



Virtual Learning - Virtual Reality

The 2nd INTERNATIONAL CONFERENCE ON VIRTUAL LEARNING

PROGRAM of ICVL 2007

The Conference will be held in the Ovidius University of Constanta - New Campus, Universitatii
Street No. 1 (Bus 100) - Mamaia - 1st Floor - HALL A02

SCHEDULE

FRIDAY - October 26, 2007

15:00#19:30 Registration Desk (1st Floor HALL A02)

19:30 Welcome Reception (Cocktail - Oxford Hotel)

SATURDAY - October 27, 2007 (1st Floor HALL A02)

8:30#9:00 a.m. Registration Desk (1st Floor HALL A02)

9:00#12:00 Conference opening and Plenary Session (Invited papers, Section TECH & SOFT)

12:00#1:30 Coffee Break

13:00#16:30 Plenary Session (Section M & M (Papers))

Measuring e-learning effectiveness through e-content and attention correlation

Bekim Fetaji¹, Nada Pop-Jordanova², Jordan Pop-Jordanov², Tatiana Zorcec², Silvana Markovska²

(1) Communication Sciences and Technologies Faculty, South East European University 305.21, Ilindenska bb, SEE University campus, 1200 Tetovo, Macedonia

(2) Macedonian Academy of Sciences and Arts

Krste Misirkov br.2, P.O.Box 428, 1000 Skopje, Macedonia

E-mail: b.fetaji@seeu.edu.mk

Abstract

This paper is a result of practical research activities focused on testing e-learning indicators e-content and attention as well as their interrelated correlation. In order to investigate further on the possibilities of improving and increasing accessibility to e-content and attention, both assessed from a previous study as most influencing e-learning indicators, we have realized empirical research analyses focused in testing this indicators and their correlation. We have combined neuroscientific testing approach combined with psychometric testing and software engineering usability testing as new methodology for assessing e-learning effectiveness. Combination of all this methodologies in assessing and measuring attention based on e-content we named as PTPMELUAT methodology. Such examination is critical considering the promises, organization and management, heavy investments, expectations, and exponential growth associated with e-learning effectiveness.

Keywords: e-learning, indicators, enhanced learning, evaluation of e-learning solutions

1 Introduction

In order to investigate further on the possibilities of improving and increasing accessibility to e-content and attention, that from the previous study Fetaji, B., (2007) both were assessed as most influencing e-learning indicators, we have realized empirical research analyses focused in testing this 2 indicators and their correlation.

We have defined e-learning indicators based on our previous study Fetaji, B., (2007) as: (1) learner education background; (2) computing skills level (3) type of learners they are, (4) their learning style and intelligence, (5) obstacles they face in e-learning (e-learning barriers), (6) attention, (7) e-content (suitability, format preferences), (8) instructional design, (9) organizational specifics, (10) preferences of e-learning logistics; (11) preferences of e-learning design; (12) technical capabilities available to respondents; (13) collaboration; (14) accessibility available to respondents; (15) motivation, (16) attitudes and interest; and (17) performance-self-efficacy (the learner sense their effectiveness in e-learning environment).

The content developed for e-learning is very different from the classical one - the print based. Preparing quality e-content delivered digitally is probably the major aspect for long term success of any e-learning endeavor. It is the content, however, that learners care for and they judge it with how much they learn

from it. However understanding and managing attention is considered as very important determinant of successful learning. In order for the e-learning content to be considered successful it has to be good in getting attention.

Attention by its nature is intangible asset and it is difficult to document its presence and to assess it. Attention cues when the learners begin to feel some mental workload, Ueno, M. (2004). In order to define the exact correlation between e-content and attention we have tested them in order to find out the exact impact and correlation between these two factors in e-learning level and effectiveness.

2 Research methodology

The research method was exploratory research to determine the best research design and then followed by empirical research to describe accurately the interaction between the learners and the system being observed focusing on e-content and attention. We have defined e-learning indicators as important concepts and factors that are used to communicate information about the level of e-learning and their impact on learning; that could be measured and described then in simpler terms.

