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A Method to Evaluate Emotions in Educational Video Games for Children

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Abstract: Although several evaluation analyses have recently been proposed to assess the user or player experience of playing a video game, we found the need for these to be adapted when we wanted to apply them to young children. However, young children are unable to spend a long time grading many attributes or indexes after playing. Thus, selecting the most important aspects to be analyzed is required in order to perform a non-time consuming and significant evaluation method to be used with children.
Hence, this work is focused on designing an evaluation method to assess emotions when young children (3-5 years old) play a video game. In particular, we are interested in educational video games because of the importance that emotion has in motivation, which in turn is highly important in education.
Although the method presented follows the pre-test, test and post-test classic structure, the activities carried out in each of these phases have been modified to, firstly, include no elements which require reading-writing skills, which are as yet undeveloped at this age and, secondly, to limit the emotional impact that children can suffer when they are aware that they are being evaluated.
We have applied the proposed method in a sample of 39 children playing the educational video game "Ato's Adventure", which was in its final development phases, obtaining very promising results both for the analysis method and for the video game.

Keywords: Educational videogames, evaluation of emotions, children's evaluation
Category: H.5.m

1 Introduction

Since the theory of digital natives and immigrants was first postulated [Prensky, 2001], and even before, children have used technological devices with an ease that a priori might seem astonishing. And this continues to be true in the case of touch mobile devices.

Seeing children playing with their parents' mobile phones or tablets is very common nowadays. This fact may be due to two main reasons. On the one hand, touch technology as a new interaction paradigm allows children to more easily manage these kinds of devices because they do not need to learn which button performs which activity: interaction is now more intuitive. On the other hand, many applications for children have been included in online markets (Google Play or Apple Store, for example), allowing parents to carry several entertaining activities in a reduced space, both physical (their mobile phones or tablets) and virtual (only requiring a few MB).

Games and video games have been widely used as a learning tool to increase students' motivation. For that reason, between the myriad of available applications for children, we are especially interested in games and video games with some educational intent; that is, those which include some content to learn, practise or train with. However, the expected effectiveness is sometimes not achieved due to the educational and recreational elements in the proposed game being unbalanced [Padilla-Zea, 2011]. Therefore, the analysis process of educational video games must include a serious study of how fun they are, since this is the most important parameter to increase motivation. In that sense, we have previously proposed measures to evaluate the playability of games [González, 2010]. However, characterising playability in educational video games requires the inclusion of several nuances, because the fun that a player experiences is immersed within a set of learning processes that act on enjoyment and promote the motivation to learn. This is what we have termed *Educational Playability* [Ibrahim, 2011], where one of the most important elements to motivate students is emotion.

This work, however, emerges from the necessity of evaluating emotions generated by educational video games for young children. Several final grade projects on this kind of video game have been advised in our research group and most of them were about the development of graph-motor skills and learning to read, which means that our target group was aged from approximately 3 to 5. For that reason, we have typically found difficulties evaluating their playability, mainly because most of these students cannot read or write and have not yet developed the necessary skills to frame their opinion about their gaming experience. For this reason, we have considered alternatives that can help us to evaluate emotions generated by these games and its educational capacity with these students.

The rest of the paper is structured as follows: section 2 presents some studies related to the evaluation of emotions in video games. Section 3 introduces the concept of Educational Playability. In section 4, we explain some of the features that make children special as video game players, and a set of guidelines considering those particularities. The proposed analysis method is presented in section 5 and its application to the educational video game "Ato's Adventure" is explained in section 6, including the particularities of the video game design as well as the results obtained

from the case study. Finally, sections 7 and 8 summarise our conclusions and suggest future work.

2 Related Works

Evaluating the player experience in educational video games is difficult. This is one of the problems that we find when designing such video games and, consequently, educational video games used in the classroom do not incorporate certain desirable features which would enhance the expected motivational impact and, therefore, the educational process. Furthermore, this could cause the students at whom the game is directed to reject it and every potential benefit that could be accrued to be thereby left unfulfilled.

Hedonics factors (elements related to pleasure) are crucial means by which the evaluation of interactive products may be realised, due to how difficult the performance of the experience analysis is and also to the way in which children express their feelings during the interactive process. For this reason, it is imperative to analyse how to perform the evaluation of the quality of the interactive process in order to obtain the correct educational product and to develop positive experiences that will help in the educative process. The analysis of the interactive experience must be taken into account during the full development process of the video game. Several authors, for example, [Markopoulos, 2008] and [Read, 2008] have described the importance of developing methodologies to complement the traditional evaluation of video games and interactive experience evaluation with new factors (hedonic and pragmatic) to ensure the correct evaluation of the interaction process in this kind of product: educational video games, with these 'special' users: children.

In [Hanna, 1997] and [Read, 2008], the most common elements with which to design a laboratory for the evaluation of the interactive experience with children are described, noting especially familiarity with the environment: classroom, home, or the incorporation of a teacher or relative as the facilitator or support staff. When we are working with children we should emphasise the great importance of following ethical standards that must be present throughout the process, due to the characteristics of our main users: children.

