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Design and Assessment of Adaptive Hypermedia Games for English Acquisition in Preschool

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Abstract: The increasing popularity of hypermedia games is reaching far beyond the boundaries of entertainment and edging its way into many educational domains. The growth in game technologies has created new teaching environments through proposals combining learning with fun and motivating expectations which make the use of digital games a relevant trend in versatile learning situations at all educational levels. Based on the implementation of the Shaiex project, funded by the government of Extremadura (Spain) and develop by the research group GexCALL, the aim of this paper is twofold. First, it analyses the steps and requirements for the design of adaptive games for the teaching of English as a foreign language at the preschool level. Exploring the general premises for task adaptation by personalizing content to children's needs and abilities, the implementation of the whole design is described in light of its applicability. Second, an assessment of the adaptive games designed is conducted, based on the assumption that selecting developmentally appropriate digital experiences to meet users' expectations and to maximize their learning potential should undergo careful evaluation.

Keywords: Hypertext and Hypermedia, Adaptive learning, eLearning Systems/Technology/ Tools/Platforms, Game Based Learning/Gaming
Categories: L.1.5, L.2.0, L.3.0, L.5.1

1 Introduction

Based on the assumption that computer technology can enrich the foreign language learning environment [Stockwell 12], our proposal aims to adapt ICT to 3-5 year olds' learning idiosyncrasy in pre-school to kindergarten. Some of the special aspects needing revision and re-visiting to work with computer games in the preschool English classroom include, as Milton & Garbi [Milton and Garbi 00] enumerate, the level of skills and knowledge, the type of materials and topics, the linguistic level, the methodology, learning styles and interaction with the technology. If effectiveness in the selection, use and evaluation of teaching practices is one of the key traits in class, this purpose can be especially complex in the case of preschool children, e.g. [Edwards et al., 02, Gonzalez-Lloret 03, Graham and Fitzgerald 10].

Initiatives to introduce ICT at earlier stages of education have generated a lively debate by parents, teachers and researchers, leading them all to question its effect on the cognitive and emotional development needs of young children. The polarization of stances includes those who pose questions about under which conditions ICT have a positive effect on teaching and learning [Voogt et al., 13] and others who even consider computers could have a negative influence on health, as well as on children's social and cognitive development.

Cordes & Miller [Durlach and Lesgold 12] contend that, instead of books, play and the physical input of the world around them, the introduction of computers in early childhood could pose serious hazards at early ages. An important problem is rooted in protection, security, privacy and the difficulty in distinguishing appropriate sites, adequate content and suitable games for such young learners.

Likewise, other concerns focus on the physical adverse effects of prolonged exposure to ICT, such those involving potential vision problems, dangers of addiction, extended sedentary lifestyles and so on [Merga 15].

However, in today's society, it is becoming increasingly essential for children to be familiar with information and communication technology [Plowman and Stephen 06, Plowman et al., 11]. For this reason, we subscribe to participation in the current ongoing debate regarding the proper implementation of ICTs at early ages. In general terms, and leaving aside the positive aspects technology can provide for young learners, the main arguments under discussion may be summarized by authors such as [Plowman and Stephen 03, Sandberg 02, Wood et al., 08], who contend that the most important requirements include the proper choice of software and the supervised assistance of an adult [McKenney and Voogt 10]. In this context, directed interaction is highlighted as the adequate method for promoting learning through ICT in preschool education [Plowman and Stephen 07]. Moreover, adult help should be limited to the right amount of support needed by the child in order to improve his/ her own learning process.

Plowman & Stephen [Plowman and Stephen 06] conclude that:

- Children's encounters with ICTs are nurtured when educators carry out directed interaction. Therefore, professional teacher-training for early ages should include guiding educators towards finding ways to enhance the value of ICT experiences by balancing the child's initiative with the assistance they receive.
- Children's encounters with ICTs under directed interaction can improve three identifiable areas of acquisition: the will to learn, knowledge of the world, and functional skills. These maximize the benefits derived from ICT learning because as values they satisfy as well as provide a sensitive-reflexive form of pedagogy.
- Children's encounters with ICT should not be restricted to the sole use of computers. It would be unadvisable for schools to exclude other valid means of learning tools. Video cameras, cell phones, keyboards and games also provide a wide range of ICT options which can alternatively foster diverse forms of educational environments.

In addition to the aforementioned, and in order to identify the real face value of any educational software program, we might advocate that teachers ask themselves if

the software being used allows them to provide learning opportunities that would otherwise be lacking should it not be available. Thus, the appropriate selection of software is a critical decision for children's active learning [Plowman et al., 11, Plowman et al., 12].

