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TRIANGLE: A Multi-Media test-bed for examining incidental learning, motivation and the Tamagotchi-Effect within a Game-Show like Computer Based Learning Module

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Abstract: At first sight, "TRIANGLE" appears to be just another piece of learning software but it is much more than this, it is an experimental test-bed for examining motivational factors in computer based training. Such a multi-media application derives its power of attraction from the quality of the interface design and the multi-medial content. Used as a trial on a defined target group of K12-students this learning module returns results on three basic effects; motivation, incidental learning and what we term a "Tamagotchi-Effect" within a Game-Show-Setting. Depending on how much an avatar has learned, it can answer questions for the player in the Game-Show. The avatar serves as a personal "Tamagotchi". Mathematics was chosen because it is rarely the favorite subject of K12-students at the age of 14-16, therefore it is ideal for testing motivational factors.

1. Introduction

A large variety of institutions are currently supporting Web Based Training (WBT) and Computer Supported Learning (CSL) as the future solution for gaining knowledge and becoming "fit" for the growing requirements of jobs in any field (cf. Rozell & Gardner, 2000). Even governments themselves and the European Union seem to see the future of education systems in promoting computer based training as an alternative to the common learning techniques used today (cf. Holzinger, 2000a, [W01]).

Coming up with a vast amount of ideas and concepts, most programmers of educational software appear not to have tested their products beyond interface usability aspects. With "TRIANGLE" [W02] we bring a specialized learning module, implementing some ideas and motivational techniques of the state of the art multimedia development. While appearing, at first sight, to be just another piece of educational software, the purpose is to provide a test-bed for examining some new principles and ideas.

The module was originally based on the work for the masters thesis of two students of Graz University of Technology, where they developed and implemented a Game-Show-like web based training environment named "VRFriends". Details and both theses are available on [W03]. The basic Idea of "VRFriends" is to learn by playing a quiz show. A virtual partner reacts on the players input, for example with anger, if all the answers are wrong, or happiness if the player wins (cf. Holzinger & Maurer, 1999). When analyzing the pros and cons of this concept, we detected the necessity of testing this learning module within its own target group (K12-students).

2. Concept of "TRIANGLE"

The concept of "TRIANGLE" is to provide a motivating computer game, where players need to gain knowledge in order to win. But more than that, even if the player is not willing to learn, nevertheless he may do so by playing the Game-Show and remembering the answers to given questions. In order to test the efficiency of the methods of incidental learning and to measure degrees of motivation, there are some demands on the learning module:

Linearity and time limits: Test-persons must be forced to play the whole module without having too great scope in controlling the game flow, also, there must be a time limit for the whole game.

Diversity: To identify oneself with the avatars in the game, the player must have the option to choose among a diversity of characters.

Attractiveness: Multi-medial attractiveness is of extremely high importance. The game "must rock", has to "be cool" in order to motivate. This is the most difficult part, because it also sets focus on hardware requirements (cf. Holzinger, 2000d), which would not commonly be the purpose of learning software (see fig.1).

Measurability: The module itself has to provide values of some kind, which can be measured and - more important - compared among different test-persons.

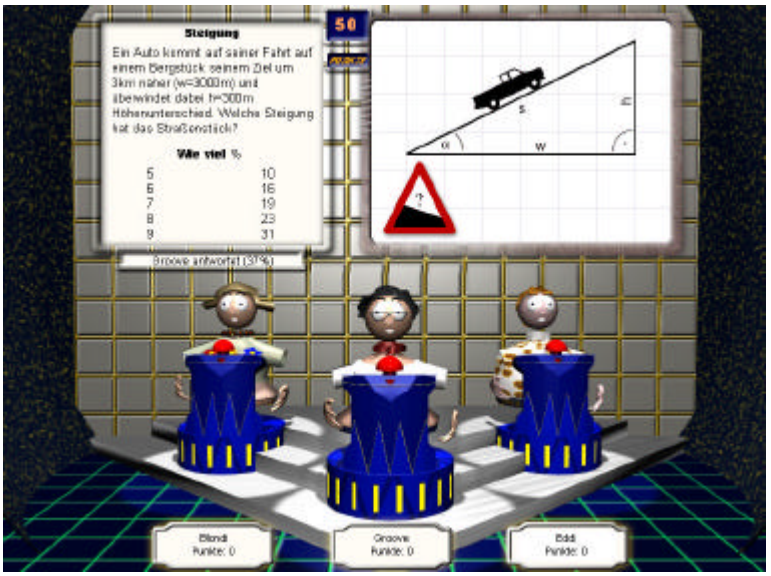

Fig.1 The “Game-Show”

