When Was the Last Time You Saved a World? Children's Informal Science Learning in a Multi-User Virtual Environment (MUVE)

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Abstract

Young children spend a great deal of time playing in MUVEs (Multi-Users Virtual Environments). Under what conditions might MUVEs promote informal science learning? We are investigating this question in a specific MUVE, called ekoloko, which is designed for children aged 8-12, which focuses on ecology and the natural environment: children are challenged to save a planet from a variety of environmental problems. Each player navigates using his or her own avatar in order to solve quests, play games and interact with other players in the world. Scientific content is transmitted via the quests, games, an online newspaper and participation in "community events". Using an educational data-mining methodology, we correlated user baseline data and game use with outcome data regarding cognitive, affective and behavioral goals. Our findings show that there were positive effects of the ekoloko MUVE in knowledge acquisition, as well as in more positive attitudes and behavior towards the environment.

Keywords: Multi-User-Virtual-Environment, Games, Environmental Education, Free Choice, Informal Science Education.

Introduction

The last several years have witnessed an explosion of activity involving both the number of MUVEs (Multi-User Virtual Environments) as well as the number of young people who play in these virtual environments (Dunleavy, Dede, & Mitchell, 2009). In such an environment, each player behaves via the agent of an *avatar*, a personalized virtual character which represents the player in the game; avatar behavior in a given MUVE can include playing a game in order to gain money, purchasing clothes and accessories for their avatar and chatting with other avatars in the environment.

Young children spend an enormous amount of time at home playing in virtual worlds (Jones 2003). One of the main reasons for this interest is that gaming appears to give them a new outlet for social interaction. For example, in one study, about 60% of students viewed gaming as helping them spend time with friends who were not otherwise available. About 65% of these students said that gaming did not detract from the time they otherwise spent with friends and family (Jones, 2003).

Some investigators claim that these environments have considerable educational potential in a variety of disciplines, including science education (Nelson, 2007). For example, Squire and Jan (2007) argue that these environments engage students in scientific thinking, by engaging them in meaningful scientific argumentation, via game features that support student thinking; they argued that these features do not exist in most inquiry-based learning environments. Neulight, Kafai, Kao, Foley, and Galas (2007) studied students participating in a virtual epidemic via a

MUVE; they concluded that engagement with this environment increased students' conceptual understanding of the causality of natural infectious disease.

Rationale and Context

Under what conditions might MUVEs promote informal science learning? Most of the above-mentioned studies that address this question use traditional methods, such as questionnaires and interviews, to gather data. In order to investigate this question, we used a relatively new educational research method, known as educational data mining. In this approach, large amounts of "real-time" user data are captured and analyzed, in order to understand user patterns. Such an analysis can inform design decisions as well as answer educational research questions; for example, the use of students' online tutoring data collected from intelligent tutoring systems can be used to build models to predict actual test scores.

Our study focused on a specific MUVE, designed for children age 8-12, which focuses on ecology and the natural environment. In *ekoloko* (link: www.ekoloko.com), children are challenged to save a planet (*ekoloko*) from a variety of environmental problems which occur in different habitats (e.g., desert, jungle, ocean, etc.). As in other MUVEs, each child has his or her own avatar; these avatars are invited to solve quests, play games and interact with other players in this world. Scientific content is transmitted to the young players via the quests, games, an online newspaper, the messages of non-playing characters (NPCs), and participation in "community events" (See example below). The designers of *ekoloko* – including gamers, computer programmers and science educators – have tried to create challenges which are both engaging and educational for 8-12 year olds. The following goals guided their development work:

(1) **Cognitive**: to increase the scientific knowledge of the young players regarding ecology and the natural environment,
(2) **Affective**: to develop positive attitudes of these users towards ecology and the natural environment, and
(3) **Behavioral**: to promote user behaviors which represent a positive approach to the natural environment.

Research Questions

We were interested in investigating if, and to what extent, the above three goals were achieved in the ekoloko MUVE. Towards this end, we asked the following two research questions:

(1) How do different kinds of players (e.g., according to age, game experience and gender) behave in this MUVE?
(2) To what extent does this MUVE increase scientific knowledge, develop positive attitudes and promote environmental-friendly behavior of the players?

Methodology

We describe our methodology in terms of participants and methods.

Participants

Although *ekokolo* "opened its doors" to the Israeli public only 10 months ago, there are currently over 250,000 users. The overwhelming majority are children from 8 to 12 years of age. Different samples of these users were used for the different aspects of the research, as described below. For our research the analysis of game use (the "frequency vs. duration" analyses), we analyzed 416,000 “playing events” that took place at the last week of April 2009. The number of players during that week was N=11,784 (51% boys. 49% girls). The attitudes survey was responded by N=1228 players (51% boys, 49% girls). In the community event designed to learn about the behavior of the children, N=2,151 players (53% boys, 47% girls).