2 How much engagement can be poured into computer games in order to promote significant learning?

We agree with Yager & Roy´s viewpoint [Yager and Roy 93] and Wood [Wood et al., 08], in that computers should be introduced into the classroom in such a way that they are not dealt with apart from the rest of the learning resources. On the contrary, computers should be accepted as just one more of the possible ways of accessing the material that is attractive and beneficial for learning.

Games have been integrated into the preschool curriculum to foster fun, facilitate content assimilation, and stimulate motivation with the purpose of promoting new learning aptitudes through a wide range of developmental activities like hand-eye coordination, motor skills, memory-building and so on [Cojocariu and Boghian 14, Petrovska et al., 13].

The educational potential of video games as a valuable tool has heightened due to such promising features as interactivity, user-centeredness, animation rendering, and high-quality. In other words, they provide a multi-sensory environment in which students can truly experience "learning by doing".

The modern preschool classroom has largely incorporated video games with colour graphics, sound, interaction, real life simulations and a wide variety of features which can significantly spark the interest of children. In this computerized learning environment it seems that children activate their cognitive strategies, interact with each other, play a more active role in the learning process, explore and experiment with everything around them, exercise memory, and develop motor skills.

According to Haugland [Haugland 00], the appropriate use of computers in the preschool classroom may increase creativity, 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 facilitate abstraction and conceptual formation skills. So, technology is not only changing what children think and know, it but also affects the way in which the cognitive process is currently being conducted at early ages.

Additionally, if young children learn through games, and most preschool programs are largely play-based [Agudo et al., 10], the technological growth can consequently create novel expectations contingent on the use of video games, an effective teaching environment which features users spending part of their time on entertaining and pleasurable virtual worlds.

Thus, departing from the premise that learning should be fun, especially for children, and that teaching through games provides ample educational opportunity for young learners to increase their cognitive skills, gaming approaches should be further exploited.

The concept of using games for more than entertainment has attracted a considerable number of educators and teachers who dedicate valuable class time to

playing computer games. Making games work for young learners involves, however, the guarantee that children can get the most educational value out of them. The introduction of video games is consequently giving teachers and researchers the chance to investigate the role of gaming in language learning by appealing to students with games which engage them and promote motivation and learning. Nonetheless, when looking at games created specifically for language learning at preschool, questions arise as to what makes a good game design, and appropriate ways of integrating games into specific teaching situations. This proposal offers answers to the aforementioned queries by means of adaptive games for the teaching of English as a foreign language in the preschool classroom.

The concept of hypermedia came into being in order to integrate the idea of interactivity and multimedia, qualities that join together in the communicative and entertaining products of the digital era. Multimedia can include many ways of expressing ideas and transmitting concepts like the human senses. Liu [Liu 96] studied the use of multimedia resources of preschool children and surprisingly concluded that children as young as three can readily use this type of technology. The phenomenon of interactivity presents several types of participation both at the psychological and physiological levels. Each hypermedia creation includes a great deal of multimedia expressions and kinds of interactivity that serve to generate experiences devoted to the so-called concept of learning by having fun.

3 Design of adaptive games for learning English at preschool

In the design of hypermedia games for preschool, classroom organization should be deeply thought out in such a way as to promote entertainment, communication, social and knowledge-building. Specific methodological proposals can include, among others:

1. Activity corners and work group to promote cooperation.
2. Collaborative work encouraging the most advanced learners to help all those who are not.
3. Individual work through the completion of adapted games.

Likewise, Donald A. Norman [Norman 93] identifies seven basic requirements for a potential learning environment:

1. A high intensity of interaction and feedback.
2. Specific goals and procedures.
3. Motivation.
4. A feeling of challenge, one that is neither too difficult to create frustration nor too easy to produce boredom.
5. A sense of direct engagement, experiencing and working on the task.
6. Appropriate tools that fit the user and task so well that they aid and do not distract.
7. Avoiding distractions.

From our point of view, computer games greatly satisfy most of these requirements, being the activities a game player performs similar to those required to achieve significant learning. There are researchers who argue that the motivating

appeal inherent in games could be applied as a paradigm in the design of general user interface [Mcgrenere 96].

In this sense, an effective gaming environment should include several key points such as [Rico et al., 07]:

- Clear and concise instructions which allow users to understand goals and objectives for the players to access.
- Challenging learning environments.
- Control over gaming options such as speed, difficulty, timing, sound effects and feedback.
- Aesthetic considerations such as screen design, graphics, animation and sound of appropriate quality.