3. Technological Background

3.1. Hardware Aspects and Software Considerations

When sending questionnaires to the schools which offered to be test partner in this project, we realized that the different hardware status is a great problem in creating a homogeneous testing environment. So we decided to limit the groups of test-persons (K12-students) to 10 and let them "play" on notebooks with headsets, in order to minimize disturbing influences and to have equal conditions for every group in any school.

While "VR-Friends" was strictly web based, we wanted "TRIANGLE" to be a state of the art multimedia, which raised the requirements for a web based module to a very high bandwidth. As the motivational aspects had precedence over public availability, and the amount of time invested in programming should not exceed the cost of testing and research of retrieved data, we decided to use a standard multimedia authoring tool. Our choice was the "Director 8" from Macromedia (cf. Endres-Niggemeyer, 2000). Additionally this software is made for publishing in internet [W05]. The current version can easily be converted to an internet application, by making use of the "Shockwave" plug-in, which comes with most common internet browsers.

3.2. Open Architecture

Another requirement which we kept from "VR Friends" is an open architecture, which allows anybody to modify contents and examples of the learning module. In the current version this is realized by using a very simple

hypertext format for the learning material and Game-Show questions, including multi-medial content organized in a strict directory and name system.

4. Theoretical Background

A big problem in successful learning is keeping the motivation for continued learning. This problem is most crucial if the material to be learnt is difficult to understand or even worse, the learners do not have much personal interest in the material but have to learn it for some "external" reason. In learning as such we have on the one hand intentional learning - used in traditional computer assisted learning systems - on the other we have incidental learning (cf. Holzinger & Maurer, 1999).

4.1. Why incidental learning is important

In traditional classroom learning as well as in traditional computer assisted learning sessions intentional learning dominates. But not all learning is intentional, a fact often overlooked. Game-Shows are an ideal example. Also the concept of avatars and agents (Wang, 1997; Lieberman, 1998). Many people are of the opinion that unless learning is planned, setting out to learn some specific, one really hasn't learned anything. Worse, many people believe that unless learning opportunities are offered by some institution, the learning is either of lower quality or, possibly, not learning at all. According to Lankard (1995) incidental learning serendipitously increases particular knowledge, skills, or understanding. Incidental learning, then, includes such things as learning from mistakes, learning by doing, learning through networking, learning from a series of interpersonal experiments. It is clearly obvious that incidental learning is particularly powerful for children. And certainly nobody would deny that children up to the age of six are learning quite a lot - their mother tongue for instance. But at the age of six incidental learning looses its importance and is replaced by a "sit down, listen and repeat" approach (Anderson, 1985). Standard research experiments in these fields include examples such as Anderson and Bower (1972), where one group of the testing persons was informed that afterwards there would be a memory test, and the other group was not. The intentional group recalled only 48,9 % of sentences while the incidental group recalled with 56,1 %, significantly more. Interviews later on showed that the intentional learners performed less well because many of them were busy employing poor memorization strategies, like saying the sentence over and over again to themselves. Many students are hampered in intentional learning situations by their mistaken ideas about memory and memorization strategies.