In [Markopoulos, 2008][Bruckman, 2003] we find some of the characteristic techniques used in the evaluation of interactive products. They are the result of prior knowledge in areas such as usability and quality in use. In Table 1, we summarise some of these techniques and analyse their advantages and disadvantages in their application to children, as well as the places where we can perform them. The context of use and the place where the evaluation is performed are essential aspects in the evaluation of the interactive process with children. The young age of the test-users and their cognitive characteristics mean that the evaluation method should be conducted in familiar environments in order to avoid rejection, fear and insecurity. Furthermore, including teachers, guardians or parents in the evaluation team offers support and confidence to children during the evaluation.

Method	For (+) / Against (-)	Context of Use
Passive observation (structured) Behaviour registration in predetermined cases	(+) The child is not pressed by the evaluation (+) They come across unexpected problems (-) The structure leads to unreliable results (-) There are problems that may be overlooked (-) Difficult to analyse data.	Classroom or UX laboratory
Passive Observation (unstructured) Registration of the interaction process with the product		Classroom or UX laboratory
Think-aloud: concurrently, retrospectively or with cards To freely express their thoughts about the interactive experience	(+) Easy to express hedonic issues (+) Convenient and enjoyable cards for children. (+) Pleasant social situation. (+) Child can be led to wherever the information is. (-) Can be cognitively demanding (-) The answers do not always focus on the interactive process.	UX laboratory
Driver Method: active, post-task or automatic User is guided in the right direction while interacting with the system.		UX laboratory
Wizard of Oz Part of the system is simulated to collect user opinion	(+) Evaluates something unfinished (-) Requires someone who knows the whole system	UX laboratory
Questionnaires List of questions in order to analyze the interactive experience	(+) Obtains a large amount of data from the user set simultaneously (+) Allows a detailed discussion with each participant (+) Offers a high capacity to obtain qualitative data (+) Delves into deeper user experience (satisfaction, emotional impact) (-) Children are not very reliable answering questions. (-) Laborious, and more difficult to analyse.	Classroom or UX laboratory
Interviews Conversation in which a set of questions about the interactive process are answered		Classroom or UX laboratory
Focus Group Information from a group is collected through a moderated conversation		Classroom or UX laboratory
Heuristic-Based methods The expert evaluator checks whether the interactive experience is right according to the rules.	(+) The evaluation is allowed when the participation of children is difficult. (+) A lot of information could be obtained from a few experts. (+) They are valid to the early evaluation of prototypes (-) No inquiry into hedonic aspects (-) Inexistent problems may appear while problems that really exist may be lost. (-) An expert cannot know what a child feels when interacting (-) Difficulty of finding experts for each case and applying these types of games in the classroom	UX laboratory or Evaluator's Office
Paths based methods A detailed revision is made of every action during the interactive process.		UX laboratory or Evaluator's Office
Diary Children or their guardians complete a daily questionnaire, or describe their interactive experience every day over a period of time	(+) Provides rich information that will have been collected during the study periods. (+) The realism of the test situation. Children describe the interaction process every day in different situations (-) Punctuality is key to processing information. (-) leaves out crucial information about children's expressions	Classroom or Home

Table 1: Summary of existing methods

Although there are some works which evaluate the emotions of the player when they are using a computer [González, 2012], their application to educational games may require some adjustments. Several authors have studied the main problems that lead to the failure of educational video games [Bruckman, 2003] [Markopoulos, 2008][Read, 2008], which can be summarised in four points, as follows:

- Educational games are not designed or tested by children, who are their main users. Therefore these kinds of games lose effectiveness as an educational tool because they do not promote the best user experience.
- Most video games are mere educational multimedia teaching units, which minimises the interest that they hold for children and causes the loss of the essence of the game. In addition, this fact diminishes the quality and the effectiveness of the player experience.
- The devices with which these kinds of games are implemented are usually unattractive for children and are far from real gaming devices.
- As age decreases, the problems of evaluation increase due to the difficulty of adapting the usual techniques of assessment to the user profiles.

Looking at these problems, it is apparent that a methodology or set of techniques to analyse the user experience (especially emotions generated in players) in educational video games is required.

3 Playability in Educational Video Games

The main argument that supports the proposal to use video games as an educational tool is the motivation that they cause in students because of their fun component. A positive interaction experience with these video games helps us to improve the learning process.

The User Experience (UX) is understood as a set of sensations, feelings or emotional responses which result from users interacting with a system. UX is focused more on the subjective part of the interaction process and goes beyond the traditional study of the skills and cognitive processes of users and their rational behaviour when interacting with computers. In video games, the term Player Experience, PX -based on user experience definitions – refers to "all aspects related to the player that are affected by and interact with the playing environment" [González, 2010]. These aspects represent pragmatic and hedonic features of the process of interaction such as: sensation, feelings, emotional response, assessment, user satisfaction and the experience obtained during playing time. A video game with good playability improves the final experience during the process of use.