A crucial factor within the preschool EFL classroom also lies in how to organize the teaching sessions and devise activities which appeal to all sorts of students and learning styles. Even with the youngest children, the variety in learning styles is nowadays more than noticeable by virtue of the environment and culture in which they are being raised.

It is already apparent that contemporary students have limited attention spans, have a more visual learning style than their predecessors, and need to be entertained in the classroom [Affisco 00].

Therefore, the way in which children learn is related to their different learning styles which may be linguistic, logical-mathematical, musical, and their intelligence type which may be bodily-kinaesthetic intelligence or intrapersonal. From this perspective, the introduction of computer games in the classroom will enable us to create a class period that explores various intelligences and reaches a variety of children instead of exclusively the linguistic style learners

3.1 Adaptation and applicability

Despite its strong potential, the inherent web-like nature of hypermedia is not exempt from intrinsic problems in its use and application as an information source in education [Durlach and Lesgold 12]. Novices tend to browse when seeking information, which is an inefficient form of navigation when compared to using online guidance. Heller [Heller 90] suggests that many younger students may not have the intellectual capacity to be able to actively ignore nonessential information as they browse a hypermedia system.

Research suggests that effective use of hypermedia learning resources requires a sense of purpose, a need to have clearly defined objectives to be achieved at the end of the instruction [Land and Hannafin 96]. Moreover, and considering children tend to make navigational choices based on their interest and curiosity demands, systems could be made to easily adapt to prospective users [Prentzas 12]. The content in the adaptive system is individually tailored to student knowledge, making learning more personal, specialized, and adapted towards individual needs [Edwards et al., 08].

In the process of selecting learning content to address learning tasks for individual needs, each and every child's learning possibilities becomes a substantial consideration. Thus, a strong argument in favour of the transformation of learning processes from a traditional model to an individualized learning one is the need for an active learning system, an important condition for effective results.

In an individualized learning environment children can implicitly take part in the organization of their instruction, by choosing from the list of options of some tasks while rejecting non-friendly, unattractive ones (e.g. what for some children is going too fast, for others means too slow). Active participation brings co-responsibility directly to the child, motivating his/her learning process and providing the chance for higher learning efficiency.

Brusilovsky [Brusilovsky 01] distinguishes two distinct types of adaptation: adaptation at the content level, and link level adaptation, or adaptive navigation support. In a video game based educational environment, adaptive navigation allows children to organize learning and present the most appropriate games according to its user model (educational level, knowledge, psychomotor skills and so on). Adaptive presentation is subdivided into text and multimedia, being the latter prominently prevalent in video games designed for preschool children.

It seems obvious to state that hypermedia games should be fitted to the children's level of knowledge and interaction skills. In this sense, there are studies claiming that educational software targeting primary school learners must comprise a set of features to increase motivation, enhance learning for/through fun, and develop individual preferences and learning styles. However, in order to achieve the goal of adapting the hypermedia games to the cognitive development of children, three fundamental aspects, namely, linguistic content, cognitive abilities and interaction should be further considered:

1. Regarding the linguistic content we highlight the careful selection of words, phrases, and, as ability levels increase in the child, the inclusion of simple sentences.
2. As for the cognitive abilities, the inclusion of mainly visual and auditory information is highly recommended, although textual information at word level is feasible. Metaphorical and abstract content is mostly avoided, and familiar content (the family, the school, the house, toys, daily habits, food) is thoroughly exploited.
3. The type of interaction required [Pariente-Martinez et al., 14], that is, dexterity with the input device, the mouse in this case, is examined in depth. From the monitorization of the basic mouse actions (click, drag and drop, or a double click), intermediate and adapted options are designed for the various games.

4 The construction of adaptive digital games (Objective 1)

To cover our first objective, in the following subsections we describe the steps and some of the requirements for the construction of adapted multimedia tasks, a proposal aimed at dynamically generating video games with an architectural design based on scalability and reusability, in addition to selecting the most appropriate multimedia elements (audio, graphics, etc.) from a database system according to the user model of a particular child [Agudo et al., 15].

4.1 Game Architecture and Running

In general terms, the architecture of the games is implemented by Macromedia Flash, configured by a XML file, loaded into the user interface and built dynamically with the configuration parameters and corresponding multimedia elements. The game running is divided into four parts to develop a complete learning process (Figure 1).

