CHAPTER 11: Motivation and Representation in Educational Games

Athanasis Karoulis and Savvas Demetriadis
Informatics Department, Aristotle University of Thessaloniki , Greece
karoulis@csd.auth.gr, sav63@csd.auth.gr

Abstract. This paper concerns the domain of educational games (in this paper called EduGames). It does not concern computer (or video) games in general, although many parallelisms are made throughout. Core point in this work is the fact that computer games, in general, are very popular, while it cannot be argued the same for educational ones. So, the main question to be addressed concerns some of the main directions current research deals with, which domains are missing or underrepresented (in contemporary research) and finally to pinpoint some interesting questions, not yet addressed or underestimated. Through this study, the motivational factor emerges as an important factor as regards to the representations used. A case study has been performed; the results are presented and discussed. A clear result is that the use of animations and sound as the main means for representations is highly motivating for the children, however a concrete and careful design of the educational parameters must be performed at the design stage, in order not to diminish its educational value.

11.1 Part I - Contemporary Research and Core Questions on Educational Games

11.1.1 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", to be held during the 18th British Group HCI 2004 annual conference at Leeds[18] are not yet common, nevertheless they cover satisfactorily a domain, which however should be more turbulent, in our opinion.

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 (Leemkuil et al., 2000). 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.

---

[18] Details at http://www.dcs.gla.ac.uk/~barry/gamesworkshop/ and at the HCI 2004 website http://www.bcs-hci.org.uk/hci2004

So, in this work it is attempted to pinpoint some interesting research directions, while some core questions are stated, which are believed to offer enough initiatives for further research.

11.2 Research Directions

11.2.1 Application of EduGames in practice

In contemporary research, major point of concern is the application of EduGames in the classroom, or, more generally expressed, in the instructional procedure. This research direction represents the majority of the published research. A close enough estimation of this percentage could be 75%. A great deal of research focuses on computer literacy and basic programming skills.

Playing computer games is a popular recreational activity for young people. Not surprisingly, many of these enthusiasts dream that one day they will develop computer games themselves. So why not use game design as a vehicle to teach youngsters computer science? Developing computer games involves many aspects of computing, including computer graphics, artificial intelligence, human-computer interaction, security, distributed programming, simulation, and software engineering. Game development also brings into play aspects of the liberal arts, the social sciences, and psychology. Creating a state-of-the-art commercial computer game is an incredibly difficult task that typically requires a multimillion-dollar budget and a development team that includes 40 or more people. But simpler alternatives - ones within the reach of students and hobbyists - exist. Budding game developers can have fun creating variations on Pac-Man, Space Invaders, or simple platform games (Overmars, 2004).

Logo (www.logosurvey.co.uk) and its many variants provide the classic example of a programming language aimed at creating interest among youngsters. Primarily seen as a language to make drawings, with Logo, the user steers a virtual turtle to draw shapes onscreen. Even the basic program can make fancy drawings this way, while modern versions extend Logo's possibilities considerably. For today's users, spoiled by console and computer games, Logo is no longer flashy enough, however. Steering a virtual turtle can't possibly compare with steering a real robot, which probably accounts for much of Lego MindStorms' success (www.legomindstorms.com). With the admittedly limited software that comes with this system, users can create and program their own robots. Fortunately, third-party developers have written complete programming languages for these robots, most notably NQC (http://bricxcc.sourceforge.net/nqc/). The main disadvantages of using robots to learn programming are their expense and limited programming possibilities. On the other hand, robots do provide great vehicles for explaining concepts such as parallel tasks.

However, all these educational approaches support more or less the persistent public image of computing as a field of programmers. In other words, many people believe computer science is only a technology field without much science and engineering (Denning, 2004). To reverse this myth, stands on the same vehicle with the challenge to apply educational toys beyond programming: perceptive, psychological (mainly motivational) and personal factors play a major role, and are discussed later.

11.2.2 Benefits and Harms

Another focus theme in contemporary research is the discussion concerning benefits and harms of the use of games by young people, in the classroom or in private. Several arguments are commonly cited for the use of games in the computing classroom. Among others, Walker (2003) states as advantages:

A. *Motivation*: (a) Some students find games very motivating, and (b) Many students have prior experience with a variety of computing games, so using games in courses may connect with students' background.

