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Evaluation of Educational Software for Marine Training with the Aid of Neuroscience Methods and Tools

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ABSTRACT: The evaluation with the use of neuroscience methods and tools of a student's satisfaction – happiness from using the e-learning system (e-learning platforms, e-games, simulators) poses an important research subject matter. In the present project it is presented a research on course conducted in the Faculty of Merchants Officers, Marine Academy of Aspropyrgos. In particular, this research with the use of a neuroscience tool-gaze trucker, investigates the amount of satisfaction of the students using a simulator by monitoring the users' eye movement in combination with the use of qualitative and quantitative methods.

1 INTRODUCTION

The effectiveness evaluation of the Information & Communication Technology (ICT) in the didactics was mainly based on the experience & analysis (positivistic) methods, which accept that knowledge may be attributed only to the objective reality existing regardless of the values and beliefs the ones seeking to discover her. Methods of the physics and behavioral sciences are adopted, as well as objective forms of knowledge and deterministic acknowledgements for the human nature. As it shown in the international bibliography, the use of multiple methods of evaluation is more effective and the combinatorial use of quantitative and qualitative approaches confines their weaknesses (Brannen, 1995, Bryman, 1995, Patton, 1990, Retalis et al., 2005). That combination may bring out multiple applications of the ICT in the educational sector, thus contributing in a more "sufficient" evaluation of an application. According to Hubermas (1971), the final target of the ICT effectivity evaluation on the educational procedure must call for the examination and the evaluation of the three interests on knowledge: the technical (suggests the scientific opinion – experience & analysis example), the practical (the interpretation methods that offer knowledge that serves the "practical" interest on the understanding and interest) and "manumission" (offers the necessary critical and dialectical basis for the substantial connection between theory and action). Knowledge is the nucleus and around should orbit the evaluation procedure as well as the result of the human action that is defined by the physical needs and interests that lead and at the same time shape the way the knowledge is structured in several human activities. It is more than obvious that all the above conclude to the fact that the evaluation targets and the interest for knowledge define the evaluation mode and its results (Carr and Kemmis, 1997, Hubermas, 1971, Retalis et al., 2005).

In the evaluation of the tutorial systems, the system's term "utility" is analyzed in two supplementary components: the utility offered to the final regarding the system's efficiency and the usability regarding the facility of the users to comprehend or use that usability. These two senses are bound together but it's not necessary one to exist without the other (Grudin, 1992). In the evaluation, in particular, is widely used the term "manageability" which is a self-evident requirement for all the systems and tools managed by men (Avouris, 2000, Avouris et al., 2001, Nielsen, 1993, Papachristos et al., 2010).

One of the problems emerging by the evaluation techniques is the fact that they are based on the observation and on the users' answers. Today a great interest is imposed on the application of the objective usability testing. This testing mainly concerns the observation of the eyes and the measurement of physical data related to several part of the human physiology (heart activities, activity of perspiration glens, electric activity of the muscles and brain). Recording the measurements requires the application of several organs and sensors on the users. The existence and correspondence of physiological measurements patterns in specific emotional situations and in

general the determination of a theoretical frame of interpretation that defines a user's emotional reaction in an interface is a state of art research field (Dix et al., 2004, Picard, 1997, Retalis et al., 2005).

Today the use of the consolidated strategic research that is called cognitive neuroscience and includes the study of the behavior and the external situations related to it, as well as the expansion of the nervous system mechanisms that intervene in this relationship, leads to a better expansion of the user's physiological reactions. In the marine education and training, in particular, the modelization of the student's satisfaction based on objective standards (biometrical measurements) that present a better frame of interpretation is an important research subject. Via cognitive neuroscience is possible to determine a background that explains the satisfaction effect and at the same time presents new considerations that will expand the existing so far educational conclusions regarding the adults' education. The coexistence of the obtainment and understanding of knowledge and the acquisition of skills (according to specific standards) necessary to practice the marine profession is a crucial element for the marine professionals. In addition it will promote the design improvement of the e-learning software programs and will help the e-learning software developers/manufacturers to improve their products on the terms of the learning success and effectiveness (Goswami, 2007, IMO, 2003, Papachristos and Nikitakos, 2010, Kluj, 2002).