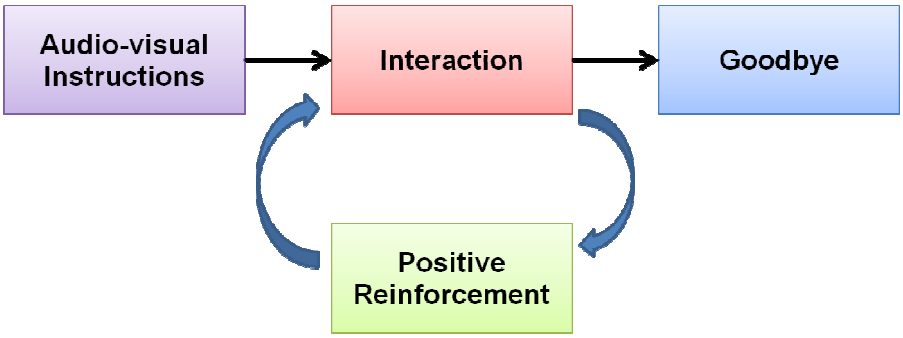

Figure 1: Game running

As we can see, after understanding the verbal /visual instructions and once the interaction with the game is completed, the child receives the reinforcement for his/her achievements and failures, and then comes to a concluding screen.

The inclusion of these four parts is based on:

1. The necessity to know the objective /goal of the game justifies the inclusion of a set of both visual and verbal instructions explaining the purpose and the actions to be taken: *"Pick and choose. Then click on and watch what happens"; "Hi there artist! Click on your favourite colour and colour in the drawing"; "What's this? Do you know? Match the pairs", etc.*
2. The completion of the game based on the child interaction with the game content should be conveniently adapted to the child's cognitive abilities. In the interaction phase, the child listens to the particular questions in order to achieve the learning goal: *"I like toys, I like my train"; We are different. Can you find us "We are small, very, very small"; Where's my Toy? Listen and then, drag and drop "My doll is here, it is smiling and happy"*. The theory behind video games is based on a powerful process of demonstration and practice where the compelling graphics and interactive qualities enhance the learning of game-playing behaviours.
3. The results of the interactions demand a type of reinforcement showing the achievement or failure, a phase which indicates how the child can keep on playing (*well done, go on; fantastic; go forward; no, no, try again; etc*). It is worth noting that many studies regarding the use of reinforcement to manage learning support find that unlike older students, young children respond best to immediate reinforcement [Cotton 88, Martin et al., 80].
4. Finally, the transition between activities and scenes is shown with a good-bye-type screen to facilitate the comprehension of the different parts comprising the whole game system.

4.2 Interaction styles

There are three general dexterities exploited with the mouse: click, double-click, and, drag and drop. Assuming that double click and drag and drop may be initially difficult for young learners [Donker and Reitsma 07], we decided to introduce variations on the three general types (Table 1).

Level	Dexterity Variations
Level 1.	Roll Over Click
Level 2.	Click – Move Click – Move – Click Double Click (long pause)
Level 3.	Double Click Double Click – Move Drag and Drop Double Click–Move-Double Click

Table 1: Interaction style levels

On the first level, the interaction is designed so that children can move the cursor and click on the objects, or, roll over them to learn and practice the basic interactions with the mouse. The second level introduces students to double-click, drag and drop, and variations including operations such as click-move, click-move-click, and double click with a longer time space between clicks. Finally, the third level shows a full implementation of double click, and drag and drop, and, more complex variations such as double-click-move, and, double-click-move-double-click.

4.3 Communication protocol

To exchange information about the game configuration, the interaction and game results (Figure 2), we have devised a communication protocol between the user interface and the Intelligent Server (SISATE). In an adaptive hypermedia system the intelligent server adapts the content or navigation using some machine learning techniques.

In analyzing the communication protocol, we should point out that when the user interface requests an activity configuration, the information is returned from the server by a XML configuration file. The user interface shows the activity to the user who completes the game. The results are sent to the server, responsible for data storing and processing, by an XML result file. Therefore, we have two in-formation flows, one from the server to the user interface (task configuration) and the other from the interface to the server (task results).

The games are also designed to work without a server, being possible to load the xml file in charge of configuration from the local file system. In this case however, the results cannot be saved.

