Educational Games: Motivation and the Role of Multimedia Representations

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It is often argued that the factor of motivation is the most important one in Educational Games (aka EduGames). This paper investigates the role of this factor as it is expressed through the multimedia representations employed in the game. A case study has been performed with the participation of 11 children aged 6-14 years. The locus of this study is not to assess the software, but merely investigate a framework to explain how users are motivational affected by means of the multimedia representations used. Bearing this in mind, a well-known taxonomy concerning the educational representations has been used, and the ARCS model of motivation has been considered, in order to interpret the obtained data from the study into results of educational value. The results show a clear domination of animations, followed by sound, which proved to be the most motivating factors.

Keywords
ARCS model of motivation, multimedia representations, educational games.

1. Introduction

There is already adequate evidence in the domain of computer or video games. Journals, such as ACM's Computers in Entertainment (http://www.acm.org/pubs /cie.html), or focused conferences, such as the workshop «Games And Social Networks: A Workshop On Multiplayer Games", held during the 18th British Group HCI 2004 annual conference at Leeds (details at http://www.dcs.gla.ac.uk/~barry/gamesworkshop/ as well as at the HCI 2004 website http://www.bcs-hci.org.uk/hci2004/), are not yet common, nevertheless they cover satisfactorily a domain, which however should be more turbulent.

In addition to this, some deliverables from EU funded research programs exist as well, such as the detailed report on the domain from the KITS consortium [10]. This study examines the theoretical analyses and empirical results from research in the area of instructional use of games and simulations. It mainly focuses on approaches taken in designing game (-like) learning environments and distils a list of characteristics of games from the instructional theory. It also tries to find evidence concerning the appropriate learning approaches and measures, which can optimize the learning effects of games and simulations.

These sources are a good starting point, however one would wish a broader coverage of the domain, considering the great consensus on the value of EduGames in the instructional procedure. Under this point of view, current research is not intensive enough, results are far from sacrosanct, and the technological progress far from satisfactorily. So, motivation of this study was to investigate the role of various representations, usually employed in EduGames, under a motivational view.

2. Description of the Software and the Study

The freeware software (2 versions on 7 Cds) „Perry and Katia – Let's go to school" series has been used, which is freely distributed in Greece. It is based on Macromedia's Flash® and covers a broad spectrum of lessons for the first six classes of the school (ages 6-12). Eleven children, aged 6 to 14 participated and used the 7 Cds for a three days period. Perry is the dog, Katia is the cat, and the interaction between them in different domains provides the learning environment with which the child can interact. The scope of the software covers a broad spectrum of lessons taught at primary school. Aspects covered (in a variety of levels) are, among others, arithmetic and mathematics, geometry, geography, language, time calculations, and logical matching. This software is more or less representative of the majority of the used educational games; this is also the reason why it has been chosen as a case study. There are of course many exceptions, however as regards to the representations used this software belongs to the majority.

The study approach followed utilizes the participatory observational approach. A set of tasks has been predefined, covering almost all domains of the environment, and the children were encouraged to "play" in the particular area. Observations of the occurrences were recorded in a notebook. It is obvious that the particular tasks were adapted to the particular age, e.g. arithmetic tasks were different for 6 years old than for 10-year-old children.

3. Characteristics of the Representations

It must be emphasized from the beginning that the animations and sounds are mainly used to motivate the pupil, than to represent cognitive aspects to be dealt with. This is the case in other EduGames as well, as multimedia elements are used rather as decorative and stimulating elements than as vehicles to transfer and manipulate the offered knowledge. On this notification will later be based the discussion on the motivational parameters of the environment.

So, the utilized here representations provide following characteristics, according to the taxonomy of [2], depicted also in the European NoE Kaleidoscope [7]:

Multiple representations. Animation, text, image and sound constitute the set of the employed representations. There is no use of video.

Code and modality. The navigational elements are all animated icons. They (the representing world) depict a navigational structure (the represented world), which is usual in educational environments: next, previous, home, exit, repeat and help. The rest of the representations occur where interaction with the user is possible. A narration prompts the pupil to act and provides help on it. So, we are talking in both cases of depictive and non-equivalent representations, which are however multimodal, as they employ aural, visual and tactile modes to interact with the user (the user is often asked to type something). Although, from a usability perspective it could be debatable in how far the used navigation icons are intuitive to a novice user of this age, the application of the software showed that children can easily overcome such burdens with little or not at all help. The exploratory nature of a child permits it to explore the interface and discover its capabilities. Important is here the "prevent errors" usability factor, so as to hinder fatal errors an exploring user could cause. Such occurrences did however not happen during the use of this software.

Animation seems to provide potency for dynamic and kinesthetic (manipulable) types of representations. However, in the particular case, only concrete, pattern imagery and symbolic elements are represented. As already stated, the majority of the animations concerns navigation or feedback actions on the interface. Animation for feedback is considered here to belong to the pattern category, as it only informs the user on the correctness or not of his/her action. As it is obvious, we are dealing here with depictive feedback (if it is correct or not) and not with constructive feedback (in what direction one should seek for the correct solution).

