INT J COMPUT COMMUN, ISSN 1841-9836
8(2):255-262, April, 2013.

Raising Energy Saving Awareness Through Educational Software

A.E. Pitic, I. Moisil, S. Dzitac

Alina Elena Pitic
Lucian Blaga University of Sibiu,
Faculty of Sciences, Department of Mathematics and Informatics
E-mail: alinap29@yahoo.com

Ioana Moisil
Lucian Blaga University of Sibiu,
Hermann Oberth Engineering Faculty
E-mail: im25sibiu@gmail.com

Simona Dzitac
University of Oradea, Romania
E-mail: simona.dzitac@gmail.com

Abstract:
A study that I have conducted on a sample of 395 children aged 6 to 12, from both the urban and the rural environments, shows that an increasing number of them use computer related technologies. Today there are an increasing number of web sites that inform the user of different ways to save energy and to reduce energy consumption because it is only natural that the modern information society would go online to research such topics. The development of an educational application that is focused on teaching the children about energy saving is represented on a timeline. We conducted a study in which a number of 29 children, aged between 8 and 10, use this educational application and a questionnaire. We describe the methodology used in the process of data gathering and then the results are interpreted. The state of happiness and fatigue of the child user has a great potential of influencing the way in which he or she uses the application, and implicitly it's educational impact. Because we want to be able to reform these concepts, we will base our work on a series of Markov models and we will define some measures that are relevant to our goal.
Keywords: energy saving, educational software, eLearning, case study.

1 Introduction

Today there are an increasing number of web sites that inform the user of different ways to save energy and to reduce energy consumption because it is only natural that the modern information society would go online to research such topics. The major issue with these sites is that although scientifically correct and very complete from an informational standpoint they do not meet the user's expectations, being much too serious and end up being considered boring.

The fast development of some technologies like computer gaming, which are very attractive to children and teen, may present an opportunity. Indeed those who have worked with children and teen on a day to day basis have seen how much they love computer games. This is backed up by a number of researchers that have conducted empirical studies [7]. Thus the technology used in computer games could be used to create educational software, raising the motivation and engagement of children and making the learning process a fun activity.

Many researchers agree to use computer games for educational purposes. In [2] we see that computer games help teach children faster, the lessons being more dynamic and engaging. This is seen as a great alternative to the slow pace and the boredom of regular school lessons. Boyle [3] points out that computer games can lead to greater engagement and pleasure in the learning process, strengthening the educational environment. Moreover there are studies that show that carefully selected computer games can improve thought processes [4]. In response to these studies many researchers have developed games for educational purposes [5], [6].

2 Initial Case Study

A study that I have conducted on a sample of 395 children aged 6 to 12, from both the urban and the rural environments, shows that an increasing number of them use computer related technologies [9]. Given their exposure to these technologies it is imperative that educational applications be designed in a way that takes into account the abilities, interests and the development demands of children.

Figure 1 and 2 shows some interesting yet somehow expected results like the high number of children having access to a computer at home, the amount of time spent by them using it or the internet navigation preferences [9].