2 RESEARCH METHODOLOGY

The recommended research procedure aims at the modelization of the (subjected) satisfaction of the students – users in marine education via the user interface evaluation of the MATLAB simulator. The experiment is conducted in the Faculty of Merchants Officers, Marine Academy of Aspropyrgos with a random sampling among the students. The experiment's researching purposes concern the evaluation of the students' satisfaction from the MATLAB simulator use and the educational evaluation of MATLAB from the user's point of view.

The research that will be conducted is a combination of a qualitative – quantitative methodology on one hand and a use of neuroscience tools (gaze trucker use) on the other hand. The purpose of that is to combine the positive elements of the corresponding methodologies: targeting at measurable results & variable testing (quantitative), interpretative, explanatory (qualitative) and more objective measurements by "observation" of physiological data of the user (neuroscience tools).

For the quantitative research, the questionnaire method will be applied in order to extract measurable results regarding the educational evaluation of the MATLAB by the users in combination to the elements that satisfy the user by the simulator's operation. The use of the qualitative research via semi-structured interviews was chosen in order to examine the deeper reasons of the users' satisfaction of the simulator and verify the neuroscience tool measurements and the quantitative research results. The use of the gaze trucker was chosen because it presents more "accurate" measurements. The course of the researching procedure in the research conduction is shown in the following figure (Fig.1).

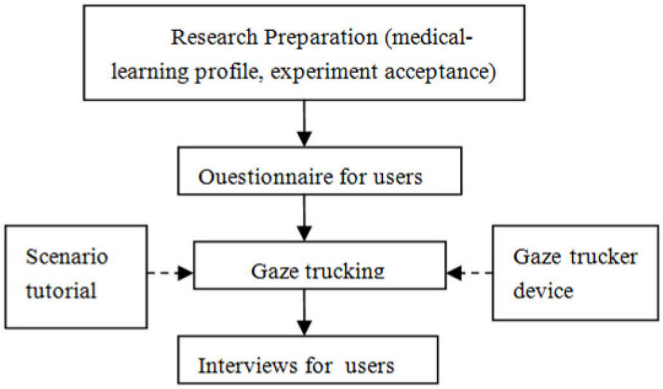

Figure 1. Research steps.

The determination of the satisfaction level concerns the following parameters: system's usability regarding the whole system (total usability), as well as the corresponding learning scenario, the stimulant for the active participation of the users (from the system and the learning scenario) and the user's friendliness regarding interface. The emerging of conclusions from the research results concludes the evaluation procedure that concerns the "identification" of the measurements from the gaze trucker in relation with firstly the questionnaire results (educational evaluation) and secondly and most importantly the interview results (educational evaluation & determination of the user's satisfaction data) (Fig. 2). The evaluation's intention is to create measurement patterns that correspond to psychological characteristics. The learning scenario applied was developed according to the STCW' 95 corresponding educational specifications on the Merchant Officers education in collaboration with the staff of the Marine Academy of Aspropyrgos.

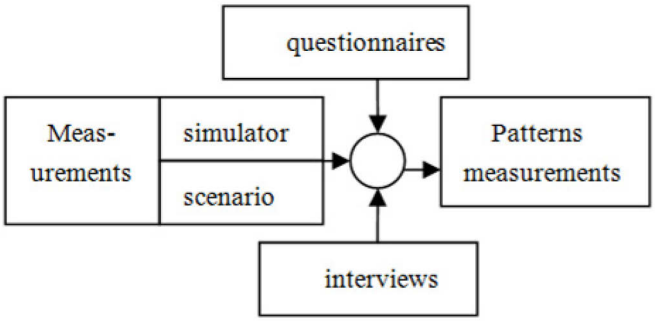

Figure 2. Verification procedure.