B. Fancy graphics can *capture students' interest and imagination*.

C. Games are often *easy to understand*, so developing programs that play games can highlight problem solving, data structures, classes/methods, and other high-level skills.

D. Games provide *options for creativity* in assignments, possibilities for extensions, and opportunities to develop projects through a sequence of assignments.

E. Games 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".

F. Games provide opportunities for *the early introduction of elements of modern technology*, such as client/server computing, concurrency, and object-oriented programming.

While games have various constructive elements within the classroom, various reports suggest that many positive elements also have counterbalancing negatives. Here are some commonly cited problems for the use of games. (Numbering is keyed to the points in the list of positives.)

A. *Motivation*: (a) Some groups, particularly women and other underrepresented groups, are often turned off by competitive games. Students in these groups often want an emphasis on socially constructive applications. (b) An emphasis on games may reinforce the popular misconception that video games represent a major component of computer science. (c) Games and game playing can be quite addictive, so emphasizing games in the classroom can reinforce anti-social behavior. (d) Assignments utilizing games can encourage distractions during class sessions, as students show off their programs.

B. *Graphics*: (a) Much class and/or student time can be devoted to graphics and I/O. If there is not a corresponding emphasis on HCI, game interfaces could focus on personal idiosyncrasies rather than principles and analysis. (b) Extensive time devoted to I/O can limit time available for such fundamentals as algorithms, data structures, and software engineering.

C. *Extensions and Creativity*: (a) Encouragement to add features may undermine a sense of writing to specifications and considering actual customer needs. (b) Options for extended functionality may encourage program bloat and unnecessary complexity.

D. When grades depend on multiple levels of functionality, *true beginners* (who often are students from underrepresented groups) can be at a significant disadvantage for the best grades and building self-confidence.

11.2.3 Classification

Some research also attempts to classify games, in general, and EduGames in specific. Games encompass many styles and subjects. For example, games may be competitive or cooperative, be played by individuals or groups, and touch on numerous themes, such as adventure, education, social interactions, science fiction, violence, and sexual circumstances. Simulations sometimes are considered games as well. Leemkuil et al. (2000) argue that games as learning environments are closely related to simulations, microworlds, adventures and case studies. The definitions of these environments partially overlap. For instance, the distinction between simulation and games is often blurred, and many recent articles in this area refer to a single "simulation game" entity.

11.3 Interesting Questions

This work aims to extend itself to questions addressed by current research and propose directions and further interesting questions, not yet addressed. Under this point of view, following research questions extend the above presented.

11.3.1 EduGames are underrepresented

If the benefits of using games in the instructional procedure are so clear, why then are they not yet a vital part of contemporary education? While gathering comparable statistics is challenging, there is one estimate of the relative size of the computer gaming industry. The Interactive Digital Software Association reported "2001 U.S. sales of computer and video games grew 7.9 percent year-on-year to $6.35 billion, ..." (See http://www.idsa.com/2001SalesData.html). Also, the Information Technology Association of America combines information and communications technology (ICT) products and services within its definition of the information technology industry and reports that "U.S. spending in ICT has increased almost 70 percent since 1992, to almost $813 billion in 2001." (See http://www.itaa.org/news/gendoc.cfm?DocID=120). Putting these numbers together, computer and video games made up 0.78% of total IT sales for the year 2001. This number is obvious far from satisfying, taking into account that these facts represent games in general and not only EduGames. An explanation here could be 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 (Moser, 1997). In realizing the problem, big enterprises are seeking solutions. Microsoft has sponsored a "Games-to-Teach" project at MIT, which is building games for learning difficult concepts in physics and environmental science on the X-Box and Pocket PC (http://cms.mit.edu/ games/education/index.html). Lucas Arts has lesson plans on its website to help teachers use its games to teach critical thinking (http://www.lucaslearning.com/ edu/lesson.htm). A UK study by TEEM (Teachers Evaluating Educational Multimedia) has shown that particular off-the-shelf games can help youngsters learn logical thinking and computer literacy (http://www.teem.org.uk/aboutteem/ press/article?nid=92). And the Liemandt Foundation has designed a contest in which college and graduate students create learning games to teach middle school subjects, competing for a $25,000 first prize (http://www.hiddenagenda.com).