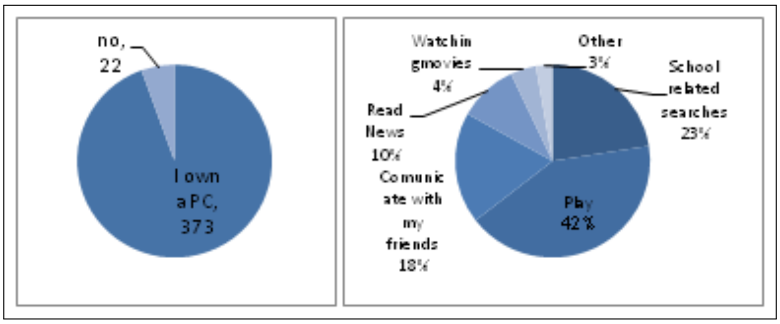

Figure 1: The number of children who own a PC / computer usage by theme

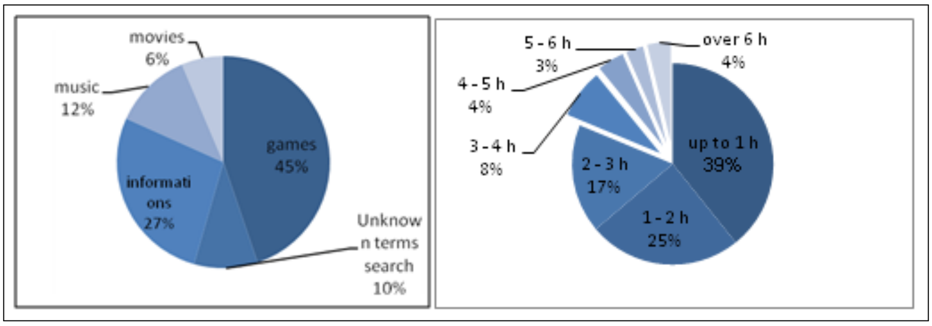

Figure 2: Child's internet navigation preferences / number of hours spent in front of the PC in one day

As expected, the recreational aspect of technology usage will overcome the educational one. Possibly the most interesting question for us, "Have you ever played a computer game that has taught you things useful for school?", was answered with YES by 72% of the children from our sample.

However, only 20% of the children have read electronic books.

A pretty large number of children (18%) declare that they use computers for communication. With regard of their age, they provided us with an interesting information on how technologies influences children at small ages.

We can tell that the informational technologies is influencing children more and more by the increasing number of hours spent by them in front of a PC (Figure 2). Only one third of those questioned spend more than two hours using a PC and of these only a handful cross into the computer dependent category. A probable cause for this could be the children's relatively small age. They are between 7 and 10 years old, primary school pupils, which means that the role of their teachers and parents is still leaving a powerful impression on their education. This theory is confirmed by Figure 3 which show a connection between the child's age and the number of hours spent using a PC. Just as predicted, as the child's age goes over 10 years the time spent in front of the computer rises to between three and four hours each day.

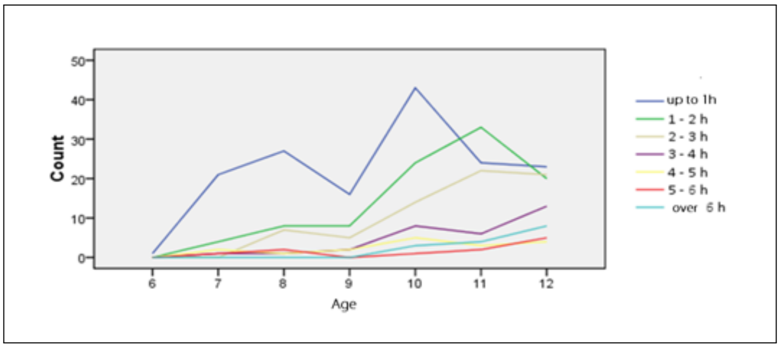

Figure 3: Chart showing child's age and the hours per day of PC usage

Seeing such an exposure to technology it is of the utmost importance to have educational applications that corroborate these interests and demands for the children's future development.

These are some of the observations that can be formulated from the initial case study data:

- The time spent in from of a PC increases with the child's age;
- Multimedia applications and computer games are the preferred content for children;
- The number of children using the World Wide Web is quite large;
- The computer has an important (second) place in a child's free time activities program;
- Not many children have read e-books;
- Educational games steadily increase in popularity among children.

Here are some of our conclusions derived from our observations:

- Educational applications over the World Wide Web may have a big impact;
- There is little interest in text format;
- The practice of using computers in the educational environment must intensify;
- The process of learning by playing and the idea of learning through discovery must be made a priority;
- Educational applications should have elements that attract a child's attention.

3 Modelling The Emotional State

We define the set of emotional states ES={pleased (P), normal (N), displeased (D)} and the set of arousal states AS={aroused (A), normal (N), sleepy (S)}.

In order to define the model we will consider:

- For the emotional states (ES) we will have Pleased > Normal > Displeased;

- For the arousal states (AS) we will have Aroused > Normal > Sleepy. where ">" has the meaning of "better than".

To model user emotions we use Markov chains to model the transition between different states as shown in Figure 4 [10].