3 OPTICAL MEASUREMENT TECHNIQUE

The human vision/eyesight is an extremely complicated activity with physical restrictions as well as restrictions concerning perception. The optical perception is distinguished in the physical reception of a stimulant from the outer world and the processing/interpretation of the certain stimulant. The observation of the gaze trucking as well as the pupil is a possibility existing in many years now but the technological developments in both material equipment and software made it more viable, mostly as an approach to measure usability (Duchowski, 2003, Dix et al., 2004). The eye movements are supposed to illustrate the amount of cognitive elaboration a screen demands and therefore the difficulties and facilities in its processing. In general the optical measurement focuses on the following (Goldberg and Kotval, 1999, Dix et al., 2004): the focus points of the eyes, the eye movement patterns and the variations of the eye pupil. The methodology of effectuation of the optical measurement that was chosen on the present experiment aims at the eye movement observation and the user's head movement regarding with time. For carrying out of the experiment the "Face Analysis" software developed by the Image, Video and Multimedia Systems Lab (IVML) του National Technical University of Athens (NTUA) is applied in collaboration with a Web camera connected to the computer hosting the research subject (MATLAB) (Asteriadis et al., 2009). That software records (parameters): (a) Eye gaze vector: vertical and horizontal movements (2 floats), (b) Head Pose Vector: pitch, yaw (2 floats), pitch and yaw come in normalized floats, (c) Dist_monitor: Float indicating distance of the user from the monitor (~1: fixed distance, <1 goes far, >1 comes close)(1 float) and (d) Head roll: roll comes in degrees (1 float). The whole data recording and analysis procedure is shown in the following figure (Fig.3).

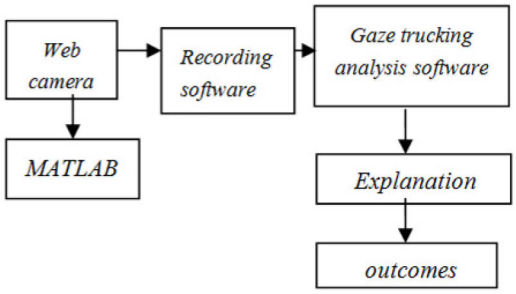

Figure 3. Optical Data Recording and Analysis procedure.

4 FIRST RESULTS

The first (random) sampling was carried out on the January 2011, in the Information Technologies Laboratory of the Marine Academy of Aspropyrgos. The samples consisted of 11 students (9 Male, 2 Female) that were subjected to a specific experimental procedure (research methodology) (Table 1). The sample's learning – medical profile as shown in Table 2 presents homogeneity, whereas from the first processing of the Matlab gaze trucker data emerge useful information (Table 3, 4).

Table 1. Structure of Sample

Variables	Male (2)*	*Female (2)*
Semester	E (9)	E (2)
Pass "Control System & Matlab" course	-	-
Study "Control System & Matlab" course	(9)	(2)
No pass "Control System & Matlab" course	-	-
Level computer using (No Use, Basic, Medium, Advance)	M(6),B(2)A(1)	B(1), M(1)

*(frequency)

Table 2. Structure of medical-learning profile

Question theme	Male (2)*	*Female (2)*
Strabismus	N*(9)	N(2)
Monochromatism	N (9)	N (2)
Eye disease	N (8), Y(1-myopia,astigmatism)	N, Y*(1-myopia)
Eye operation	N(9)	N(2)
Dyslexia	N(8), Y(1)	N(2)
ADHD	N(9)	N(2)

*N: No, *Y: Yes, *(frequency)

Table 3. 1st Data Set of Sample.

	Time (min) (aprox.)	Eye gaze vector vertical	Eye gaze vector horizontal
Average	F*(13.5), M*(8.5), T*(9.4)	F*(0), M*(0), T*(0)	F*(-.16), M*(7.04), T*(6.16)
Standard Dev	F*(2.12), M*(3.3), T*(3.67)	F*(0), M*(0), T*(0)	F*(0.54), M*(31.81), T*(29.7)

F*:Female, M*:Male, T*:Total

Table 4. 2nd Data Set of Sample.

	Dist_monitor	Head roll	Head pose vector pitch	Head pose vector yaw
Average	F*(1.2), M*(1.23), T*(1.22)	F*(-1.2), M*(2.03), T*(1.14)	F*(0.04), M*(0.04), T*(0.04)	F*(-0.16), M*(-0.04), T*(-0.07)
Standard Dev	F*(0.29), M*(1.07), T*(0.92)	F*(7.90), M*(10.12), T*(9.67)	F*(0.31), M*(0.25), T*(0.21)	F*(0.54), M*(0.35), T*(0.41)

F*:Female, M*:Male, T*:Total

The first measurements show that men needed less time to execute the scenario than women (the interview showed that women are more informed about Matlab and the control systems and answered in more questions than men). In the distance from screen observation (dist_mon variable) it was recorded that both men and women approach the screen (>1), which means that they both fully watching the scenario and have difficulty in using Matlab. As the screen distance increased in men, they seemed to have a more attention of the scenario and the Matlab use, even though they don't seem to achieve the same success in the scenario solving case as the women. In the next variable, we observe a non-balance in the inclination of the head (~0) in both sexes, which probably suggests a deeper inspection of the Matlab interface (that is probably ought to the lack of more practice time). The eye gaze vector approximately shows (the females marginally watch inside the screen although the sample is small), the students watch inside the screen and not outside of it (there is an interest on the scenario execution with the help of Matlab software or search about that).