But in Educational Video Games (EVG) the playability concept must be redefined to adapt the analysis of experience to the objective of these video games: learning new educative concepts through entertainment and fun. The Educational Playability concept [Ibrahim, 2011] was proposed due to the characteristics of educational video games, and it does not only consider the fun aspects experienced in the game, but takes into account its educational side. Therefore, we define educational playability as "*the set of properties that describe the PX in the gaming environment, the main goal of which is to provide fun and learning in a playable and learnable context, during the entire time spent playing*". In this definition, we keep fun as a subjective concept separate from playability and extend the definition to include the

educational goals. The Playability and Educational Playability concepts share a set of attributes, which refer to the recreational side of the videogame: satisfaction, learning effectiveness, immersion, motivation, emotion and socialisation. However, Educational Playability adds two attributes which focus on the educational component and its relation to the individual aspects of the game: supportability and educability. We describe all these elements in order to help us focus the evaluation of the interactive experience:

- **Satisfaction**: the gratification or pleasure derived from playing a complete video game or from some aspect of it.
- **Learnability**: the player's capacity to understand and master the game system and mechanics (objectives, rules, how to interact with the video game, etc).
- **Effectiveness**: the necessary resources to offer players a new experience (fun and learning) whilst they achieve the game's various objectives and reach the final goal.
- **Immersion**: the capacity of the EVG contents to be believable, so that the player becomes directly involved in the virtual game world. At the educational level, with this property we measure the ability of EVG to present the educational aspects implicitly.
- **Motivation**: the set of game characteristics that prompt a player to carry out specific actions and to continue undertaking them until they are completed. The motivation to play produces indirect motivation to learn.
- **Emotion**: This refers to the player's involuntary impulses in response to the stimulus of the EVG that induces feelings or a chain reaction of automatic behaviours.
- **Socialisation**: the set of game attributes, elements and resources that promote the social dimension of the game experience in a group scenario. From an educational perspective, socialisation is the ability to support the learning process of students by other students.
- **Supportability**: the ability of an EVG to keep the player motivated, to teach players/students effectively and encourage them to continue learning and to achieve the learning objectives.
- **Educability**: the educational characteristics of the game and the ability of the player to be aware of, understand, master and achieve the learning goals.

In previous experiences, these attributes were measured using questionnaires and metrics [González, 2009] [González, 2012]. However, when we try to analyse the Educational Playability in video games for young children, we have the problem that most of them are difficult to measure with these methods. Some even lose their meaning or importance in this context. For this reason, in this work we are focused on the emotion attribute which is, in our view, the most important aspect to promote motivation, especially in children.

4 Designing for Children is Special

As discussed in the previous sections, designing educational video games for young children requires taking into account certain constraints arising from the incipient development of the target users. From different disciplines, some attention is being paid to issues relating to the different characteristics of interactive systems users and,

particularly, of educational video games. In this work, we highlight the importance of adapting the evaluation process as well as the application. For this reason, skills that vary due to the age range of the users are particularly important, as are aspects such as interests or background, for example. Taking those limitations into account, we can tailor an evaluation method for the users at whom our educational video games are targeted.

We started from the classification performed in [Acuff, 1997] and referenced by [Markopoulos, 2008]. In that research, four different age groups can be distinguished: 0-2, 3-7, 8-12 and 13 and older. Our target group is in the range of 3-7 years old, especially between 3 and 5. At this stage, children enjoy fantasy and magic and they are not yet able to play in groups, because of which the activities proposed in the game should have a strong individual component. They need to feel stimulated, loved and secure, but as soon as they grow they also begin to develop a need for autonomy. They are able to handle simple concepts and they begin to learn to write some letters at about 4 years old. Their spoken vocabulary is then broader and they learn to use more complex sentences ("and", "because" etc).

Applying all these features to the design of educational video games; it is desirable that they should be set in fantasy worlds, in which children would have to find items that allow them to achieve a final goal while learning language skills, motor abilities, and so on. Due to the limitations in our target group's communication skills (reading and writing), both the information offered in the video game and the performed tests must use symbols and animations, avoiding the use of words.

In particular, there are certain recommendations that we have found to be primordial in the making of a good video game design for children at this age:

- Proper and consistent feedback is essential for the child to be able to progress through the game. The game should behave similarly to similar situations so that children are able to understand how it works.
- Children must be able to take in everything that is happening. If they do not see what is happening, they assume that nothing happens.
- Avoid waiting times. If an application takes more than a few seconds to load, children will think that it does not work. It is necessary to include other activities or distractions for children who are waiting.
- Children do not need to access the application settings: only allow access to adults in order to prevent application malfunctions.
- The child's curiosity will enable him to explore all the options that he can. For this reason, it is necessary to limit his access only to the required options.
- Instructions should be appropriate to the age of the players. This is especially important in the age range on which we are focused (3 to 5 years old), because their reading ability is limited. Graphic icons and oral instructions are preferable, and the explanation should be able to be repeated.

A very important aspect to learn is motivation because it helps us to feel good while we are working. In the case of educational video games, motivation is a key factor to encourage children to play and, while doing so, to learn via the video game. Current works about motivation argue that it is better to encourage intrinsic motivation [Ryan, 2000][Pink, 2009] in the various activities of life (work, education, leisure etc); however, in the case of very young children, we think that using external resources can better foster motivation as they are not mature enough to perform

complex processes of self-determination. In this sense, some researchers (for example, [Pink, 2009]) propose three elements which trigger motivation and which should be included in the educational video games' design:

- Autonomy: Auto-administration skill.
- Mastery: Being able to dominate an activity or task provides personal satisfaction.
- Purpose: It is necessary to include a goal in the game and to make it reachable. In addition, players must be aware of how they advance towards that goal.