In order to assess the correlation between the e-content and attention we have chosen an approach of combining different methodologies: Psychometric tests, Psycho physiological measuring, and ELUAT (E-learning Usability Attributes Testing) methodology. For the needs of our research we have used the methodology called ELUAT (E-learning Usability Attributes Testing) and as measuring instrument the PET (predefined evaluation tasks) inspection technique from Fetaji, B (2007).

Combination of all this methodologies in assessing and measuring attention based on e-content we named as PTPMELUAT methodology. This methodology approach was realized in order to assess the correlation between the e-content and attention approaches in combining different types of measurements which was realized using Task based learning.

3 The experiment

The experiment was based on the developed PTPMELUAT methodology consisted of 3 (three) types of testing and measurements:

1. Psychometric tests
2. Psycho physiological measuring - Biofeedback test
3. ELUAT (E-learning Usability Attributes Testing)

The psychometric test was the first testing realized and it was independent from the other two. The objective of the first testing was to assess the visual conceptualization and the type of learner the students respondents were.

The second and third testing and measurements were realized simultaneously and were conducted in parallel. The objective of the second testing was to measure the attention of the student respondents based on their task based learning process. The objective of the third task was to measure the e-learning effectiveness assessing the e-content. The student participants were given 5 tasks in using Angel (www.angellearning.com) information system:

- 1) TASK 1 - Read the lecture material
- 2) TASK 2 - Read the practical material
- 3) TASK 3 - Work on practical assignment announce its results
- 4) TASK 4 - Do a quiz that has questions based on the previous tasks
- 5) TASK 5 - Go to a discussion Forum and discuss their opinion

Before each task each student was first tested using the second biofeedback test and then moved to doing the next task. While doing the tasks they were at the same being observed and measured using the ELUAT methodology and then went back to the second testing, and then back and forth until they have finished all their tasks

3.1 Psychometric test experiment

The Trail Making Test (TMT) Schmidt, M., (2006) is measuring abilities of visual conceptualization and visual-motor tracking as well as attention and concentration. It has two forms - form A and form B. In

form A, subjects are asked to complete number connection task (1, 2, 3...) while in form B, subjects are asked to complete a number - letter connection task (1-A, 2-B, 3-C...), requiring them to switch between two sets of stimuli, hence adding the cognitive load of directing behavior according a complex plan. Developed by the U.S. Army around 1944, the test became part of the Army Individual Test of General Ability and was given the name Trail Making Test, and is now part of the Halstead-Reitan Test Battery and the test is considered to be within the public domain and thus may be reproduced without permission. The test was standardized by Partington and Leiter who found the test to be a good predictor of general mental ability Kay, Gary G. (1984). Rey Auditory Verbal Learning Test (RAVLT) is one of the most common and useful methods of assessing memory functioning. Using the word list-learning paradigm, subjects are asked to remember as many words as they can in five repeated readings. According to Schmidt, M., (2006) the RAVLT is useful in evaluating verbal learning and memory, including proactive inhibition, retroactive inhibition, retention, encoding versus retrieval, and subjective organization. The Auditory Verbal Learning Test was developed by André Rey and first published in France in the 1960's. The list learning format that it utilizes has become virtually the standard for verbal learning tests as can be readily seen when examining the California Verbal Learning Test, WMS-III Word Lists Test, and Hopkins Verbal Learning Test.

3.2 Psycho physiological experiment

Is realized with Instruments constructed by Biofeedback Computer Systems Laboratory, Research Institute for Molecular Biology and Biophysics, Novosibirsk, Russia.

We have realised this measurements having as subject 36 students from South East European University-Tetovo, Macedonia (<http://www.seeu.edu.mk>).

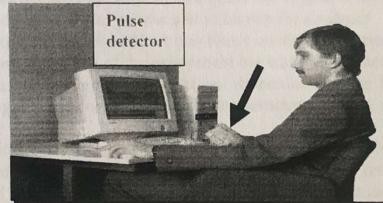


Figure 1. Psycho physiological measuring with biofeedback

The biofeedback test situation was to reveal impairment of performance abilities by immersing a person into psycho physiological model of stress situation (as stress we comprise the learning tasks). We have based the psycho physiological measuring with biofeedback on RALLY, which is a car race game. The speed of player's car depends on his heart rate (HR).