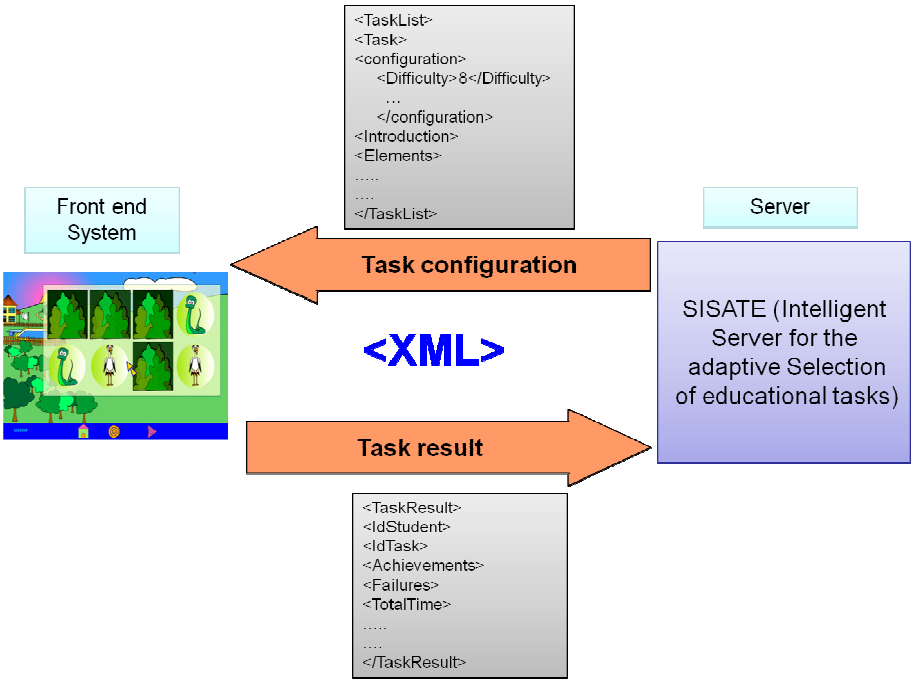

Figure 2: Communication protocol

The game configuration is divided into three parts: task data, configuration and content.

1. The task data stores general information about the task: ID, logo, name, type, etc.
2. The configuration side includes the game configuration parameters necessary to dynamically build the activity.
3. The content stores the elements that make up the game: images, animations and sounds. In all types of activities these elements are divided into blocks and the blocks themselves contain the elements (Figure 3).

Though different types of tasks have been designed in our game system (matching, pairs, bubbles, stickers, colouring…), all the games share the same architecture, the only difference being the distribution of the elements into blocks. Whereas, for example, in the matching game type each block has two elements, in the case of choosing, each block contains a single element.

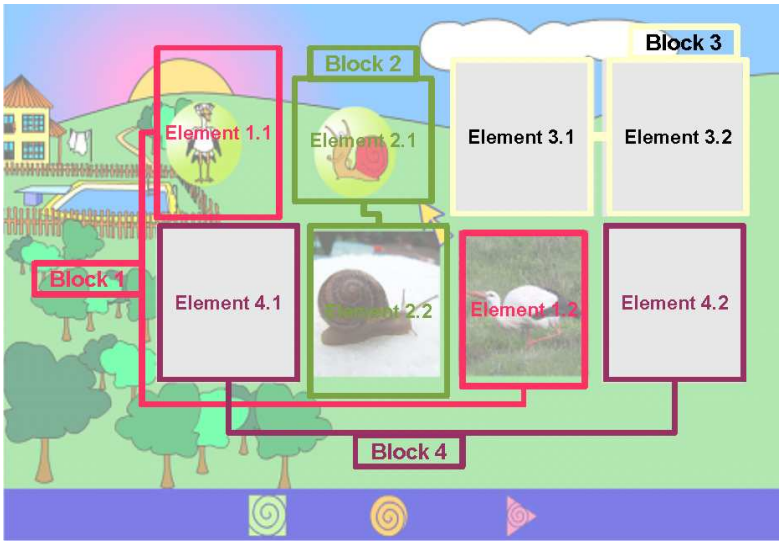

Figure 3: Games Architecture

5 Engagement and learning: assessment of adaptive games (Objective 2)

To fulfil the second objective, measuring the appropriateness of digital products to assess some of the factors which could determine engagement and learning at early ages when working with video games [Martins et al., 14], we have conducted two preliminary research analyses (preschool teachers through the completion of a questionnaire and children under in-class observation analysis) focused on gaining insights into how much motivation and learning might be determined in the exploitation of our adaptive hypermedia games.

Study 1: Preschool teachers' questionnaire

Thus, by a questionnaire based on the Haugland Developmental Software Scale for children [Haugland and Wright 97], we aimed to assess the role motivation seems to play on the target group when playing with the games under study. The questionnaire was answered by preschool education experts and school teachers and included a set of questions under 10 general sections.

Tabulation for each question on the video games contains the average percentage, denoting the total number of items marked by the surveyors as fulfilling quality specifications during the classroom pilot research (Table 2 third column). Items receiving a score of 50% or higher are considered a favourable feature of the system. Those items receiving an evaluation lower than 50% have been marked in bold print. The column on the far right represents the total score for each section according to the Haugland scale applied.