5 Analysis Method to Evaluate Emotions in Children

One of the main problems we have found when analyzing emotions in very young children is that their skills are still limited and they are not able to identify on a scale the sensations and emotions that they feel during the game. This occurs due to the complexity of discerning from among many adjectives or ratings. As a result, the traditional Likert's scales are not an option in this case. In addition, there are other limitations related to the psychological development of the children that should be taken into consideration at the time of the testing, such as: tests must be performed in environments that children know (for example, their classroom), in the company of people that they trust (for example, their parents or teachers), using a vocabulary adapted to their comprehension and using devices that they are used to, which could generate the necessity of a previous training.

Another important aspect to be considered is the very immersive hardware which is normally used to analyse emotions. These devices, such as eye-trackers (to record where you look), recording systems (to save the gestures made) or pulse monitors (to calculate the heart rate) are, in many cases, not very usable with young children.

Phase	Activity	Actor
Pre-Test	Making profiles	Evaluator
	Selecting individuals	Evaluator + Teacher
	Educative Evaluation	Teacher
Test	Playing	Children
	Observing	Evaluator or recording
Post-Test	Emotional Evaluation	Evaluator
	Educative Evaluation	Teacher

Table 2: Methods to evaluate emotions in children

Taking this into account, our evaluation proposal will be divided into three stages: Pre-Test, Test and Post-Test. The results will be documented following the standard CIF (SQuaRE) - Common Industry Format) ISO/IEC 25062 (2006). The activities conforming to our evaluation method are summarised in Table 2.

5.1 Pre-test Stage

In this stage, the main goal is to choose the profile of players to be studied, and to choose the children that meet those requirements. In order to determine the player's

profile, several aspects have to be established, such as age, gender (if it is relevant), previous experience with similar devices and questions related to the educational level of the players, which depend on the educational content included in the game.

At that point, the participation of teachers is fundamental, as they will guide us in the process of identifying the educational restrictions and the most interesting individuals for the tests. In addition, they will play the role of facilitators during the process.

In particular, we propose two tasks to be performed with the teacher:

- *Selecting of individuals for analysis*: Even though we could find a high number of pupils in the classroom, it would be necessary to discount the participation those who could introduce any kind of bias. For example, deaf pupils or those who have already mastered the game to be tested.
- *Evaluating previous knowledge of the educative contents included in the game*: The initial knowledge that students have of the content to be trained in the game is important. To obtain this information, we can perform tests or ask the teacher: if the educational content included in the game has already been practiced in the classroom, the teacher could inform us of the students' knowledge level in that content. This will allow us to reduce the testing time and, as a result, the children will be more focused, since young children could easily become tired if the experiment takes too much time.

As a result of this pre-test, we will obtain a selection of children to perform the analysis and an evaluation (high / medium / low) of the initial knowledge that children have of the educational content to be trained via the game. This latter information will be very important in order to set up the game according to each child's skills, because in the age range on which we are focused differences of maturity among the pupils can be very significant.

5.2 Test Stage

In this stage, two activities will be conducted: while the children are playing the proposed game, part of the analysis is being carried out, particularly that pertaining to observation and annotation. As the evaluation is centred on the emotions felt by the children during the game, and taking into consideration the previously mentioned restrictions, the observation method is based on the study of the non-verbal language expressed by children at significant points of the game (structured observation according to Table 1). To carry this out, we will record the gaming sessions.

In [Doherty-Sneddon, 2009], a study on the meaning of the non-verbal language of the children is conducted. More specifically, it is focused on four aspects:

- Hand gestures: During speech communication, we usually move our hands to emphasise some question or to report something we are talking about, for example. For children, this gesture is even more important, as their communication skills may still be in development. Three types of hand gestures can be distinguished:
    - Badges: They are directly and simply translated into words (i.e. "Ok" or the "V" for victory...)
    - Illustrative gestures: These are linked to speech. Generally, the quantity of gestures is increased when we are describing something complicated or when the subject of a discussion agitates or shocks us. They are almost impossible to understand when there is no knowledge of what is spoken.

  - Emotional gestures: These gestures are the most relevant to this work as they reveal the emotional state of the children without them having to describe those emotions. We will focus mainly on the following: 1) in order to reduce stress, they touch themselves more than usually (i.e., they scratch themselves, or touch their hair); 2) they suck their thumbs when in a state of conflict or negative emotions; 3) they touch their hair or ears when they feel tired; 4) they lean forward with clenched fists when they feel aggressiveness; and 5) when there is sympathy between people, they imitate their gestures and postures.

- Looks: As is indicated in the [Doherty-Sneddon, 2009] study: "The look has many functions in human communication", so we can use some of those characteristics in order to determine some emotions. More specifically, we will study whether the child stares at the floor in order to determine whether the game is causing him any kind of conflict, or if the child looks at the teacher/evaluator in approval or seeking information.

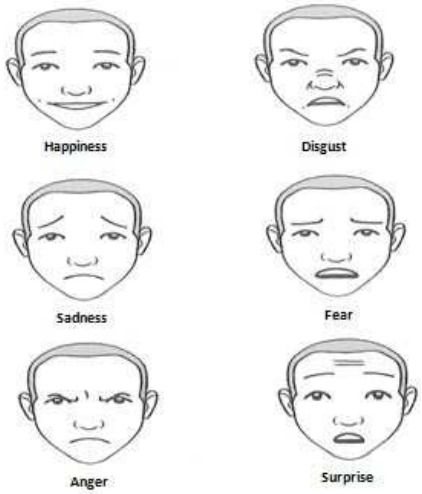

Figure 1: Facial expressions and their meanings [Cohen, 2007]

- Facial expressions: "Faces are particularly important to express emotions" [Doherty-Sneddon, 2009], for this reason, a very important part of the method is centred on the study of faces during play time.
  As the human being develops, he learns to control his facial expressions to reveal the moods he wishes to express, or those that are considered more appropriate in certain situations. However, this process develops over time and children in the age range on which we are focused are supposed to not have this skill. We can point out two types of facial expressions: 1) pretended or deliberate, which does not necessarily reflect how we feel, but how we want to tell the world we feel; and 2) spontaneous, which is a direct consequence of an emotional experience or feeling, and are shown automatically, naturally. Figure 1 shows a representation of the basic facial expressions [Cohen, 2007], which are going to be studied throughout the game.