Given the almost perfect overlap between the profiles of gamers and military recruits, the US Military uses over 50 different video and computer games to teach everything from doctrine, to strategy and tactics (http://www.dodgames community.com). One of these, “America’s Army: Operations,” a recruiting game released for free in 2002, now has almost 2 million registered users, with almost a million having completed “virtual basic training” (http://www. americasarmy.com).

So after all, why are educational games underrepresented in the instructional procedure? Some possible reasons could be suboptimal application scenarios, or lack of motivation. Prensky (2003) also states that despite all the findings, research, and cries for help from the kids in school, many parents and educators still tend to think of video and computer games as frivolous at best and harmful at worst. The press often encourages this with headlines about “killing games”, when in fact two-thirds of all computer and video games are rated “E (everybody)”, and 16 of the top 20 sellers are rated either “E” or “T (teen)”.

There are however, many more reasons for this phenomenon, which research has to find out.

11.3.2 Does the “ZPD” play an important role in EduGames?

The zone of proximal development (ZPD) as described by Vygotsky (1930, 1978). Most of contemporary research argues that the application of educational games is of benefit to the learner, however, extremely low percentage emphasizes the aspect that, in fact, the educational game is the scaffolding factor, which aids the learner to the crossing of the ZPD. So, an interesting question in this direction is the mapping between the principles of the ZPD-theory with those of the educational theories, using the educational game as a catalyst.

An optimized view of the application of ICTs in the classroom argues that contemporary research in learner-centered design is developing new technology, curricula and professional development materials that integrate desktop and handheld computers into classrooms to support activities as diverse as story writing, scientific field experiments and online research (Lee et al., 2004). Educational design recognizes that learners have unique needs – such as a lack of background knowledge and a lack of motivation – that need to be addressed in the design of educational software tools (Quintana et al., 2003). When using educational technology, learners’ needs arise both from the tool and from the activity. For example, in order to use a word processor to write a cover letter for a job application, learners must understand both how to create and edit a file using the word processor (a need arising from the tool) and what content and format is required in order to create a good cover letter (a need arising from the activity). To address learners’ unique needs, educational technology practitioners often incorporate additional supports or “scaffolds” into their educational software. Scaffolds are temporary supports that assist learners in engaging in an unfamiliar task (Bransford et al., 2000). In software, scaffolds often appear as part of the user interface, providing support and guidance throughout the activity.

11.3.3 The factor of motivation.

Prensky (2003) states that a *sine qua non* of successful learning is motivation: a motivated learner can’t be stopped. Almost every paper dealing with educational games refers to the term "motivation" somewhere in the text; however the term itself is seldom defined, neither is it adequately explained as regards of the motivational parameters underlying the context of its use. An aid here could provide the four-factor theory of John Keller (Keller, 1983). According to this researcher, motivation can be analyzed into four distinct factors:

i. *Interest & curiosity* refers to whether the learner's curiosity is aroused and whether this arousal is sustained appropriately over time
ii. *Relevance* refers to the learner's perception of personal need satisfaction in relation to the instruction, or whether a highly desired goal is perceived to relate to the instructional activity.
iii. *Expectancy* refers to the perceived likelihood of success, and the extend to which success is under learner control.
iv. *Satisfaction & outcomes* refers to the combination of extrinsic rewards and intrinsic motivation, and whether these are compatible with the learner's anticipations.

According to this theory, vague claims, such as "students find games very motivating", can be analyzed in more detail, as «they have prior experience" (the *relevance* factor) or «women are often turned off by competitive games" (the *expectancy* factor).

Moser (1997), in attempting to answer the question why learning to program is so difficult, argues that it is merely computer- and knowledge-centered than human-centered. He argues that programming is a multi-layered skill, it is unrelated to much day-to-day experience, it is learned in a single context, it is boring and it is intimidating. In an attempt to optimally facilitate knowledge acquisition, most educational software encloses more or less all of these pitfalls as well. So, the question of the motivational factors that must be present in any EduGame is still to be addressed.