4.2. Motivation

According to Brehm & Self (1989) intensity of motivation is reflected by changes in the sympathetic nervous system. Increasing motivation is dependent on increasing arousal, which - as a psychological concept - refers to the degree of alertness, awareness, vigilance, or wakefulness (Robbins, 1997). It varies from very low values (coma or sleep) to very high values (panic or extreme anxiety), however the relationship between arousal and intensity of motivation is not linear. This relationship is called the Yerkes-Dodson-Law, first described by Yerkes and Dodson (1908), which points out that there is an optimal level of arousal for the most effective learning behaviour (Holzinger, 2000b). The chance of the VR-Friends concept is to keep arousal of the students as often as possible in optimal areas to get best learning performance. Berlyne (1965) pointed out, that one of the most important sources of arousal are stimulation, meaningfulness, and for VR-Friends particularly relevant, the novelty of situations, and the surprises that come with them. A further interesting cognitive factor is described by Brehm & Self (1989): Motivational arousal may be a function of the extent to which the learner assumes personal responsibility for the outcomes of behaviour. That is directly connected with something we call the "Tamagotchi-Effect":

4.3. Tamagotchi-Effect

Since Tamagotchis [W04] became a worldwide success in 1997, experts have been wondering why these Tamagotchis have been successful in such an unexpected way. It would be very interesting if these virtual beings could be used for other, possibly, more useful things. As a result an idea emerged to develop a completely new learning software that could considerably improve the quality of learning with computers by using such effects. This approach was called "VR-Friends" and should represent some sort of virtual learning-companion based on the Internet. VR-Friends differ in three ways from original Tamagotchis. They are kept happy if their owners answer questions correctly, they are implemented in software, not in hardware and they live on the web.

5. Implementation

5.1. Incidental Learning

One of the main theses to be tested with "TRIANGLE" is the efficiency of incidental learning. The primary knowledge imparted in the game is mathematical (the content is specialized on the triangle, hence the name). But an equal amount of additional knowledge is involved. In the training phase these two areas of knowledge are not kept separate, although internally there is a strict distinction between mathematical knowledge and additional facts, meaning that the avatar also gains only mathematical knowledge, if the player only retrieves pages with primary content.

5.2. The Tamagotchi Effect

The virtual companion is implemented as a sequence of pre-rendered video files. In the training phase, the avatar rests on the lower right side of the screen, reading in a book, looking around, talking to the player and reacting to screen changes (see Fig.1). This is implemented by an event driven system. At every event occurrence a video sequence is added to a animation queue. For greater diversity there are up to three different video sequences for the same event. This avoids repetitions and makes the avatar more "alive". In the Game-Show the chosen avatar is one of three candidates playing. Depending on the correctness of the answer it is delighted or sad.

But the most important fact about the Tamagotchi is the ability to learn with the player and to help in the Game-Show. This is implemented in a very simple, but effective manner. A routine calculates the time required for reading the whole page, based on the number of words, after about 70% of this time passed without a change to another page, the avatar "learns" this part of the material. Depending on how much the avatar has learned, it can answer questions for the player in the Game-Show. So it is up to the player, the avatar itself is his "Tamagotchi".

5.3. Motivational Factors

A multi-media application like "TRIANGLE" derives its power of attraction from the quality of the interface design and the multi-medial content. On the other hand, the interface itself has to be quite functional, as it serves as a replacement for common learning environments. While learning, the player deals with a text area ("the book"), a multimedia content window ("the blackboard") and some navigational elements. The virtual companion also has a very prominent place on the screen and is always present and in motion. The training phase could bore some students, so the avatar (the learning partner) comes up with witty comments, creating a moment of motivation to continue learning in order to see all the funny comments. The primary motivational element is the Game-Show. Here the player can show what he has learned and win points by answering correct questions. So the training appears to be only preparation for the Game-Show, while really being the main purpose of the whole module. In addition to the multi-medial components of the interface, animated jingles introduce the player to the phases of the game. Music is not a carrying element throughout the program, nevertheless it fills the game show with ambience.

5.4. Open Architecture

An open architecture for the content data structure was a basic requirement. "TRIANGLE" is planned as a prototype of learning software, which provides multi-medial fun and edutainment capabilities while being open to everyone who likes to impart any kind of knowledge to students. Therefore a very simple hypertext format was developed. There are two types of hypertext: content and examples, both in plain text format and divided in sections initiated by defined tags. The examples contain the question title, the question, the correct answer and the maximum points. Content consists of a head, any numbered tags and the information itself. In the text hyperlinks can be set by formatting a word in a certain structure. The target of a hyperlink is simply the filename of another text file, similar to HTML. In addition multimedia content can be provided by tags pointing at bitmaps or video files in the corresponding directories, and also the witty comments of the avatar are defined in the content hypertext files. Considering this simple data structure one can see that it would be easy to provide a simple content editor for anyone who likes to adapt the module for his learning material.