- Touch: Inappropriate touch contact made by children (to other children) could be a sign that they are nervous or upset about something.

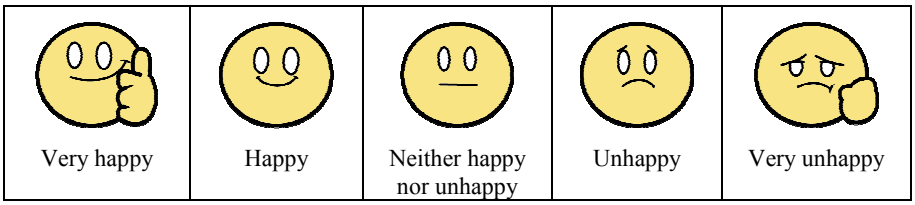

Table 3: Summary of existing methods

These four aspects of non-verbal communication are important for our evaluation method. However, the one focused on facial expressions needs to be modified in order to allow the children to use it since they could have some difficulties in distinguishing this kind of representation. Thus, the initial activity in the design of our analysis method was deciding how we were going to present the facial representation test to children. Initially, we tried to adapt the philosophy of Likert's scale by using sequences of emoticons (facial expression representations) for each of the moods we wanted to study. In this way, we asked children to select one of them according to how strong the feeling was each time. In Table 3 one of those sequences is shown.

When the emoticons were designed, coinciding with the video game development phase, we performed some informal tests. In those previous works, we realised that many of the children with whom we tried the emoticons were unable to grade how strong the feeling was, but that they could identify the feeling itself, as discussed, for example, by [Naidu, 2005]. Thus, we re-designed the emoticons choosing the one which better represented the mood in each of the cases.

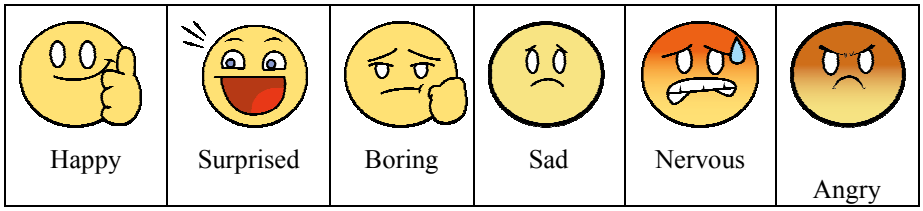

Table 4: Designed facial expressions

Once this informal study was conducted, we had a set of emoticons representing the set of facial expressions that we wanted to show, which had been especially designed for children. These emoticons are simpler and their features have been highlighted in order to allow the children to select the most appropriate in an easy way, decreasing ambiguity. In Table 4 we can see the final design of these emoticons.

During the test phase, the subjects of analysis will play the proposed game. While playing, a camera will record them, paying special attention to their faces, which will reveal the different sensations they are experiencing.

Subsequently, the videos will be tagged manually and analysed to add information about the emotions detected by using the previously explained four aspects of non-verbal language.

5.3 Post-test Stage

Usually, in the Post-Test stage, a set of questionnaires about different aspects of the game is drawn up and, in the specific case of educational video games, some tests are conducted in order to determine the knowledge acquired through the game. In our case, it is necessary to adapt these mechanisms to the constraints presented by the subjects at whom our evaluation method is aimed. Specifically, we will use emoticons in order to let the children express their feelings in a reduced set of scenes from the game. These scenes will be the ones that we consider to be most relevant and, because of their importance within the development of the game, may remain in the memory of the child. In addition, guided interviews will be conducted between pairs, so two or three pupils will talk about what they have done in the game or which part they liked most. In order to obtain the key information needed by the evaluator from the conversation, he or the tutor will sit with them and formulate questions to guide the development of the conversation, in order to avoid deviating from the concerns of the study. In some schools, teachers hold meetings with students that serve as a space in which they can share their interests and points of view. If the study is performed in a place such as this, this may be a good time to talk with the students about what they have done in the game, what they liked most, what they liked least and so on.

Furthermore, since we are analysing educational video games, it is important to know the extent to which the game has contributed to their education process. Thus, it will be proposed to the teacher that he conduct an activity related to the educational content of the game and provide us with the results obtained from each child in relation to their level of previous knowledge. We consider the carrying out of this activity in a regular way to be important in, for example, the classroom, with the teacher and his colleagues. In this way, this stage will be performed with the feeling of a normal day at school, as opposed to doing it with the evaluator, individually, without the teacher and outside the classroom.