Categories	**Specifications**	**Average %**	**Score**
1. Age appropriate	1.a Realistic concepts	78,2	1
	1.b Appropriate methods	55,2	
2. Child in control	2.a Actors no reactors	37,9	0,5
	2.b Can escape	59,8	
	2.c Children set the pace	59,8	
	2.c Children set the pace	59,8	
3.Clear instructions	3.a Picture choices	73,6	1
	3.b Simple, precise instructions	76,7	
	3.c Verbal instructions	60,9	
4. Expanding complexity	4.a Low entry, high ceiling	54	1
	4.b Learning sequence clarity	57,5	
	4.c Teaches powerful ideas	70,1	
5. Independence	5. Adult supervision not needed after initial exposure	48,3	0
6.Non violence	6.a Software is free of violent characters and actions	96,6	1
	6.b Software models positive social values	71,3	
7. Process orientation	7.a Discovery learning, not skills learning	60,9	1
	7.b Intrinsic motivation	86,2	
	7.c Process engages, product secondary	57,5	
8. Real world model	8.a Concrete representations	66,7	0,5
	8.b Object functions	32,2	
	8.c Simple, reliable model	78,2	
9. Technical features	9.a Animation	86,2	0,5
	9.b Colorful	97,7	
	9.c Install easy	62,1	
	9.d Operates consistently	40,2	
	9.e Realistic sound effects and music	41,4	
	9.f Uncluttered realistic graphics	52,9	
10. Transformations	10.a Objects and situation change	71,3	0,5
	10.b Process highlighter	48,3	
	TOTAL		7

Table 2: Results: Adapted from Haugland's scale

As seen in the last column of table 2, the global score is 7, the threshold level for considering the software suitable for young learners. From these results, obtained by the application of the Haugland Developmental Software Scale for children, we can

state that though there are some aspects subject to improvement, in general terms, the games under study suit young learner abilities and enhance motivation, interaction and cognitive development. There are even items which a surpass 75% rating, namely, the inclusion of realistic concepts, the design of simple, precise instructions, void of violent characters and actions, its intrinsic motivation, the representation of a simple, reliable model, and adequate animations and colour, items which contest to the appropriateness of the software.

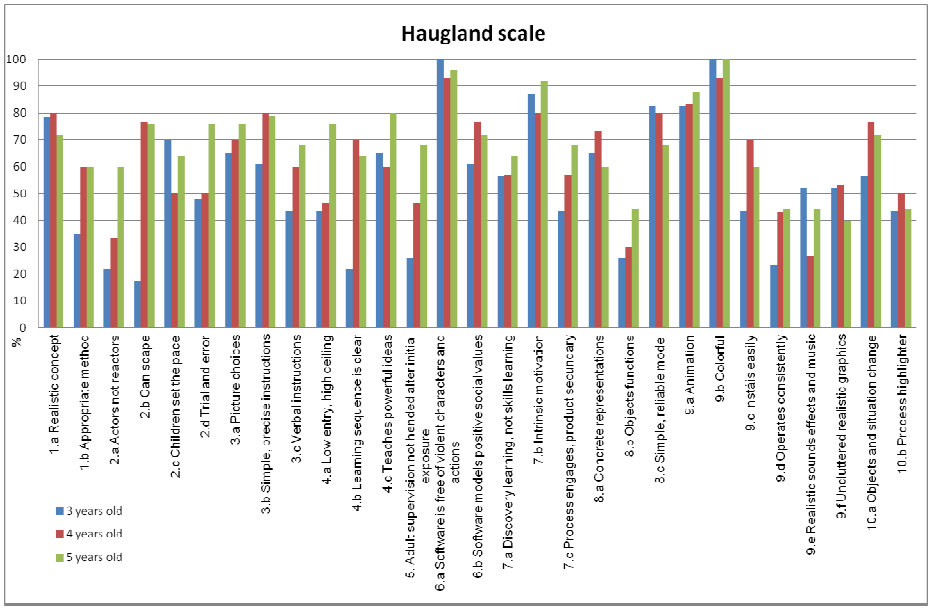

Figure 4: Evaluations results by age

Similarly, figure 4 shows global and partial results by age, where we observe that for 3 year old children (in blue) most of the items are below 50%, results far lower than for the older participants.

As seen, in the case of 4 and 5 years old children (in red and yellow respectively) percentages show similar results, though improvement is significant as the age of the participants increase.