The "good" transitions are the blue dotted lines (Figure 4), the red lines represent the "bad" transitions and the black ones are "neutral" transitions. High values for P(P,P), P(N,P),

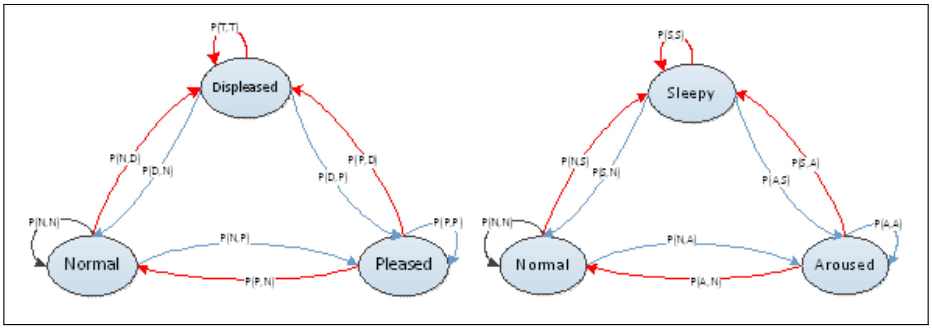

Figure 4: Modeling pleasure and arousal of the user (M_{ES} and M_{AS})

P(D,N), P(D,P), and low values for P(D,D), P(N,D), P(P,N) and P(P,D) will describe a good interaction between user and our application. The P(N,N) transition doesn't offer information about emotional state.

We define a measure of "wellbeing" (user feelings during the use of an application) as dES= (α1 P(P,P)+ α2 P(N,P) + α3 P(D,N) + α4 P(D,P) - (β1 P(D,D) + β2 P(N,D) + β3 P(P,N) + β4 P(P,D)), where $\alpha = (\alpha 1, \alpha 2, \alpha 3, \alpha 4)$ and $\beta = (\beta 1, \beta 2, \beta 3, \beta 4)$ are nonnegative real numbers, empirical determined, with at least one non-zero value.

We also define dnES=dES $/(\sum_{i=1}^{4} \alpha i + \sum_{i=1}^{4} \beta i)$, a normalized measure of the "wellbeing". Greater values of dnES characterizes a good user-application intereaction.

To model user arousal, we will define the Markov model as elements of the AS set (Figure 4).

Similarly MES, the blue dotted arcs represent "good" transitions, the black ones "neutral" and the red represent "bad" transitions. A good user-application interaction will have greater values for P(S,S), P(N,S), P(A,N) and P(A,S), and lower values for P(A,A), P(N,A), P(S,N) and P(S,A). The P(N,N) transition doesn't offer any useful information.

We define a measure of the "fatigue stare" as dAS= α1P(A,A)+ α2P(N,A) + α3P(S,N) + α4P(S,A) - (β1 P(S,S) + β2 P(N,S) + β3 P(A,N) + β4 P(A,S)), $\alpha = (\alpha 1, \alpha 2, \alpha 3, \alpha 4)$ and $\beta = (\beta 1, \beta 2, \beta 3, \beta 4)$ are nonnegative real numbers, empirical determined, with at least one non-zero value. The normalized measure of the "fatigue state" is defined as dnAS=dAS $/((\sum_{i=1}^{4} \alpha i + \sum_{i=1}^{4} \beta i))$.

To characterize a user session of an application we can use dnES and dnAS [10].

4 The "Energy" Educational Application

This application began it's history in January of 2010. We wanted to create an educational web application with a topic focused on the "ADAPTIVE WEB APPLICATION FOR CITIZENS' EDUCATION - TEACHING CHILDREN THE VALUE OF ELECTRICAL ENERGY" [1]. A succession of the most important changes suffered by the application and it's interface is shown in Figure 5.

We conducted a study in the 2009-2011 timeframe, on a sample of 276 children, aged 6 through 12. The children have responded to a questionnaire and some partial results were used as a starting point.