Malone (1980a, 1980b) also studies the question "what makes things fun to learn?" and gives a *taxonomy of intrinsic motivation*, according to three categories, *challenge*, *fantasy*, and *curiosity*. He concludes in a list of heuristics, as follows: A *goal* whose attainment is uncertain (subdivided in several corresponding conditions), *fantasy* involvement (also subdivided in extrinsic and intrinsic fantasy, as well as emotional aspects of fantasy), and *curiosity* (also divided in sensory and cognitive curiosity). There is obviously a matching between these parameters to the four Keller's factors of motivation, which in its turn implies that research based on this theory is on good track.

11.3.4 The factor of addiction

In contrary to this, the issue of addiction is, by so far, not studied enough. In a recent survey on how computer games affect students' school performance, Messerly (2004) states that in fact (games) ruin the social and scholastic lives of many students. He pinpoints role-playing games as most addictive, because players create characters and alter egos in cyberspace, living out their personal fantasies, usually by adopting the traits they believe they lack in the real world. In extending the above question, one wonder, *why some games are so addictive, while none educational is*. Is it the good graphics factor, the close-to-reality and sophisticated game play, the compelling environment, the escapism from reality or what? And why can't designers of educational games implement these features in EduGames? This could maybe be proved to be the most important factor, if it comes to practical considerations. Prensky (2003) argues that the amount of time today's young people spend playing computer and video games, estimated at 10,000 hours by the time they are 21 – often in multihour bursts – belies the "short attention span" criticism of educators. And while years ago the group attracted to video and computer games was almost entirely adolescent boys, it is now increasingly girls and all children of all ages and social groups. If designers of educational games could implement some of these "addictive factors" to their games, then the EduGames would greatly be augmented in terms of motivation. However, a very critical question emerges here, which is the ethic of the whole approach, namely to implement *a hidden psychological factor* to enhance the use of the product, even it is for a good purpose, as it is the fact in an educational game. On the other hand, one could argue that entertainment industry, which is profit-oriented, does it. And, after all, if players can develop alter egos in cyberspace with features they lack in real lives (as Messerly (2004) argues), isn't it the talk about an educational parameter worth to investigate and, under circumstances, to exploit? Nevertheless, this issue is from many perspectives very interesting.

11.3.5 Do underrepresented groups have a disadvantage?

The issue of the representation of women or other underrepresented groups in the technology-enhanced instruction is another important factor, when it comes on the use of ICT in the classroom. Negative perspectives by women of computer games are discussed in several articles in the Women and Computing special issue of the SIGCSE Bulletin inroads, June 2002. There is also interesting discussion in Educational Foundation Commission on Technology, Gender, and Teacher Education, Tech-Savvy: Educating Girls in the New Computer Age, American Association of University Women Educational Foundation, 2000. However, no clear results or even guidelines on how to confront this problem and aim these users during their work with ICT are broadly known or acceptable. In other words, this is a permanent and nagging question.

11.4 Discussion

This chapter by so far does not give answers. It only states questions, together with multiple hints to deal with. Current research, although present, misses the core point to address psychological factors which could motivate young people to use EduGames beyond the classroom, extending the instruction to the sphere of entertainment, realizing thus the term Edutainment, which is, at present, marginally successful.

There are on the domain many interesting questions, as well as interesting answers and counter-arguments, such as the development cost of an EduGame that could compete popular commercial games. However, there can be discussion on it: let's outsource the EduGame to one of these «commercial» companies, because EduGames are constructed once to be used forever. For example, a historical conquest game could be used repeatedly in schools over the world, and simultaneously played at home teaching children while amusing them. Under this point of view, cost and complexity are no more determinant factors. Our lack of knowledge on the psychological parameters and our unwillingness are more important.