6. Experimental Setting

6.1. Target Group

The target group for testing our module were K12-students. There were a couple of reasons for this choice. The students were aged between 14 and 16 and they already had some experience in using computers. The mathematics curriculum is independent of the school type, which made it possible to test the module without the necessity of producing various versions with different contents. Mathematics was chosen because it is rarely the favorite subject of students at this age, therefore it is ideal for testing motivational factors (cf. Boaler, 2000).

6.2. Classroom settings

Groups of ten students were placed in a classroom each equipped with a notebook computer. The first questionnaire collected data about motivation, mood, readiness etc. Then the students played the learning module in a time limited (20 minutes) training process, in which the students were allowed two attempts to win the Game-Show with a maximum of points. During the game the module collected data about the user behavior. A further test of motivation showed the students' enjoyment when playing the game (and learning). Finally a questionnaire collected general data.

6.3. Data Provided by Module

The module itself collected a variety of data, some for reasons of user interface testing, others required for motivation tests. The program saved the data in an external file, which was easily transferred to a statistical program (SPSS). The collected data contained: the chosen avatar, the number of correctly answered questions (divided into mathematical and additional knowledge), the intensity of content study (by measuring time in relation to the amount of text on a page), the number of hyperlinks followed, pictures watched etc. Most of this data were used to control questionnaire results.

7. Results

The first questionnaire measured the motivation according to the AMS-Scale (Gjesme & Nygaard, 1970). The first 15 items determining the performance of motivation (expectation and success). The remaining items measuring the unsuccessfulness and fear. Thus, the first questionnaire showed the level of motivation before starting "TRIANGLE". Our program delivered the values during the game by storing all links used in log-files. The second questionnaire set, after playing with "TRIANGLE", delivered a standard of comparison to the first test. Finally, a special test showed the adjustment in attitude to mathematics in school.

7.1. Thesis 1: Incidental Learning

The results of the case study showed that additional factual knowledge provided by hyperlinks was also memorized. Supported by carefully selected multimedia elements to serve as "anchor points" the learner builds a network of facts - a mind map of the knowledge contained in hypertext. Since there was very little probability that the students were acquainted with the material before their participation the correctly answered questions serve as prove for the success of incidental learning.

7.2. Thesis 2: Tamagotchi Effect

Although the students enjoyed the interaction with the virtual partner in the program, no positive effect was measured in the case study. There were no significant differences in the motivation and success of the two groups using different versions of "TRIANGLE". The overall motivation was very high and the avatar or it's absence did not influence on the groups enjoyment. The original concept of the "VR-friends" could not be carried out. Due to the low level artificial intelligence, time and technical limitations the personal interaction was weaker as planned. By further experimentation more versions should be used.

7.3. Thesis 3: Motivation

The case study showed a high level of basic motivation among the students using "TRIANGLE". Whether, due to real interest in the program or the novelty of something new is difficult to judge: most students enjoyed the game show. Several students reacted emotionally to success and failure, showing that they were really "in the game". These motivational factors can be used to intensity previously learned material. Multimedia elements received a higher level of acceptance than the classical education methods. An advantage of this multi medial software was proved by the correlation between the number of correct answers and the media elements participated in.

8. Links

[W01] http://europa.eu.int/comm/education/elearning/index.html (eLearning Initiative of the EU, last visited 24th Oct. 2000)
[W02] http://www.meet.at/triangle (Triangle Projectpage, last visisted 28th March 2001)
[W03] http://www-ang.kfunigraz.ac.at/~holzinge/vrfriends.html (VR-Friends-Page, last visited 28th March 2001)
[W04] http://www.urban.ne.jp/home/jun/tama (Tamagotchi-Web-Page, Jun Matsuda, last visited 24th Oct. 2000)
[W05] http://www.macromedia.com/software/director (Director 8, last visited 25th Oct. 2000)

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