Intermediate results were used because of the ongoing study and the work on the "Energy" application. The questionnaire is made up of three open answer questions ("Do you know how to save energy?", "How is electricity produced?", "How do you save electricity?"). Methodology:

- Children where given the questions during the civic education classes;

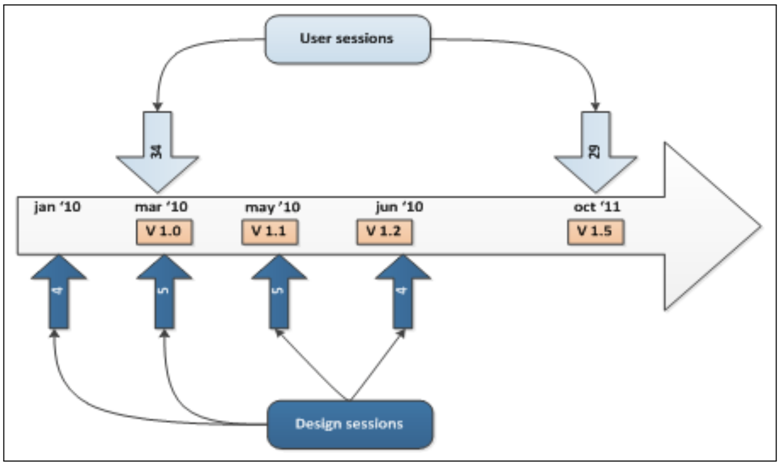

Figure 5: The versions of the "Energy" application

• The evaluator shows the questionnaire to the children in the classrom in the presence of a teacher and then distributes it to all children (5 minutes);

• The children fill in the questions (a maximum of 15 minutes);

• In lower classes (age group from 6 to 8) the children where given aid in reading and had their question answered;

• The questionnaires are then gathered by the evaluator/teacher.

The answers where free form and they were gathered in a list of answers obtained after the results were interpreted. The final results are given in Figure 6:

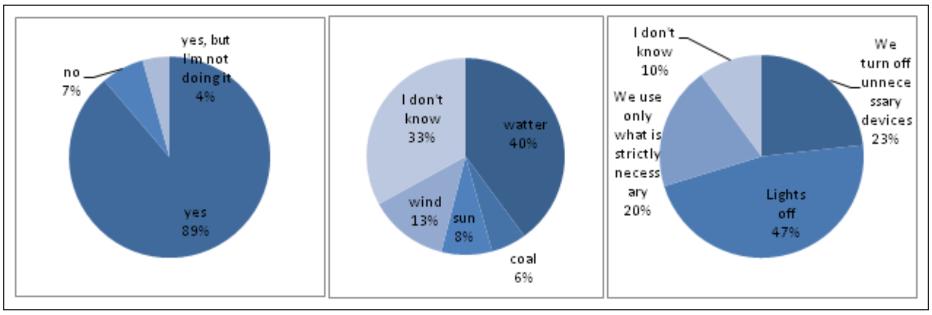

Figure 6: Did you save energy/how the energy is produced/how can you save energy?

Some of the conclusions are:

• 245 of the children (88%) are aware of the importance of saving energy;

• 91 children (33%) don't know how electricity is produced;

• 130 children (47%) asociate the saving of energy with turning the lights off.

Based on these conclusions we chose the educational content for the first version of the "Energy" application. A part of the results from Figure 6 where used in [1].

The first design session took place in January of 2010. We chose four children (two where 8 years old and the other two 9 years old) who together with two adults formed the design team for the application. The programming team was seldom present at the meetings. Up to the meeting in March 2010 the design team gained one 9 year old. In the beginning meetings took place at a rate of two per week, each meeting being two or three hours long.

Among the challenges encountered is the inability to capture the children attention for more than half the meeting time. In time, by limiting meetings to two hours and by combining work with fun the children were drawn more and more to the project. Discussions related to technology where always followed by examples that children could try out for themselves. The last meeting in which children where involved took place in June of 2010. The changes in the applications up to version 1.5 where of a technical nature (optimizing and bug fixing).

In October of 2011 we conducted one last study in which the children had the role of the user. The study was comprised by the "Energy" application (Version 1.5) together with a questionnaire.

29 children aged 8 through 10 took part in the study, all pupils of the No. 4 General School in Sibiu, together with three teachers (Figure 7).