The interview shows that 7 people from a total of 11 consider that Matlab software improves teaching the control systems (6 male, 1 female), all of them consider the Matlab interface to be friendly to the user and that it is necessary to have a basic mathematics background in order to use it. Without a mathematics background, its operation is difficult. During the execution of the learning scenario (closed control system solving exercise and calculation of time response with a paced entrance) none of the 11 students could get to a point of solution, rendering it to the lack of necessary time practice of Matlab in the School's educational program and 4 students (4 male) to the fact that they are not interested in the control systems & Matlab material. Furthermore 2 people from 11 (1 man, 1 woman) thought that the scenario solution was difficult due to the difficulty in Matlab use. In total 7 people from 11 agreed that the test (scenario) conducted in Matlab in the control systems course is satisfying, whereas 4 of them thought otherwise (3 male, 1 female).

5 DISCUSSION

The scientific approach regarding the study of psychological phenomena has wider application in the fields of education, since a basic objective of the educational process is to facilitate the process of learning and of Neuroscience, is the study of the nervous system as a mediator of behaviour. The evaluation using neuroscience methods and tools of happiness, satisfaction of the trainee after the use of electronic learning systems (e-learning platforms, e-games, simulators) is an important issue of research. Furthermore in the marine education, the use of more objective evaluation methods of the modern educational environments will offer a qualitative improvement of the educational programs and at the same time the re-development of the e-learning methods that will benefit both the students and the educational process (Blakemore and Frith, 2005, Goswami, 2007, Pare – Blagoev, 2007).

Qualitative upgrading of the educational process at university level marine education depends largely on the instructive value of the trainers' educational software. Marine education software has developed out of a specific initial implementation in an equivalent manner to which the programs of practice and training have been applied in cases of simulations and programming environments. In most cases, educational software categories have developed without taking into consideration any special pedagogical theory (Tsoukalas et al., 2008).

In the present study, the evaluation of educational software (simulator type) is conducted, in particular MATLAB, which is used in the laboratory of control systems of the engineers of the Merchant Navy from the learners' perspective. The research takes place in the School of Engineering of the Merchant Marine Academy of Aspropyrgos in a first sample of 11 students (target:21 students). Specifically, a biometric tool of visual recording (a neuroscience tool) records the trainees' satisfaction from the educational use of the simulator, by watching the users' eye movements in conjunction with questionnaires & interviews (Photo 1, 2).

6 CONCLUSIONS

A research that offers an objective data recording concerning the emotional state of a user that affects his/her problem solving ability and carrying out of projects poses an important challenge. Overall the first results indicate the following so far: (a) possible relationship between the scenario comprehension and the Matlab use with the head being in a distance from the screen, (b) the head's inclination shows the expansion of the Matlab use among the users, indicating an increase in training time of the Matlab use (modification of the educational program and the corresponding standard STCW'96) and (c) possible relationship between the eye gaze vector (screen monitoring) and the users' satisfaction (interest = satisfaction).

The research continues with the numeral increase of the sample and the total processing and evaluation of the research findings (qualitative and quantitative data).

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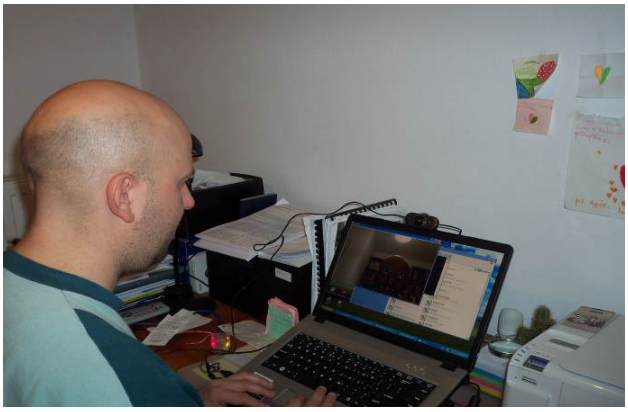

Photo 1. Biometric tool (web camera & software 'Face Analysis') in action (back side).

Photo 2. Biometric tool (web camera & software 'Face Analysis') in action (side face)