Methods

In order to answer our research questions, we investigated different parameters of avatar behavior in *ekoloko*. In other words, we were interested in investigating which parameters of avatar behavior in this MUVE which can be “mined” and analyzed, in order to help us determine the cognitive, affective and behavioral development of the players. We looked at the following parameters:

(1) **User Baseline Data**. For each user, we gathered data relating to the player’s age, gender and game level in the MUVE. This latter term is an indicator of the user’s ability to solve multiple challenges in *ekoloko*.
(2) **Analysis of Game Use**. For each game in *ekoloko*, we gathered data about the number of users who actually played the game during a given period of time (frequency) and the average amount of time spent (duration).
(3) **Knowledge**. We captured user data regarding their “trivia scores”. These scores represent user knowledge regarding ecology and the natural environmental, as measured in their performance on the trivia quizzes offered in *ekoloko*.
(4) **Affective Goals**. We captured user answers to a questionnaire, placed in the *ekoloko* environment, designed to measure attitudes regarding the environment (Makki, Abd-el-Khalick, & Boujaoude, 2003), The questionnaire is attached in Table 1.
(5) **Behavioral Goals**. We captured user data about the following “community event”: the players in *ekoloko* have two weeks to remove the garbage located in the jungle and the desert environments; the garbage needs to be collected before it causes permanent damage. In order to prepare a proper dump site, money is needed and the players are asked to contribute the money they earned in *ekoloko*.

We analyzed user data with an “attractiveness (frequency) versus holding power (duration)” analysis for each game in the MUVE. This methodology has been used to analyze visitor behavior in other informal educational settings, such as museums and zoos (Diamond, 1999). We calculated each game’s attractiveness (frequency = the percentage of users who played the game) and its holding power (the average time duration). This analysis enabled us to learn about the way kids use *ekoloko* and to ask the following questions: What games are more attractive for the kids? What games have high holding power? We were also interested in comparing how different kinds of players (according to age, game experience, and gender) interact with the different games in this MUVE.

In short, we collected and analyzed date in the following areas: (1) Frequency vs. duration data for the different games in the MUVE, (2) an environmental attitudes survey, (3) knowledge acquisition via trivia scores and (3) a community event, as described above.

Findings and Conclusions

Using a large data set (N=416,000 game sessions) we found that most of the games share the same holding power (duration) for both genders, yet they have a higher attractiveness (frequency) for boys, as shown in Fig. 1. In only two games did we find gender differences relating to holding power; in each case, there were no significant differences in the game’s attractiveness. We also found that as the users increased their playing time in the *ekoloko* environment, they tended to focus more on fewer games, which resulted in the increased holding power of these games.

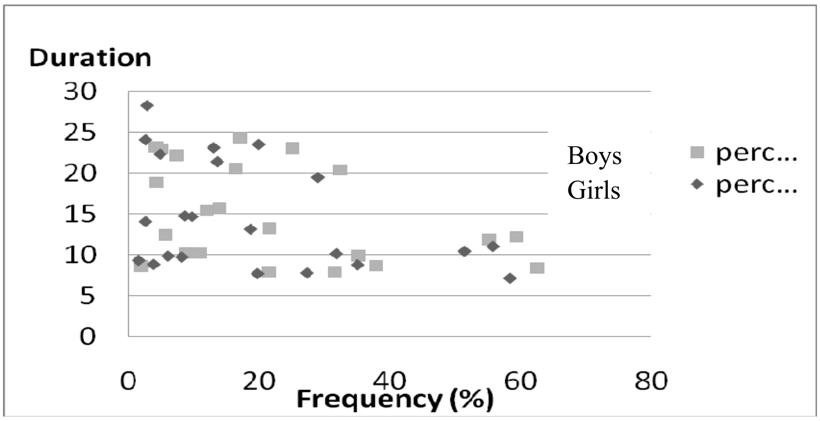

Figure 1. How Do Boys and Girls Use the *ekoloko* MUVE? Each game in the MUVE is represented by two plots in the duration/frequency graph -- one for boys and one for girls. See text for discussion.

In response to our attitude questionnaire on the environment, we found that players start with a strong emotional attachment to the environment and that they develop even stronger attitudes towards the environment, the longer they play in the MUVE. No consistent gender differences were found, as shown in Table 1.

Table 1. Response of Boys and Girls to the Environmental Attitudes Survey The percentages of positive responses are compared. See text for discussion.

Item	Positive Boys (%)	Positive Girls (%)
To save water, I would be willing to **use less water** when I bathe.	82	85
I would be willing to **save energy** by using less air conditioning.	69	59
I would give 250 kilos of my own money to **help wild animals.**	80	74
I would be willing to separate my family's trash for **recycling**.	79	83
I would be willing to stop buying some products to **save animal's lives**.	77	75
I would be willing to go from house to house, asking people to **recycle**.	52	55

By analyzing the user's "trivia scores," we found that the user's knowledge acquisition increases with their age and expertise, as presented in Figure 2. There were no gender differences.