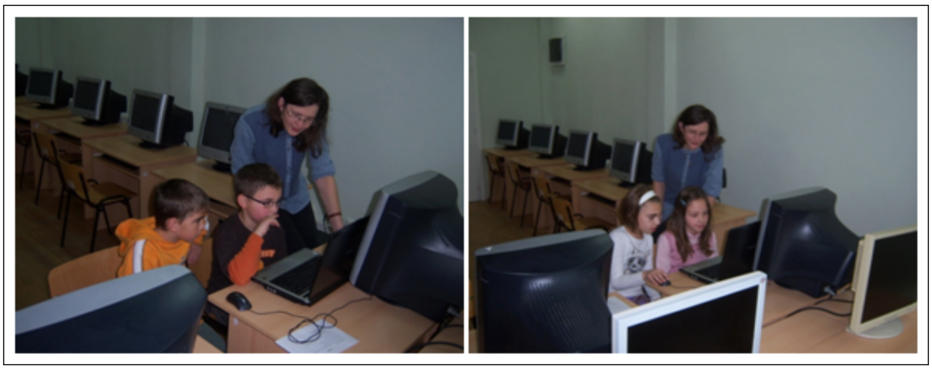

Figure 7: Study Progress

In order to determine the emotional state of the subjects we have used a variant on the Affect-Grid for Children Method [8]. Here follows a part of the results obtained from the study.

The tendency of the user to pass from an emotional state to another can be seen in Figure 8. Here the initial state is given by the start of the application and the final one by exiting the application.

The diagrams do not take into account possible variations during the use of the application. If a child goes through a succession of emotional states like (F, N, T, N, F), the result will be 0, even if there have been variations in between.

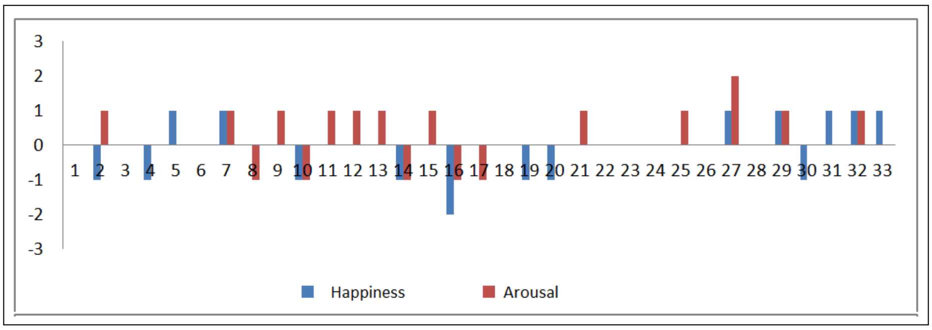

Figure 8: Going from an emotional state to another

No observable rule can be set, users passing randomly from one emotional state to another. At first sight this result could appear strange because we were expecting the application to be a success resulting in a positive emotional state in the subjects after its use. We have stumbled upon the reason by chance and from one of the children participating in the study. The reasons given by him for being sad at the end of the reserved time where that he "still wanted to play" and "didn't want to go back to class". Having found out this we have revised the diagram, and came up with Figure 9. In it the initial state is given by the start of the application but the final one is given by the last page reached.

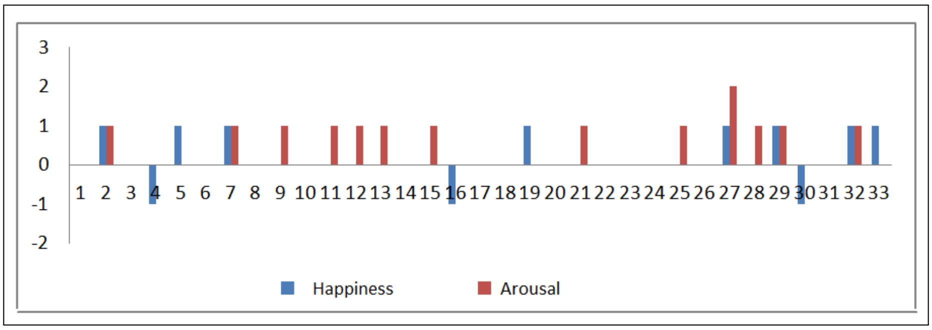

Figure 9: Going from an emotional state to another (version 2)

It is now clear that our application is interesting for the children that took part in the study:

• only 9% of the have felt a drop in their happy state, a possible explination beeing that they did not succed in finding all the usefull pages, thus not finishing the story;

• 24% have felt an increase and the rest where stagnant;

• None of the children where more tired after using the application;

• 42% of the children felt more stimulated.