Affordances. Rarely the visual representations in this case study provide concrete affordances, e.g. by helping to visualize the information. In this sense, they help to structure the cognitive activity and provide patterns for experimentation. In most other cases animations and sound cues are used as feedback or as a helping facility (explaining narration).

As regards to the *dimensions* of the used representations, it can be argued that this aspect is here not applicable, as it does not concern depictive modes, such as the crossword or the time representation modules, which are more or less an "information container". The scope of these representations is relative broad, as they are abstract enough to be applicable in almost all corresponding situations. In other words, the crossword representation suits for all wording exercises, while the watch representation (with the embodied interactivity) provides additionally a detailed granularity, corresponding to the one of the real world. In this sense, all used representations in the particular software are time-singular instances, according to the classification by [1].

Concerning the underlying *theoretical support*, the theories of dual coding and cognitive load seem to be implicitly employed in the design of the system, however there are not clear indications that the authors intended to do so. Dual coding theory is de facto implemented in any multimedia environment, and its ultimate purpose is to reduce cognitive load, so it can be argued that the use of multimedia animations intends to benefit from these theories. In contrary, *multimedia design theories* seem to be explicitly employed in the design and construction of the interface. Image, text, animation and sound are extensively used and extensively perceived by the children who used the software. It was observed that older children equally paid attention on all modalities, while younger children showed a clear preference to aural feedback and avoided to read or write the text.

As regards the *cognitive modeling support*, it is not apparent in the designers' intentions, although the overall interface does not provide any problems on it. Children could easily work in the interface, without any hindering. One remark must be stated here, concerning the redundancy principle and the claim "avoid presenting verbal information in both textual and narrative form especially when graphics are presented at the same time", which is in accordance to our observations, and a claim stated by [6] that "it (the game) must not contain narration; everything must happen in the now of the playing". It is already stated that there has been observed a clear preference of the narrative form instead of the text for younger children. A more detailed discussion on using multiple representations on educational software can be found in [13].

At this point, the provided *degrees of freedom* must be discussed. The overall environment can not be characterized as a constructivist one, as most of the exercises are already known to the pupils from school and must be performed in a pre-defined way. The environment simulates the school environment, by providing virtual classrooms and blackboards, as well as themes from the real world, such as a clock or a crossword. So, it can be argued that the used representations significantly reduce the degrees of freedom, while they provide only limited affordances.

Direct results of the above are two effects; one (positive) concerns the problems of the presentations, which are now diminished, and a second (negative) that no collaboration activities are implemented. The syntax is clear and consistent through the whole set of CDs, translations between the representations are coherent and reasonable. On the other hand, the environment is used as a stand-alone application and the participating children worked in it one after the other, with no option to collaborate, besides the questioning and answering between them on the presented activities, as they usually sat in groups in front of the computer, however, only one child operating the environment at any time.

As a result of the above presented, it can be elicited that no clear purpose on resulting benefits due to the use of the particular representations has been set by the designers. From an educational perspective, the software only mimics the school duties and represents them in an electronic form. It does not base on any specific educational theories, or targets to achieve some special results, due to the use of the representations. One can argue that this is about an entertainment educational piece, based on well-known school activities. However, the particular software is very popular to children, and is used and maintained since several years. The children referred to it as “to play with Perry and Katia”, indicating that the playing parameter is perceived to dominate over the educational one. So, the emerging question is what makes the environment so popular and stimulates the children to use it. We believe that the explanation must be seeked in the examination of the motivational factor.

4. The Motivational Factor

Although the extensive use of animations provides a fruitful background for simulations, it is rarely the case in EduGames, or the simulations are limited to a low percentage of the software. This has its reasons, as the high complexity of simulation environments, the design and construction difficulty and the bad cost/performance factor. So, the emerging question is “why then to use animations?” [5] emphasize, “Students like to watch animation even if they do not really get any substantial learning benefits”. So, designers often implement animations mainly to activate students to deal with the environment, in other words to motivate them. It seems that designers of EduGames see the animation rather as a motivational and stimulating factor than as a possibility to represent a real system in another way. So, the issue of motivation emerges here and must be discussed.

4.1. Keller's ARCS Model for Motivation

Motivation is the most overlooked aspect of instructional strategy, and perhaps the most critical element needed for employee-learners. [12] states that a sine qua non of successful learning is motivation: a motivated learner can’t be stopped. Even the most elegantly designed training program will fail if the students are not motivated to learn. Without a desire to learn on the part of the student, retention is unlikely. Many students in a corporate setting who are forced to complete training programs are motivated only to "pass the test." Designers must strive to create a deeper motivation in learners for them to learn new skills and transfer those skills back into the work environment.

As a first step, instructional designers should not assume they understand the target audience's motivation. To analyze needs, the designer should ask prospective learners questions such as:

- What would the value be to you from this type of program?
- What do you hope to get out of this program?
- What are your interests in this topic?
- What are you most pressing problems?

The answers to these types of questions are likely to provide insight into learner motivation, as well as desirable behavioral outcomes.

