only requires implementation of the XML communication protocol between the client and the Server in order to avail itself of the SISATE features which supply the adaptation, once again, based on the system's tasks and rules.

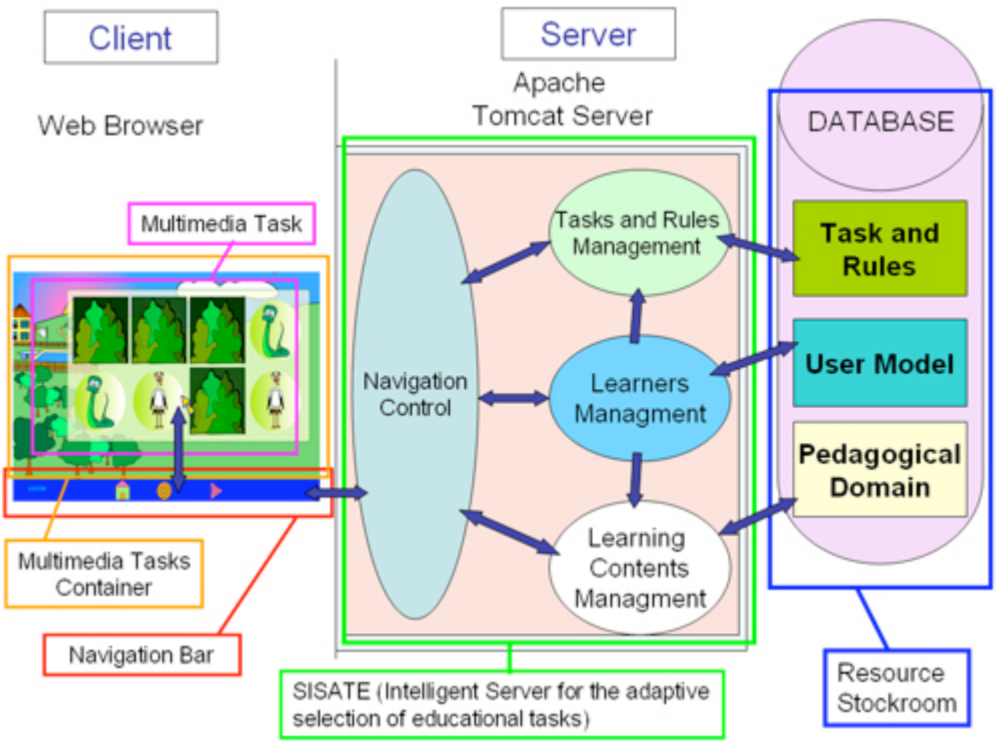

Figure 3. The architecture of SHAIEx (Agudo, Sánchez, & Rico, 2010)

i. User interface

The user interface is implemented in Macromedia Flash and is executed in the navigator belonging to the last user. It is divided into two main parts referred to as the navigation bar and, the container of the multimedia tasks.

The navigation bar consists of three buttons which permit user navigation through the contents offered. Its design has been carefully analyzed in order to adjust to the needs of very young learners. It searches for an interface which facilitates an intuitive as well as a simple navigation through the contents in order to avoid problems arising from the limited physical development in this age group. The image of the tiny house (the button on the extreme left) allows the child to go back home, that is, to the main menu of the application. This option is always available to facilitate a return to the beginning should the child feel the desire to do so. The full spiral circle (the button in the centre) goes around and around allowing for the repetition of the current tasks simply because the child has found it to be attractive, or just because he/she needs to do it again. Lastly, the directional triangle (the button on the far right) pointing towards the right is used to move onwards and advance in that particular activity.

We can visualize an identification type LxUyTz on the screen to the extreme left of the buttons themselves. Here, Lx indicates the level of the current user, wherein Uy stands for the learning unit in which the student is currently working, while Tz represents the activity which is on display at the current moment. At this age level this information is of little or no interest to the child, but rather it serves as ID which facilitates an easy reference for the teacher to improve on errors and locate where exactly the learner is stuck if help is solicited. On the other hand, the buttons displayed on the right identify the user of the application by means of a photo or drawing.