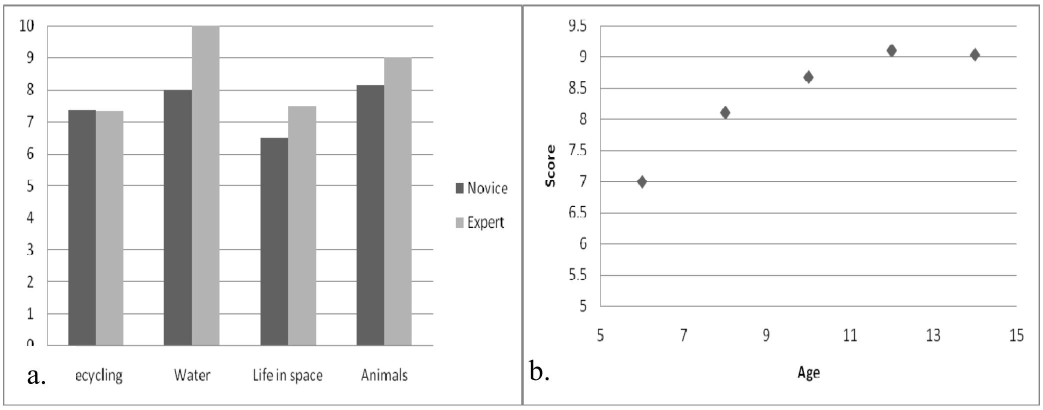

Figure 2. Knowledge Acquisition via Trivia Scores

Graph **a** shows an increase of average environmental trivia scores for different ages while the histograms in **b** show an increase of average scores for more experienced players compare with more novice players, in different trivia quizzes.

We analyzed a large sample of players (N=1,907) who donated money for the "community event" described above. We investigated the variables age, gender, game level, weeks in *ekoloko*, and looked for correlations with the level of donations, using the Pearson Correlation Coefficient test. We found statistically significant correlations ($p<.0001$) between a player's level of donations and his/her game level and weeks playing in *ekoloko*. This means that the more time players spent in this ecological MUVE, the more likely they would behave in an ecologically-responsible way. Moreover, we found a gender effect, i.e., boy players contributed twice as much money as girl players. We hypothesize that this finding can be explained by the fact that this community event highlighted the names and donations of the "top donors," and that the boys were more extrinsically-motivated than the girls. We plan to test this hypothesis by analyzing the donation levels in a future intrinsically-motivated community event, which will be the same but which will not publicize the top donors. If our hypothesis is right, we expect to find a different gender split.

In summary, our study shows positive effects of the *ekoloko* MUVE in knowledge acquisition, as well as in more positive attitudes and behavior towards the environment. An increase of knowledge acquisition was indicated by the increase of the trivia scores, as players spent more time in the MUVE. Our results also suggest that the children developed more positive attitudes and behaviors toward the environment; strengthened attitudes were demonstrated in the environment attitudes survey, while the development of more ecologically-responsible behavior (at least within the confines of the *ekoloko* MUVE) were suggested by the results of the community game. In addition, we can conclude that our analytical tools (e.g., frequency vs. duration analysis) helped us make sense of large amounts of data regarding game use. Combining this game-playing data with user data allowed us to make conclusions about how different populations of users (e.g., regarding gender, age, game-playing experience) use this MUVE and are affected by it.

We plan to use and refine the above-mentioned methodology, in order to continue our investigation of children's behavior in the *ekoloko* MUVE and we hope to report new findings and conclusions at the Chais 2010 Conference.

References

Diamond, J. (1999). *Practical Evaluation Guide: Tools for Museums & other Informal Educational Settings*. Walnut Creek, CA: AltaMira Press.

Dunleavy, M., Dede, C., & Mitchell, R., (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of Science Education & Technology*, *18*, 321-333.

Jones, S. (2003). *Let the games begin: Gaming technology and entertainment among college students*. Washington, D.C.: Pew Internet and American Life Project.

Makki, M. H., Abd-el-Khalick, F., & Boujaoude, S., (2003). Lebanese secondary school students' environmental knowledge and attitudes. *Environmental Education Research*, *9*, 21-33.

Nelson, B. C., (2007). Exploring the use of individualized, reflective guidance in an educational multi-user virtual environment. *Journal of Science Education and Technology*, *16*, 83-97.

Neulight, N., Kafai,Y. B., Kao, L., Foley, B., and Galas, C., (2007). Children's participation in a virtual epidemic in the science classroom: making connections to natural infectious diseases. *Journal of Science Education and Technology*, *16*, 47-58.

Squire, K. D., and J., Mingfong , (2007). Mad city mystery: developing scientific argumentation skills with a place-based augmented reality game on handheld computers. *Journal of Science Education & Technology*, *16*, 5-29.