11.5 Part II – Representations and Motivation: A Case Study

After current research and core questions have been stated on the domain of the educational games, and the importance of the motivational factor has been emphasized, our main concern now focuses on the question *„which is the role of motivation in the representations in multimedia environments“*. This question must be further analyzed, in order to be studied. So, we have to confront following issues:

- Is there any motivation at all in using representations in multimedia learning environments?
- Are the four factors present?
- What is the exact mode that each factor makes its present perceptible?
- In how far are the four motivational factors compatible to the representations theory, stated here by so far?
- Are these factors supported by the way the representations are materialized in educational games?

In order to answer these questions, a case study has been organized and performed. We used the freeware (2 versions on 7 CDs) „Perry and Katia – Let’s got o school“ series, 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.

11.5.1 Description of the software

Below is the startup screen of one of the CDs.

Figure 11.1. Intro screen

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. Below we present only some of them with a brief description.

Arithmetic and Mathematics

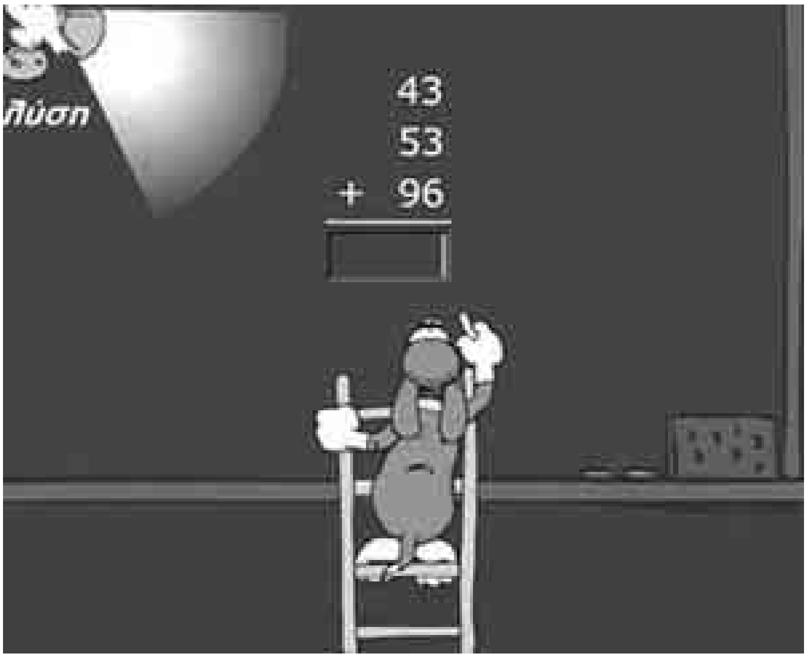

Figure 11.2. Addition

Basic skills in arithmetic. The difficulty grade is adjustable; the solution is presented by activating the light on the top left.

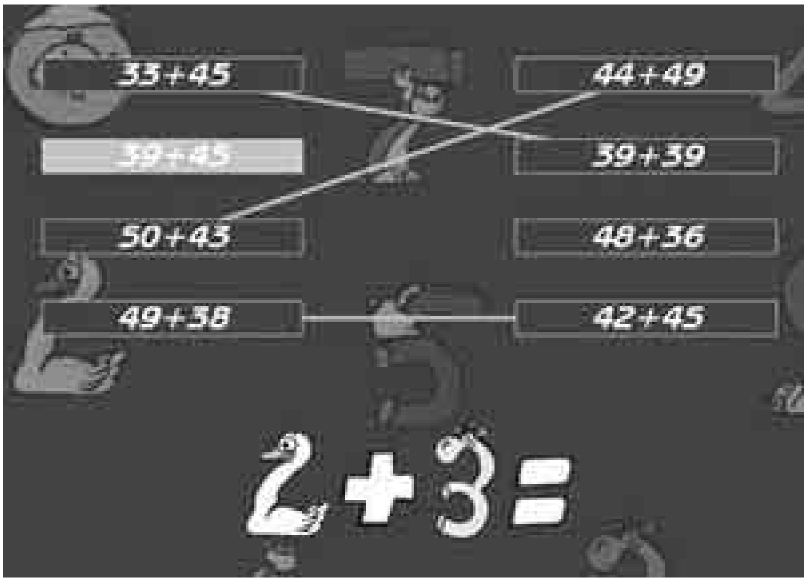

Figure 11.3. Matching of the sums

Matching the additions. The pupil has to use his/her mind, as there is no noting facility. Not an easy task at all. It enhances memory skills as well as the arithmetic ones.