The container of the multimedia tasks completes the mission of showing the educational tasks, be it in scenes or be it in activities according to the information received in the intelligent Server by means of the navigation bar. The container dynamically builds the tasks with the content adapted to the user and thus, makes it visible to him or her.

The navigation bar is in charge of communicating with the intelligent Server, which in turn sends back the task to be visualized. When dealing specifically with a task, the navigation bar informs the multimedia task container which task it should show as well as its contents. When several tasks should be returned, the navigation bar dynamically builds a menu with the possible tasks to be done, and, informs the container of those multimedia tasks to be shown.

Intelligent Server for the adaptive selection of educational tasks.

SISATE is the true core of the SHAIEx platform as it is responsible for deciding the most adequate task for each individual user at any given moment of the learning process. For the purposes of implementation the Apache Tomcat Server has been utilized for the development of a series of Servlets which apply the required functions. SISATE consists of four main components, namely, navigation control, tasks and rules management, user management system, and learning contents management.

Firstly, the role played by navigation control is that of communication between the intelligent Server and the user interface. Fundamentally, it transfers the interface calls to various administrators, and it formats the information received so as to return it to the client side.

Secondly, the tasks and rules management system is in charge of running through the dynamic structure of the corresponding tasks to each user by means of teaching learning rules which determine the most appropriate path for the student to follow.

Thirdly, the user management system handles the data corresponding to the user model of each student and keeps the aforementioned data up to date regarding student progress.

Fourthly, the content management is fed by what is contained in the pedagogical domain in order to determine what contents are the most appropriate ones within the tasks or scenes in adapting to the user's features.

Based on the previously outlined premises, the work process of SHAIEx can be expressed in the following terms: Once the user has been recognized by the system, the navigation bar solicits the next task from SISATE through navigation control, which communicates with the tasks and rules management, which in turn indicates the task which corresponds to each learner. At this point the system determines the corresponding tasks and rules by consulting the teaching database of the same name, and through the user management system, the student user model. Having established the corresponding tasks, all this information is returned to navigation control, although we reiterate that under those circumstances when several tasks are being dealt with, the information is returned to the navigation bar.

The information itself is returned by means of an XML file which stores the task list along with a reduced amount of information on each task so that a menu can be built in the user interface which allows for selection of the desired activity. The menu can be visualized in the multimedia container and the user can choose one of the many possible tasks offered there. Choosing a task makes the navigation bar resume communication with the navigation control system to request full information regarding that particular activity. Given this situation, as we are already aware of the activity we are to show, the learning contents management is directly consulted on what is contained in the task in question. The contents of the task are determined by the learning contents management, by the task itself and by the user model obtained from the learner's management system. Thus, the information on these task contents are returned to navigation control which returns an XML file with all of the information surrounding that particular activity as follows: configuration, content, and blocks of content in the case of adaptive activities. The navigation bar receives the information and dynamically builds the adaptive activity with the elements indicated, and finally, provides for its visualization in the multimedia task container.

When the tasks and rules management is consulted, one sole task is returned. Instead of only returning the information relative to that task, the navigation control system consults the contents management system of all the task associate content (animations, graphs and sounds). Afterwards, this contents management consults the pedagogical domain for all the necessary information to directly build the task. Furthermore, the information in the XML file is sent to the navigation bar, which in turn, dynamically builds the adaptive scene or activity in order to show it by means of the multimedia task container.

Resource stockroom

The intelligent Server needs to store user information, the contents and the structuring through the use of tasks and rules. This information is stored in a database that is divided into what are referred to as the pedagogical domain, tasks and rules, and, the user model.

Within the pedagogical domain the contents of every task and scene are stored in the form of animations, graphs and sounds. The aforementioned contents are grouped in blocks that associate the content which refers to each concept relative to the various activities and levels.

The structure of the adaptive course is stored in the section on tasks and rules by means of a description of the activities which make it up, and those rules that determine which tasks will be shown to each user type. The intelligent Server is based on a user model in order to determine what teaching rules are to be applied, and therefore, what tasks will be chosen.