Other results were obtained by interpreting the results of the questionnaire given to the children, a part of these being shown in Figure 10.

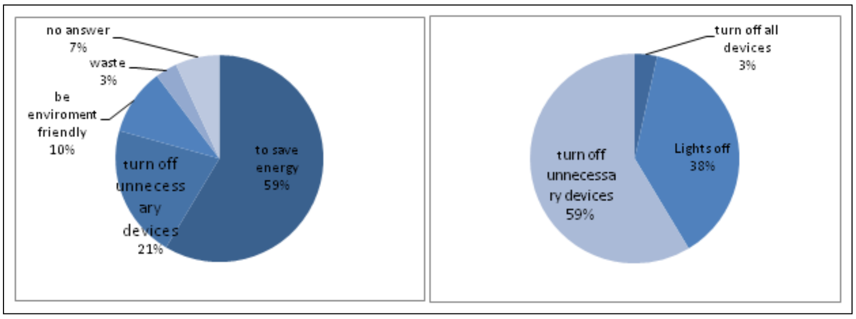

Figure 10: What did this application teach you? / How did you save energy?

5 Conclusions

The cost of educational software for children is very high because they imply a greater effort both in time spent and in developing abilities for working with children. One solution would be to offer instruments that would permit software developers to test the quality of their applications at a lower cost, on small groups of users. The models that we have proposed permit the testing of the emotional aspect, but not the cognitive one.

Gaining children as design partners or as users is possible and useful but it presents a real challenge. Developing educational software together with children comes with a series of inherent and specific difficulties that where surpassed by treating them as equal partners and because we had the help of teachers trained to work with children.

We developed an application with the aid of children that where treated as design partners and afterwards as users. A study conducted on the latest version of the application proves that children like it and it has a positive influence on how they think on the subject of saving energy.

Bibliography

[1] Moisil, I., Dzitac, S., Popper, L., Pitic, A., Adaptive WEB Aplication for Citizens‘ Education - Teaching Choldren the Value of ElectricalL Energy, *Int J Comput Commun*, 5(5): 819-825, 2010.

[2] Papert, S., The Children's Machine: Rethinking School in the Age of the Computers, New York: Basic Books, 1993.

[3] Boyle, T., Design for Multimedia Learning, London: Prentice Hall, 1997.

[4] Aliya, S. K., The role of computer games in the development of theoretical analysis, flexibility and reflective thinking in children. A longitudinal study, *International Journal of Psychophysiology*, 149, 2002.

[5] Virvou, M. K., Combining Software Games with Education: Evaluation of its Educational Effectiveness, *Educational Technology & Society*, 8: 54-65, 2005.

[6] Conati, C., & Zhou, X., Modeling students' emotions from cognitive appraisal in educational games., *Proceedings of the Intelligent Tutoring Systems*, 994-954, 2002.

[7] Mumtaz, S., Children's enjoyment and perception of computer use in the home and the school, *Computers and Education*, 36: 347-362, 2001.

[8] Widen, S. C., & Russell, J. A., Children's Scales of Pleasure and Arousal, *APS Conference*, Toronto: 1-8, 2001.

[9] Pitic, A., Moisil, I., Computers in School. A Case Study with children 6 to 12 Years Old, *THE 8TH International Scientific Conference Elearning and Software for Education*, Bucharest, 26-27, April 2012.

[10] Pitic, A., Moisil, I., A novel method to characterize user sessions of educational software. 3rd Word Conference on Psychology, Counselling and Guidance, Efes Kusadasi Izmir,Turkey, WCPCG 09-12 MAY 2012.