Geometry

The pupil needs here to calculate the area of the square. Note the „chalkboard“ at the lower of the screen. It is to make calculations, while the sponge on the right initializes (erases) it.

The light on the left unveils the correct solution.

Figure 11.4. Geometry

Geography

Figure 11.5. European geography

There are plenty of exercises; here is one presented where Perry is trying to identify Belgium among 4 presented countries. Difficulty is also adjustable, interaction trough clicking.

Language

There are plenty of activities here, such as word spelling, or verbs.

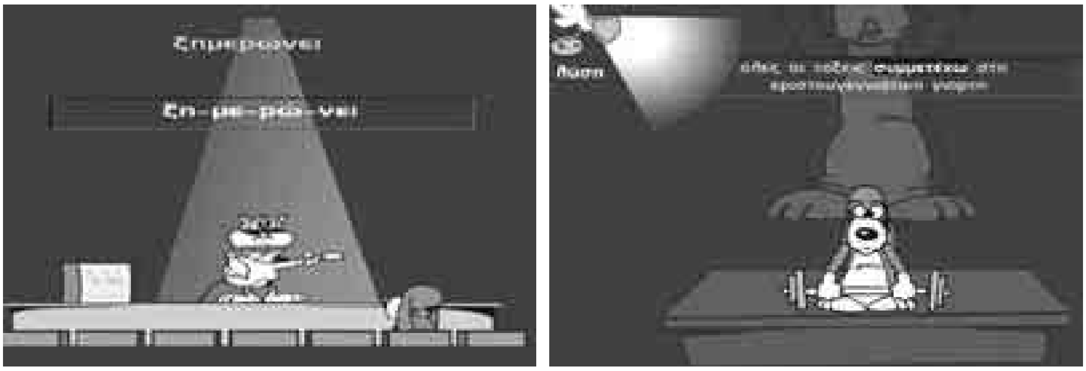

Figure 11.6. a and b: Word spelling and verb usage

Time

For the first classes, time practice is important. The pupil can interact with the watch, which animates accordingly.

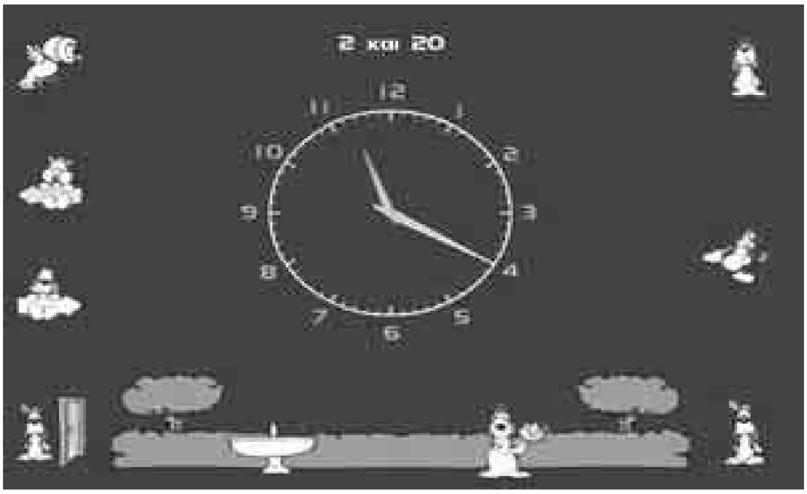

Figure 11.7. Time

Matching

Representations of the real world (through images) and matching to words with vocabulary.