Finally, the user model stores all the necessary user information required for realization of the adaptation and follow up of student activity in the platform. As a result of this follow up, the tutor establishes when to update the user model with the express purpose of moving the learner up to the next educational level.

The database additionally sees to it that all the necessary information is stored for the system administration. Therefore the information as regards teachers, educational centers and classrooms is stored, assuring the correct functioning of the platform.

b. Adaptation

Our system (Agudo, Sánchez, & Rico, 2006) provides adaptation of the information presented to the student according to the following specific user features:

- Educational level: Based on the curriculum for pre-school education.
- Knowledge: Contents adapted as the child progresses.
- Dexterity with the mouse: Adaptation of the mouse interaction style in those activities and games relevant to the actual dexterity preschoolers possess in order for them to be able to handle it (Agudo, Sánchez, & Rico, 2010). This feature can be assessed by examining the speed at which children execute the operation, the number of mistakes they make and how comfortable children feel while using the mouse (Donker & Reitsma, 2007).
- Language: We will allow the inclusion of other languages (French, Spanish, etc.) that the children may be learning at school.
- Difficulty of the activities: The complexity of the activities and games will be adapted to the age level.
- Textual information: We may, or may not, include a textual label according to the age level of the target learners.

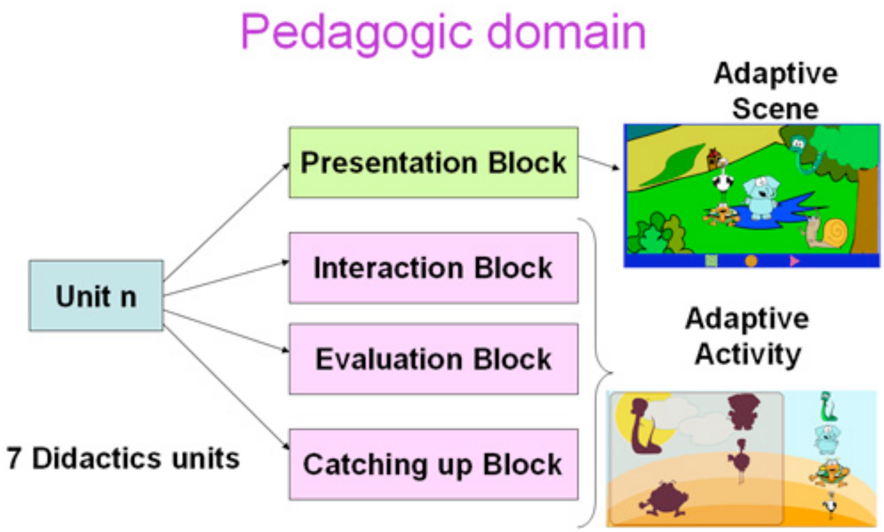

Figure 4. Pedagogic domain structure

These features comprise the set up of the user model which allows for adaptive navigation support, adaptive presentation and adaptive interaction according to the user's features (Brusilovsky, 2001; Durlach & Lesgold, 2012). The children's educational level and their knowledge are both used to provide adaptive navigation support and determine the adequate learning path for the children. For adaptive presentation we use the language, the difficulty of the task, the textual information and also the educational level to be kept in mind when presenting the contents. Lastly, we use dexterity with the mouse to provide adaptive interaction, the activities children will be able to do with click, double click, drag & drop, etc. depending on their motor abilities.

We implement the adaptation through the adaptive scenes, adaptive activities and structural rules (Carro, Pulido, & Rodríguez, 1999). By means of the structural rules we divide the pedagogic domain in didactic units, each of which includes four blocks of activities, namely: presentation, interaction, evaluation and review (Figure 4).

- The first block is aimed at familiarizing learners with word association and vocabulary acquisition by interactive means.
- The second block is designed to consolidate concepts and linguistic content by means of interactive games.
- The third part evaluates acquired knowledge. The teaching blocks are presented to the user in an orderly fashion according to specific teaching rules. So, before accessing the evaluation block, input and interaction blocks should have been previously successfully achieved.
- The fourth block will be presented to the student only when the evaluation block has not been achieved, or alternatively, for revision purposes.