We can deduct how well the educational activities have been performed in the game by using the obtained score. It is also desirable that the educational videogame makes a register of some of the aspects related to the process followed by children during the realisation of those activities in order to study the process of learning in addition to the result obtained. However, this part of the analysis depends largely on the type of game used and the educational content practised in it.

6 Case Study: "Ato's Adventure"

The educational video game "Ato's Adventure" [Abad-Arranz, 2012] is an iPad application which is in its final stages of development. It is intended for children aged from 3 to 5 and includes graph-motor exercises within a fantastic story that encourages imagination and brings enjoyment to the player.

Figure 2: Space Pirates in "Ato's Adventure"

In "Ato's Adventure" the player accompanies a group of characters through different planets. In this journey, players chase the Space Pirates, who have stolen their toys. The design of the characters featured in the game is geared towards provoking a range of emotions in the player. There are, therefore, *good* and *bad* characters and they are intended to cause empathy in children. To accomplish this, each character has a favourite toy, which contributes to the player being able to identify with them, if his favourite toy matches that represented, or simply because the player also has a favourite toy. Meanwhile, the evil characters are the Space Pirates who, although demonstrating inappropriate behaviour, have been given some comic components in order to avoid rejection (Figure 2).

Since carrying out a design focused on playability is very important [González, 2009], we have found that applying the proposed analysis method could improve the final version of the game. In addition, the age range of the players targeted by the game matches the profile of the subjects who are the object of the proposed method.

6.1 "Ato's Adventure", designed for children

For the development of the game "Ato's Adventure", the recommendations and guidelines presented in section 4 have been followed. First of all, a fantastic world has been created to capture the attention of children. A subject of fiction appropriate to the maturity of the children targeted by the game has been chosen so that we have a set of planets which the characters will travel along using spaceships. These planets are set in outstanding periods in the history of mankind, but with magical elements such as dragons or impossible machines. Even the main characters have fantastical elements because they are unknown creatures with the ability to change their shape (Fig. 3).

In the early stages of development, the idea of including a cooperative game mode arose, but after several interviews with experts, that idea was discarded because children at that age do not have the ability to play as a group.

Moreover, to satisfy the need for constant approval and to increase the extrinsic motivation that children have at this age, positive reinforcement is included during the performance of the activities and exercises, such as sounds of mind or error indications with the narrator's voice. Moreover, to keep the player's interest, there is a

set of short-term objectives that bring the player to the main objective (to retrieve the toys stolen by the Space Pirates).

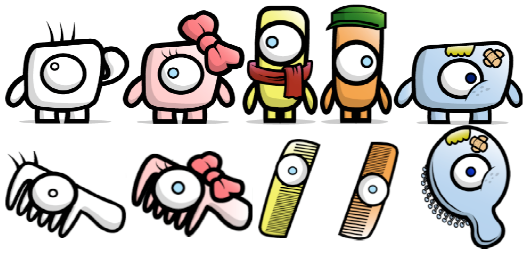

Figure 3: Comb shaped characters in "Ato's Adventure"

All the instructions are given to the player by the narrator using spoken instructions with a vocabulary adapted to the age of the players. In addition, we have a *help icon* on the upper left corner of every screen. This icon is represented as a child and, when it is touched, the indications needed to overcome the level are repeated. We can see the help icon in Fig. 4.

Figure 4: "Ato's Adventure": In the park.

All phases are overcome in the same way (similar behaviour): moving one or more objects from one point to another. The way in which these movements have to be made is always indicated by an arrow pointing to the object and the moving direction, a guide line, and a point indicating the final position. Concepts are included aimed at strengthening logical-mathematical knowledge and the ability of the students to identify attributes of objects and to build relations between them.

The educational content built into the game is achieved through diverse graph-motor exercises (with various types of graphs) that are hidden in the displacements of objects and characters that the players have to perform.

As regards waiting times, a memory management has been incorporated that enables the immediate loading of each phase of the game. Also, the set up menu is completely separate from the application (see Figure 5), within the general settings of the iPad device, so the player cannot access them accidentally.

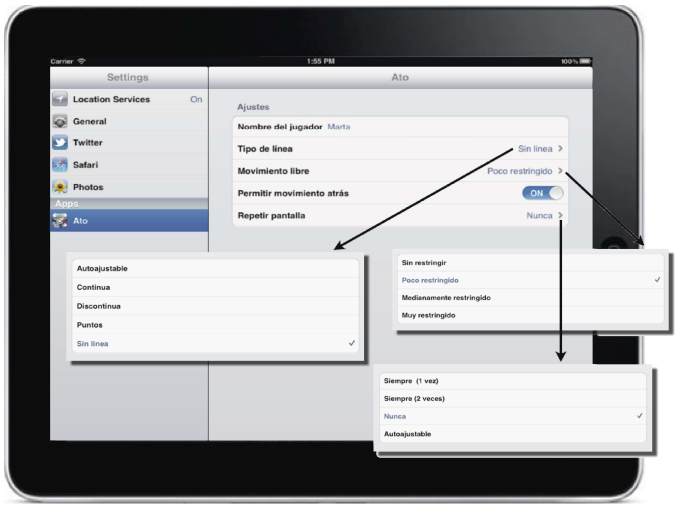

Figure 5: "Ato's Adventure". Setup Screen

Finally, regarding the motivation the game provides, it is interesting to note that the video game has been developed so that the child can play without being assisted by an adult (autonomy) and that the difficulty of the activities increases progressively (mastery).