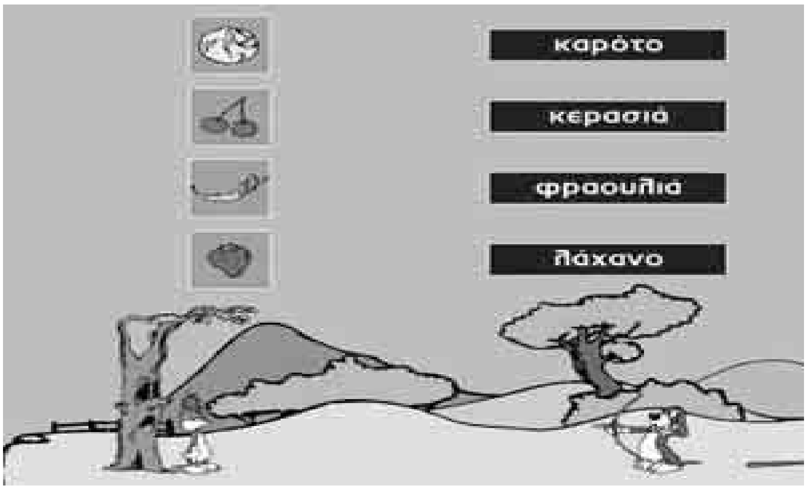

Figure 11.8. Matching of images and words

Figure 11.9. Crossword

For the greater classes, crosswords combine knowledge from different domains, geography, history etc., with wording and spelling skills. It is considered to be a higher level matching activity.

11.5.2 Feedback

Feedback occurs in all exercises with animation and sound, positive and negative with a „try again“ prompt. For example, in a problem solving activity, the correct answer brings the bus to Perry, who is waiting at the bus stop, while the wrong answer results the passing of Katia in a car, splashing the waiting Perry with mud.

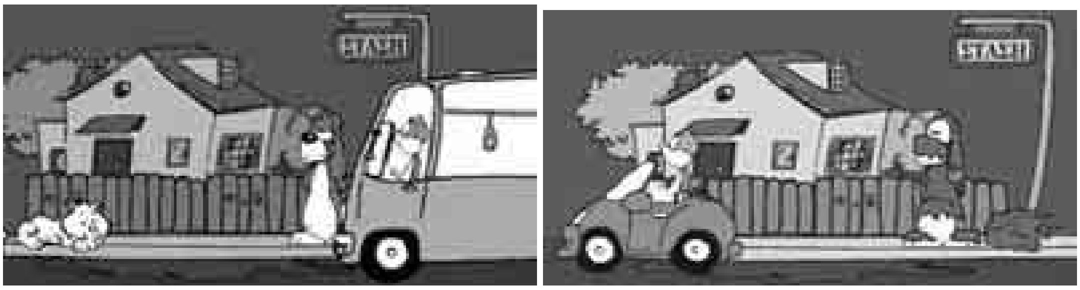

Figure 11.10. Positive and negative feedback

In another exercise (multiplication), the correct answer makes Perry smile, while the wrong drops him from the stair.

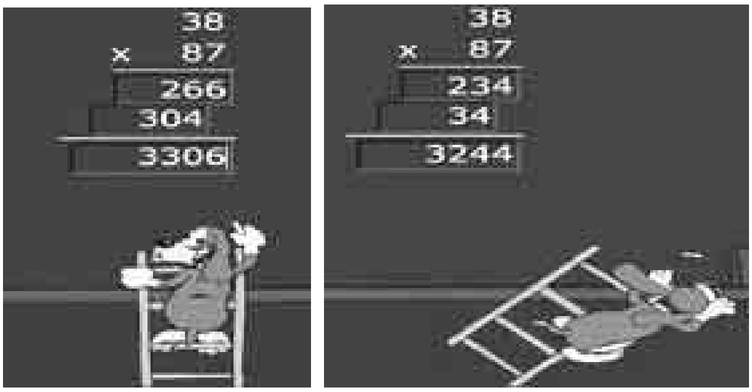

Figure 11.11. Another positive and negative feedback

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 main characteristics of the representations are described subsequently.

11.5.3 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:

- *Multiple representations*. Animation (which embodies image representations) and sound constitute 90% of the used representations.
- *Code and modality*. The navigational elements (shown clearly in Figure 11.7 at the left hand and the right hand side) 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, as it is the case of Geometry (Figure 11.4) or Crossword (Figure 11.9), where they help 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, 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 peace are *time-singular* instances, according to the classification by Ainsworth and van Labeke (2004).
- 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, as the application showed. It was observed that older children equally paid attention on all modalities, while younger children showed a clear preference to aural feedback and hated 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 Juul (2000) 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. Besides, there is an open question whether narration and textual information presented together can assist young children in their first steps in literacy.
- 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, as it is apparent in figures 11.2 and 11.11 (addition and multiplication) or the real world, as in figures 11.7 (the watch) and 11.9 (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 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.