Each block consists of one or more activity scenes (i.e. tasks), which are essentially educational games or animated scenes that the young learner is either to complete o simply observe. These tasks are implemented with adaptive scenes and activities. The adaptive scenes present content according to the educational level of each student and the target language to be learned. As illustrated in figure 2, the sample presentation of unit 2 "The Body" for learning levels 2 and 3, the number of characters differs with respect to the learning level we encounter. Whereas level 2 introduces the stork, turtle, snake and elephant as starting input, level 3 adds the snail and the frog to the cast of actors. As the level increases, so does the complexity of the dialogues with the aim of introducing additional expressions and vocabulary. Continuing with the example shown in Figure 5, the vocabulary of level 2 includes "Head, Body, Leg, Foot, Hand and Shoulder", to consecutively expand to "Face, Mouth, Eyes, Nose and Ears" in level 3.

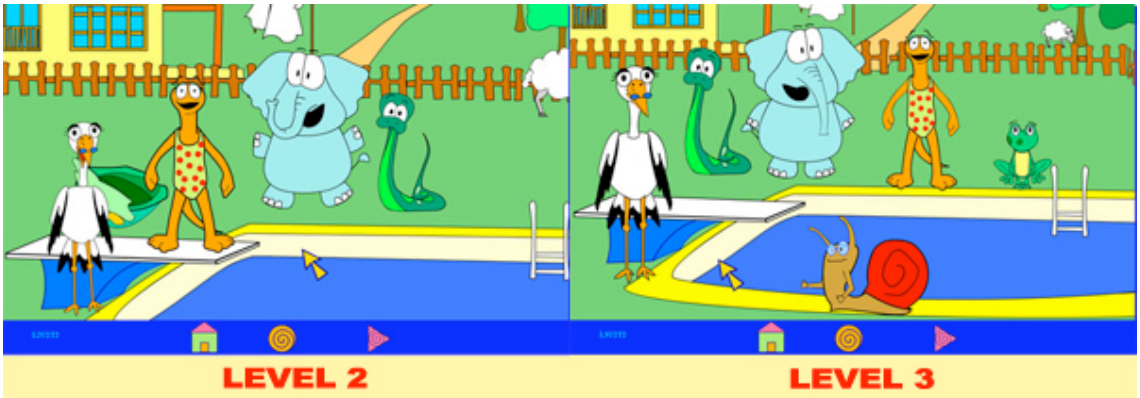

Figure 5. Adaptive scene from SHAIEx.

Immediately following the presentation of the contents, children are allowed to interact with the elements in the scene by clicking on each of them to reinforce vocabulary as well as to encourage their active participation. Finally, to conclude the presentation block, each one of the elements is individually shown as a separate item for a few seconds in order to reinforce the concepts hopefully acquired.

	Level 1	Level 2	Level 3
Mouse interaction style	One Click	Click move click	Drag and drop
Objetives	Identify Characters	Identify Animals	Identify Countries
Number of elements (difficulty)	3	4	5
Language	English	English	English
Text information	No	No	Yes

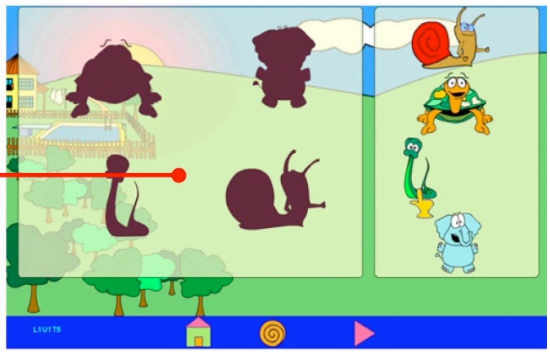

Figure 6. Adaptive activity.

The adaptive activities, on the other hand, take into account the educational level, the interaction level (that is, the interaction with the mouse), and the target language.