In detail for example for the seventh concept (Process orientation), the analysis of the first question (discovery learning) shows that about 60% of the experts consider that the design of the games could easily promote learning by discovery, providing children with educational, developmental and fun activities (Figure 5). No significant differences between ages are noticed. From the results of the second question, we observe that games present a high motivational level, more than 80% in all the cases. The analysis of the last item (engagement) shows the rate of child engagement in the learning process, obtaining a global result near 60% with a slight engagement increase according to age [Rico et al., 07].

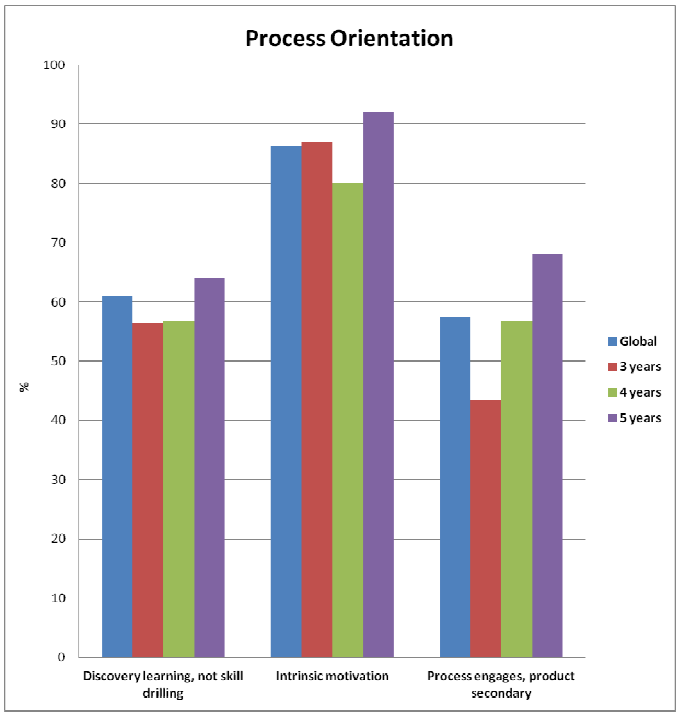

Figure 5: Process Orientation

Study 2. Children in-class observation

As the second phase of the study, we evaluated the suitability of games for the preschool class-room through in-class- observation of the use of the games by the children.

The goal of this final assessment was to determine the appropriate functioning of the system as a pedagogical tool in addition to evaluating the adaptation of content and interaction components during the learning process. The study is divided into aspects of quality regarding navigation and sound, as well as an analysis of the content (Figure 6).

Results obtained on the quality of navigation are highly positive in each of the items analyzed, with the exception of understanding activity instructions which could withstand room for improvement. Aspects pertaining to the quality of the sound were rated as very adequate, allowing the children to understand what they heard and respond accordingly.

The language content of the games, on the other hand, is divided into three operational levels: word, phrase and sentence level. Results are coded positively (+) if student understanding of the learning objective is classified as always-often, and negatively (-) if student understanding of the language content is never-rarely.

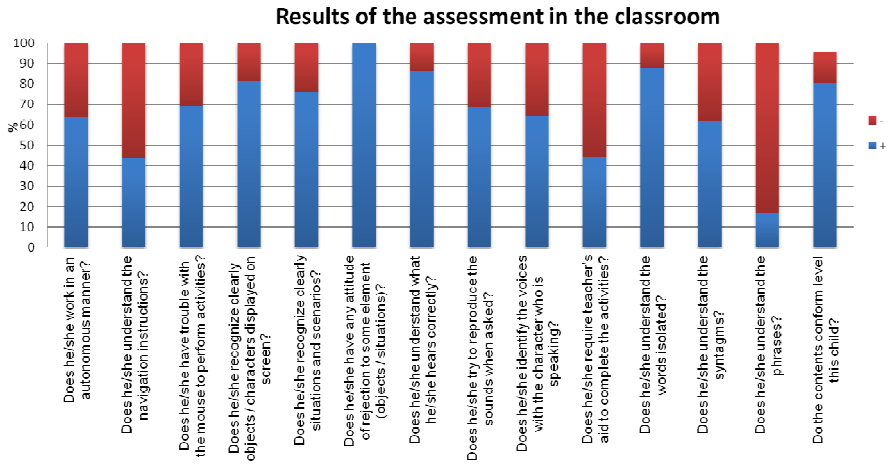

Figure 6: Software Assessment in the Preschool Classroom

Involving conceptual phases addressing 3, 4 and 5 year olds, figure 7 shows that more than 80% of the children can easily work on the word level (you, me body, leg, mom, train, school, juice, etc.); more than 60% can easily cope with the phrase level (my mom, beautiful chair, by car, pink sofa, etc.), whereas only 20% can handle the sentence level (I like my green pencil case, His name is Thai, He is from Thailand, etc.). The sentence level has proved to be difficult at this age while word and phrase levels seem to be appropriated for preschool children.