However, the particular software is very popular to children, and is used and developed since three 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 lies in the examination of the motivational factor.

11.6 The motivational factor

11.6.1 Overall Concerns

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?" This is number 6 question in table 1.1. in chapter 1 of this work ("Reasons for using representations of a real system"). 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.

In chapter four it is stated (and backed up with adequate literature review) that "students like to watch animation even if they do not really get any substantial learning benefits". So, designers implement animations mainly to activate students to deal with the environment, in other words to motivate them.

Which are the parameters of motivation. According to the already stated theory of the four factors, following parameters have been examined during this case study:

1. *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.
2. *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.
3. *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.
4. *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 behaves stupid here". In conclusion, the option to neglect an exercise and repeat another seemed to stimulate the children at most.

11.7 Conclusions

The use of animations as the main means to represent is proved to be a very substantial part of the software, especially regarding 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 watch, seemed familiar (factor of relevance) and supported 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. This case study has shown that the extensive use of animations and sound as the main vehicles 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.

References

Ainsworth, S., & VanLabeke, N. (2004). Multiple forms of dynamic representation. *Learning and Instruction,* 14(3), 241-255.

Bransford, J.L., Brown, A.L. and Cocking, R.R. (eds.) (2000). How People Learn: Brain, Mind, Experience, and School. Washington, D.C.: National Academy Press.

Denning, P. (2004). The Field of Programmers Myth. Communications of the ACM 47(7), 15-20.

Juul, J. (2000). What computer games can and can't do. Proc. of Digital Arts & Culture Conf., Bergen, 2-4 Aug. 2000. Retrieved on 30 Aug. 2004 from http://www.jesperjuul.dk/text/WCGCACD.html

Keller, J. M. (1983). Motivational Design of Instruction. In Reigeluth C. M. (edt.), Instructional Design Theories and Models: An Overview of Their Current Status. New York: Lawrence Erlbaum, 383-434.

Lee, J., Luchini, K., Michael, B., Norris, C., and Soloway, E. More than Just Fun and Games: Assessing the Value of Educational Video Games in the Classroom. Proc of CHI 2004, 24-29 April, Vienna Austria., 1375-1378.

Leemkuil, H., de Jong, T., Ootes, S. (2000). Review of Educational Use of Games and Simulations. Knowledge Management Interactive Training System, University of Twente. KITS concortium.

Malone, T.W. (1980a). What makes things fun to learn? A study of intrinsically motivating computer games. Technical report, Xerox Palo Alto Research Center, Palo Alto, Calif.

Malone, T.W. (1980b). What makes things fun to learn? Heuristics for Designing Instructional Computer Games. Proceedings of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems. Palo Alto, Cal. 162 – 169.

Messerly, J.G. (2004). How computer Games Affect CS (and Other) Students' School Performance. Communications of the ACM. 47(3), 29-31.

Moser, R. (1997). A fantasy adventure game as a learning environment: Why learning to program is so difficult and what can be done about it. Proc. Of ACM ITiCSE 97, Uppsala, Sweden. 114-116.

Overmars, M. (2004). Teaching Computer Science through Game Design. IEEE Computer, 37(4), 81-83.

Prensky, M. (2003). Digital Game-Based Learning. Computers in Entertainment, vol. 1(1).

Quintana, C., Krajcik, J. and Soloway, E. (2003). Issues and Approaches for Developing Learner-Centered Technology. Advances in Computers, 57. 271-321.

Vygotsky, L. (1930/1978). Mind in Society: The Development of Higher Psychological Processes. Cambridge: Harvard University Press.

Walker, H.M. (2003). Do Computer Games Have a Role in the Computing Classroom? Inroads-The SIGCSE Bulletin, 35(4), 18-20.