6.2 Experimental Results

The proposed evaluation method was used in the game "Ato's Adventure" in order to identify the improvements necessary before its development process ends.

The evaluation test was conducted on a sample of 39 children of between 3 and 4 years old from two childcare centres in the metropolitan area and the city centre of Granada, Spain. All the children from the classes in which our study was conducted became part of the study sample, because all of them were at a similar level of development in graph-motor maturity. Furthermore, during the pre-test, an activity to measure their skills using the iPad device was included. Due to the device characteristics and the fact that touch technology allows natural interaction, most of the students had medium or high skills.

In particular, we conducted two case studies according to the following objectives: 1) Evaluate the ease with which feelings in the designed emoticons are

recognised; and 2) compare the validity of our evaluation method working both individually and in groups.

To achieve these goals, two different designs of case study were developed:

- Case 1: Only two emoticons were offered for the scenes regarding which we were going to ask about their feelings and the video game was played in the students' normal classroom, in the same seating arrangement.
- Case 2: Four emoticons were offered and the video game was played in a separate classroom, avoiding the noise from the playground and from other children.

Observing the non-verbal language of children while they are playing and the usage difficulties arising provides useful information for the evaluation of the playability and the set of interactive experiences in the game, and to complete its development. In our work, we have chosen a set of representative events in the game to study the emotions that they cause in children. Specifically, we selected six keys: 1) reaching the end of the guide line in graph-motor exercises (scene 1 in Fig. 6), 2) the moment when pirates steal toys from Ato and his friends (scene 2), 3) the scene when the pirates escape (scene 3), 4) the scene when the ship of Ato and his friends crashes during the chase (scene 4), 5) when Ato and his friends reach the pirate ship (scene 5), 6) the final scene, where Ato and his friends recover the toys but they have to be careful not to wake up the pirates (scene 6). In addition, due to the characteristics of the video game used in this case study we decided to only use the following subset of emoticons: 1) happy; 2) surprised; 3) boring, to represent both boring and unhappy; and 4) nervous, representing both nervous and angry. The main results obtained are explained below.

To perform the graph-motor exercises, there is: a starting point, marked by the element to move and a red arrow, the trace that the child must perform, marked with a line (in this case, dashed) and the end of the trail, marked with a red dot placed at the end of the guideline. Each time one of these exercises is completed, the game makes a sound that functions as a positive message. At that point, there were several gestures from the players: laughter, looking at the tutor for approval, raised arms, sighs, hands joined on the chest or small hops on the chair. All these gestures are interpreted as a feeling of satisfaction because of the joy that the child feels when he successfully completes an activity.

Watching the scene where the pirates steal the protagonists' toys, the children showed a high variety of expression. Although all these gestures were a sign of surprise, we can distinguish various shades: sheer surprise (raised eyebrows, blinking repeatedly, pursing the lips without actually closing or opening the mouth), nervousness (lip biting and nervous laughter) and pity (biting the lower lip, frowning or raising the eyebrows while lowering the corners of the mouth). In these reactions, it follows that the players empathise with the characters in the feelings they may have because of losing their favourite toys

Throughout the story, the pirates escape several times. Given this situation, many children asked the tutor about recovering the toys and made gestures such as biting their lips, raising their eyebrows and widening their eyes. From this it follows that their motivation is maintained and that the players remember that they must chase the pirates to recover the stolen toys.

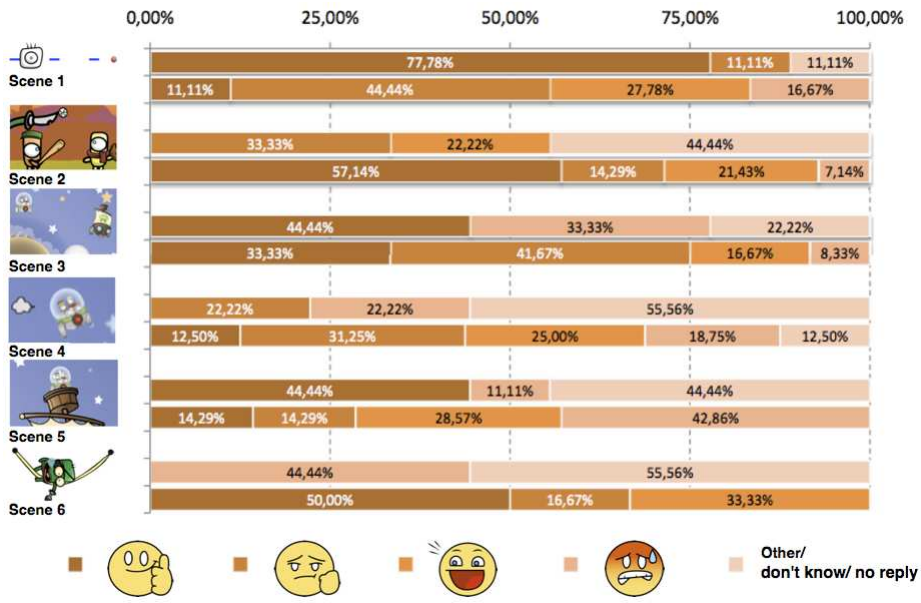

Figure 6: Post-test results

At one point in the story of the game, the ship of the main characters is damaged. Although some children did understand the scene and their gestures showed surprise and concern about the problem involved (eyebrows raised quickly, raise their hands, etc), most of them did not understand the situation and requested more information about the game, asking the teacher, or simply becoming expressionless.