John Keller synthesized existing research on psychological motivation and created the ARCS model ([8], [9]). ARCS stands for Attention, Relevance, Confidence, and Satisfaction. This model is not intended to stand apart as a separate system for instructional design, but can be incorporated within Gagne's events of instruction ([3], [4]).

Attention. The first and single most important aspect of the ARCS model is gaining and keeping the learner's attention, which coincides with the first step in Gagne's model. Keller's strategies for attention include sensory stimuli (as discussed previously), inquiry arousal (thought provoking questions), and variability (variance in exercises and use of media).

Relevance. Attention and motivation will not be maintained, however, unless the learner believes the training is relevant. Put simply, the training program should answer the critical question, "What's in it for me?" Benefits should be clearly stated. For a sales training program, the benefit might be to help representatives increase their sales and personal commissions. For a safety-training program, the benefit might be to reduce the number of workers getting hurt. For a software-training program, the benefit to users could be to make them more productive or reduce their frustration with an application. A healthcare program might have the benefit that it can teach doctors how to treat certain patients.

Confidence. The confidence aspect of the ARCS model is required so that students feel that they should put a good faith effort into the program. If they think they are incapable of achieving the objectives or that it will take too much time or effort, their motivation will decrease. In technology-based training programs, students should be given estimates of the time required to complete lessons or a measure of their progress through the program.

Satisfaction. Finally, learners must obtain some type of satisfaction or reward from the learning experience. This can be in the form of entertainment or a sense of achievement. A self-assessment game, for example, might end with an animation sequence acknowledging the player's high score. A passing grade on a post-test might be rewarded with a completion certificate. Other forms of external rewards would include praise from a supervisor, a raise, or a promotion. Ultimately, though, the best way for learners to achieve satisfaction is for them to find their new skills immediately useful and beneficial on their job.

So, following parameters have been examined:

Attention (Interest and curiosity). It has already been stated, “fancy graphics can capture students' interest”. As a cartoon-based software shows a very fancy and colorful screen, the factor of interest is here well served. The children equally attempt to give correct and wrong answers, just to see the reaction of Perry (or Katia). An important parameter of interest is, that it must be maintained over time. So, in this particular case study, animations prove to fulfill this requirement. A second parameter to preserve curiosity is to provide learners with unexpected and unpredicted events. As every animation is different in any context, this parameter is maintained perfectly.

Relevance. Cartoons are, by default, relevant to the children’s’ nature. They consume a lot by TV watching and they learn also through the stories displayed. So, the cartoon animations in this software are very relevant to the children’s’ interest. Through the case study, children were able to notice every new figure emerging on the screen and characterize it correctly (“Look! Perry as a fireman!”), even if the (adult) observer failed to.

Confidence (Expectancy). No such factor was apparent in this case study. Expectance of success was observed only in cases were the correct answer was difficult to achieve, and the resulting animation was not revealed. However, it was observed that children loosed quickly interest and proceeded to the next exercise, as there are plenty available on the 7 CDs. So, it can be argued that a certain failure in the educational parameter is stated, as there was a clear locus by the children only on the entertaining one.

Satisfaction and outcomes. There was no clear aiming to achieve any target, as the entertainment orientation of the software dominated. Satisfaction was also granted through the flexible navigation structure, as the completion of one exercise was not prerequisite to go further on. So the children could repeat favored exercises and neglect more “difficult” ones, as it was observed during the case study. On the question “why don’t you like this exercise”, the answers varied from “it is difficult” to “Perry/Katia behaves stupid here”. In conclusion, the option to neglect an exercise and repeat another seemed to stimulate the children at most.

5. Conclusions

The use of animations as the main means to represent is proved to be a very substantial part of the software, especially as regards the motivational factor. However, not all representations in the studied software were animations. Sound, text and images also contributed to motivate the young users. As already stated, sound seemed to be a substantial part, especially for younger children. Representations of other aspects of the world, such as the clock, seemed familiar (factor of relevance) and supported the transparency of the interaction with the environment.

As a final conclusion it can be stated that, although the educational value of such an EduGame is underrepresented, its motivational potency is very high, providing thus a good starting point. The problem here is that designing an educational game is fraught with difficulties beyond those normally associated with writing a "normal" educational software program, as there are conflicts between educational and entertainment goals [11]. The present case study shows that extensive use of animations and sound as the main means of representations can help children to interact transparent and intuitive with the educational environment. So, a more careful and precise educational design is highest insisted, if one wants also to implement a high educational value to an already highly stimulating environment.

A final clear result was that older children (12-14 year old) quickly covered the scope of the CDs and became bored. Animations and sounds were no more a stimuli for them and they simply stopped participating. An explanation here could be in the factors of attention and relevance. [14] states that games provide options for creativity in assignments, possibilities for extensions, and opportunities to develop projects through a sequence of assignments. They also allow assignments to be described in layers, where a moderate level of functionality is required for a "C", additional features constitute a "B", and extensive refinements yield an "A". So, if the design of the software is single layered, it fails to maintain the interest of the user over time (attention) and the user sees no clear benefits from an extended use. This result is of paramount importance when it comes to design educational pieces, which must be used over a longer period of time.

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