It is important to account for the difficulty and the mouse interaction style when adapting the activities to the educational level and psychomotor skills of very young learners. The location of the multimedia elements inside these activities is randomly determined to produce a range of variations. In the activity shown in Figure 6, the child is asked to place the character in the corresponding silhouette after having listened to information and descriptive hints.

Likewise, the adaptation will be carried out according to different parameters such as the number of characters, the audio information related to each character, showing the text information or not, and the mouse interaction style.

The audio attached to each character depends on the language and educational level the child is currently at. To illustrate language level considerations, at level 1 the character's name will be identified; for level two the animal type will be chosen and for level 3 the information to be identified is the character's origin. As is to be expected, the textual information only appears at level 3, due to the target age group. Finally, the way of carrying out the activity for each level of dexterity with the mouse will also be adapted (i.e. one click, click move click, drag and drop).

c. Adaptive Games

For the current version of SHAIEx, we have developed 10 different educational games (Agudo, Sánchez, Holguín & Tello, 2007) and for some of them several versions have been implemented.
As an outline example, in the following subparagraphs we describe the interactive games that appear in the didactic unit "Hello" of the present version of SHAIEx. The block of presentation of this unit also changes based on the selected educational level. Thus, in Level 1, the child listens to the name of the mascots of SHAIEx. In Level 2, in addition to the name, also the kind of animal to which each mascot belongs is listened. Finally, in Level 3, the audio includes the country of origin and the nationality of each character.

For all the games and within each educational level, there can be several levels of difficulty. This adaptation parameter forms the number of elements with which the child will have to interact. On the other hand, only at educational level 3 is the image accompanied by textual information.

V. Final discussions

In general terms, Pre-school education is a particularly interesting area for investigating the use of ICT as it offers opportunities to observe the relationship between in-class and informal learning and, in our case, the suitability of combining learner-adapted games and adult-guided instructions.
Our study also reveals the difficulties of the process –e.g. the challenges of mastering computer interactions at this level, the design of adapted material for childhood settings, the process of language acquisition, etc.- while also showing us why these complexities are mastered naturally by children all over the world, regardless of the language they're learning.

Based on the potential advantages derived from the positive attitude children show towards learning foreign languages, SHAIEx aims to design and develop a web-based educational AHS to enhance language learning at early ages by means of individualized hypermedia tasks and through the potential of its multi-sensorial richness. We claim that an adaptive hypermedia system, such as the ongoing SHAIEX project, could adapt to the main features of educational software for young learners and favourably influence the learning of a second language at early ages.

The conclusions drawn from the data obtained as a result of the factor analysis carried out can be summarized as follows:

The language learning process in the design of L2 hypermedia tasks for early ages must be studied in order to tailor designs to meet children's requirements. Hypermedia tasks should be consequently adapted to young learners, meaning that the tasks are adjusted so as to consider the children's cognitive abilities. Though children may not yet have the ability to categorize or accomplish complex tasks such as the ones involving text information, tasks should be simplified, and textual content should be restricted or postponed till higher educational levels.

As for dexterity with the mouse, the different interaction types (click, click-move-click, double click and dragging) may require previous training and extended practice in the case of young learners.
In this context, SHAIEx can provide adaptation in different areas so as to achieve the adaptation and necessary motivation for preschool children to obtain the highest possible benefits from the learning process with technologies. The web-based architecture of the system allows SHAIEx to scale to other educational levels and centralize the adaptation process. The power of SHAIEx as an educational tool also makes it possible to analyze the learning process through the use of ICTs at early ages.

We are aware that computer-based evaluation with primary school children can be an extremely intricate process; however, evaluation constitutes a key point in the design of the SHAIEX Project and one of the future lines of research in order to develop a successful system suited to children's special needs. For this evaluation, we will use the guidelines for usability and fun testing with children –an assessment methodology based on the taxonomy of usability problems proposed and extended to computer game (Barendregt, Bekker, Bouwhuis, & Baauw, 2006).

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