However, when they reached the pirate ship, most of the children showed joy, (opened their eyes and mouth, laughed etc) because they knew the recovery of the toys was coming.

The final screen of the game consists of a scene in which the pirates are sleeping and the player has to bring the toys to the protagonists without touching the pirates in order to avoid waking them up. During the development of this activity, the following gestures have been observed: relaxing the mouth, frowning, moving closer to the screen, laughing nervously, touching their hair, biting their lips etc. These gestures reflect the situation of stress and higher concentration to finally achieve the goal that has been present throughout the game.

During the post-test, children were asked about the same key points discussed in the analysis of non-verbal language. Figure 6 shows the obtained results. Each pair of bars represents the result obtained in the screen placed on the left side, the upper bar refers to case study 1 and the bottom bar to case 2. The divisions along each bar represent the percentage of students who selected each emoticon previously presented. The first one means happy / approval, the second one boring / sad, the third one surprise / very happy and the last one is angry / nervous / frustrated. The last option means another state or no answer.

By comparing the results of test and post-test, we perceived a correspondence between the reactions observed in the children and the emotions that have been subsequently chosen by them. The results also demonstrate that the ability of the child to express feelings is associated with his ability to identify the emoticons and to give them one or more meaning. With this knowledge and thanks to the dialogue between the student and the evaluator, it has been proven that, generally, the selected events in the game have conveyed the emotions that the developers intended: completing an exercise has caused joy and satisfaction, theft has come as a sad surprise for the players, but it increases their interest in continuing the game, and finally, the persecutions , the breakage of the ship of the protagonists and, above all, the final scene, retrieving toys, have transmitted tension to the player and enhanced motivation.

6.3 Discussion

As a result of this experimentation, we have found several points that could be improved upon and which, therefore, will be addressed in the final development phase of "Ato's Adventure".

With regard to the presentation of the story, we must divide the introductory video (intro) into two parts, so that, before actively playing, the child knows the protagonists and their favourite toys. In this way, we will connect with the children from the beginning of the game. Moreover, it was found that the majority of the children do not recognize the baseball game played by Titin and Pipín, the twins. We think that acceptance of these characters will be made easier if we include another game with which children are better acquainted. Finally, although the children understood that at the end the toys had been recovered, we think that including a video in which the pirates appear defeated or angry and the protagonists look happy playing with the recovered toys, could strengthen the children's satisfaction.

Moreover, we detected some technical features that should be modified to enhance the gameplay and quality in use of "Ato's Adventure". In particular, there are two elements to modify: the first one consists of increasing the action area of the elements that children should move when they are very small. Currently, the enabled touch area for scrolling occupies only the same size as the object, which makes it hard to perform exercises on screens with several objects, because they have to be smaller. Second, when the difficulty of the exercise increases, we think that instead of moving an object, the exercise would be better if children were asked to draw an item: with zig-zag lines, objects did not allow children to see the guideline and they did not know if they were doing it well, as on this screen also the elements that move are smaller than previously.

Finally, regarding the emotions which the game causes, changes are needed in two areas. Although children know that they have to do the activities proposed to achieve the objective, we think it is necessary to include elements explaining to the student how this activity contributes to approaching the pirates and retrieving the toys; for example, the player gets a key after each exercise block, knowing that with that he will be able to open the chests where the toys are locked at the end of the game. In addition, we will introduce more stories, videos and sounds during the realisation of the activities to introduce more playful elements that increase student motivation and their immersion in the story.

7 Conclusions and Future Works

In this paper we have presented a method which allows us to evaluate the emotions of children aged 3 to 5 playing an educational video game. We have introduced the particularities to consider and how an analysis based on them could be made.

This method is divided into three phases: pre-test, test and post-test. In both the pre and post-test phases, we have determined that the teacher is vital because of information that they already have about their students and the existing trust between them, which makes the test process with the users easier. Therefore, it would be desirable that the information about the previous knowledge of each child and the evaluation of the skills acquired from the game be given by the teacher.

During test phase it is necessary to limit possible distractions which, for children at this age, could come from numerous sources. Therefore, it would be desirable to carry out the experience with small groups, in which each one has a separate evaluator.

With respect to post-test, there were some circumstances worthy of comment. First, the emotional post-test evaluation cannot be realised independently of the non verbal language observation, because the emoticons which have been used could have a different meanings for each child, and the same child could give different meanings depending on the particular question. These ambiguities are solved through dialogue between the evaluator and the child and checking the expressions the children have made. Therefore, it has been observed that, if the test is performed maintaining a dialogue which allows us to know the meaning the child gives to the emoticons, the results and the test match in regard to the emotion (or lack of emotion) which each event has prompted in the players. Also, it is important to say that there is a percentage of children who we have to work with who are not able to give a meaning to the emoticons. This inability, according to discussions with their teachers, is related with their maturity level and their own expressive power.

We are currently defining new emoticons that children can recognise more easily. Therefore, we are analysing the gestures they make and studying how to translate them into figures. We also think that options could be introduced through the different phases which enable studies to be carried out with other age ranges, maintaining the philosophy of analysis. Finally, our future research is based on the formal study of the relation between including emotions into video games, playability and motivation.

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