Further to those results requiring improvement and identified as those falling below a 50% average, as shown in Table 2 in bold print, it seems fitting to point out the following observations. Regarding the question of whether or not the child takes initiative to play, only five year olds have obtained favourable results. This may be due to the limited amount of ICT exposure and use for youngsters in the 3 and 4 year old bands. Likewise, another crucial aspect to highlight is the actual amount of adult supervision needed. The data received indicates that there is a progressive autonomy underway since percentages are very low at 3 years old, contrasting those that are significantly high at 5. It therefore appears that both aspects have much to do with age development and prior experience.

On the other hand, analysis of the functionality aspect of the objects points towards the need for improved interaction during the presentation phases of the contents and songs across the board and regardless of age band. A possible solution might be found in the introduction of activities in which learner observation of content sans direct interaction provides an assimilation period of reinforcement for consequent engagement later on.

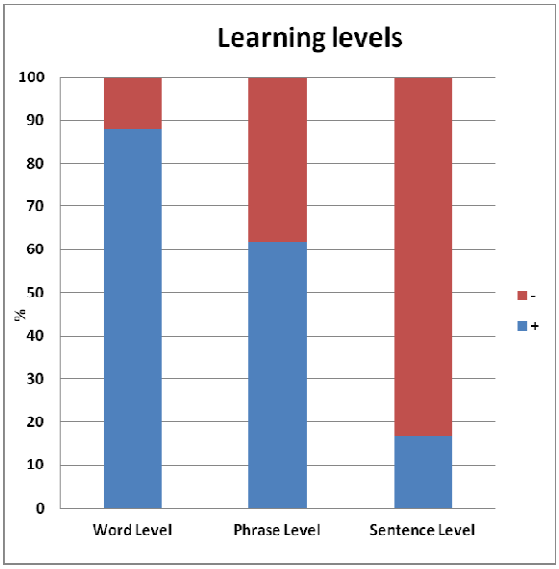

Figure 7: Learning levels

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As with any prototype under development, it is expected that certain technical difficulties like irregular working conditions of the equipment, musical imperfections, faulty visual effects and other similar glitches can be easily worked out in subsequent editions of the program. Action research has allowed us to detect the occasional need to signal out learner options in order to facilitate navigation and general management of the system.

6 Conclusions

It has been our purpose to probe the role of hypermedia games for English as a foreign language tool in pre-school based on the curriculum requisites of learning and the psychological profiles involved in having fun.

Though educational software targeting primary school learners must comprise a set of features to increase motivation, to enhance learning for / through fun, and foster learning, it seems necessary to state that multimedia games should be fitted to the children's level of knowledge and interaction skills and adapted to the cognitive development of children by means of adaptive hypermedia games. A chief consideration has been the capacity at early ages to function with this medium. Due to their special characteristics regarding cognitive and psycho-motor development, attention has initially been placed on learning styles and intelligence variables. Then, linguistic content, informational formats and interaction with the input device was designed for appropriateness. Next, the actual construction of the digital games was undertaken in order to provide a database system of adaptation and applicability in the user model. Finally, empirical testing with teachers and their preschoolers on site has rendered valuable information regarding the processes of English, fun and learning for this age band (3-5 years).

Our probes have rendered mixed results, although the majority of favourable outcomes have outweighed those that require further study and improvement. This validates the software created as at least partially adequate for children at early ages from the observable data collected from direct use in the classroom. The trouble spots detected suggest there is a certain amount of difficulty involved in understanding and following directions for doing some tasks, thus indicating a greater need for teacher supervision especially with the smallest children. In all fairness to both the children and the researchers, the fact that evaluation took place in one sole session with each individual child may be a contributing factor to problems derived from this point. Nonetheless, it does seem clear that language comprehension of full sentences in this age band proves to be much more complex than the understanding of simple phrases and single words.

Encouraging results have shown that such important items as discovery learning, intrinsic motivation and process engagement are definitely present in varying degrees for the young participants of our study, and that as to be expected, considerable levels of learning are reached in the simplest format (word level), to a progressively lesser extent in complex formats (phrases and sentences). Further study is needed in order to determine if indeed the adaptive system can provide an efficient correction factor to offset these differences by allowing individual learning progress to supplement group learning progress. Indications are that fun in combination with learning just might supply the missing link.

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