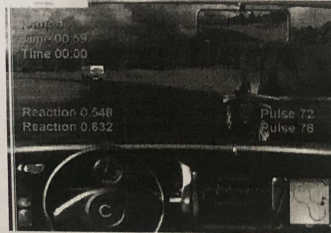


Figure 2. RALLY car race game for measuring biofeedback

The calmer the subject is, the faster the car moves. The monotonous condition is simulated by long flat road, and the task to reduce HR induces development of fatigue in the subjects.



Figure 3. Psycho physiological measuring with students - biofeedback on RALLY

Time of reaction to the obstacles which appeared occasionally on the racer's way measures the power of the distributed attention and correlates with the performance level. The game-based biofeedback technology in our study was used to achieve the following goals:

- to model situation of ambiguity
- to reveal individual stress response pattern
- to train self-regulation techniques

The experimental situation involved high level of ambiguity for subjects because:

- Biofeedback method appeared to be new and unknown for a subject
- Information incompleteness for a subject was based on the use of uncertain instructions
- A subject was aware of the aim of the experiment but was not instructed how to achieve this aim

In this test, attention concentration level was registered determined by the latent response time (RT) to obstacles (rocks appearing on the road). Successful performance during stress test depended on the subject's skill of heart rate control.

We calculated: reaction time (RT), omissions (inattention), commissions (impulsive reactions) and time of performance (PT) as indicators of attention and concentration and heart rate (HR) as indicator of stress-regulation ability. We had student participants out of which: 36 healthy students, 12 girls, 24 boys, mean age 20.9 ± 2.15

Example for RT of one student:

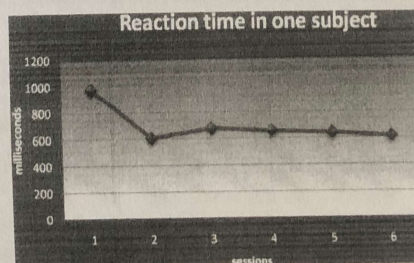


Figure 4. Reaction time for one subject

The reaction time is diminished 60%, which is an excellent result.

4 Software Engineering Usability Experiment

Major challenge for e-learning researchers is to assess e-learning effectiveness.

In order to do that we have proposed a methodology, called ELUAT (E-learning Usability Attributes Testing), which combines an inspection technique with user-testing based on 4 usability attributes we have set. The usability attributes we have set are: 1) Time to learn, 2) Performance speed; 3) Rate of errors; 4) Subjective satisfaction. The e-learning-methodology is necessary for presenting the e-learning in an efficient aspect.

The theoretical bases are pedagogical conceptions defined from Klauser et al (2004):

- Learning according to the constructivist perspective,
- Usability of the e-learning environment and
- Research about user opinions.

We have based the measuring instrument on the use of predefined evaluation tasks (PET), which precisely describe the activities to be performed during inspection in the form of predefined tasks, measuring previously assessed usability attributes. We have named it as PET inspection technique and using this technique we evaluated usability attributes using evaluation tasks for a particular scenario.

Evaluation tasks in this technique are determined through designing several user scenarios and choosing the scenarios that include the most of the options of the software.

This kind of approach using this technique has shown very effective, straightforward and useful in determining the distance between learner activities and preconceived scenarios in several research projects we conducted.

Using the ELUAT methodology and PET inspection technique we have gathered information on interactions between human actors (intervention strategies and content). Scenario contains at least a collection of components and a method.

The components are roles, activities or activity-structures, which role does what (which activity) and at which moment is determined by the method which is made up of one or many plays formed by a series of acts. In an e-learning environment, information obtained from learner activity contain a certain pedagogical semantic.

The observed route of a learner has been used to give feedback information on the level of learning and its effectiveness. We have considered the next learning modeling approaches: the content-oriented, the tool-oriented, and the task-oriented approach, and we have chosen the task oriented approach for which we developed the methodology to suite to our specifics.

| Task n# | Task completion | Time for: | | M | S | E | R | O | H | F | * |
|---------|-----------------|----------------|---------------------|--------|---|---|---|---|---|---|---|
| | | Help search | Recover from errors | | | | | | | | |
| | | | | | | | | | | | |
| | | Time to Learn: | | Total: | | | | | | | |

Table 1. PET inspection technique task based form

The PET inspection technique uses the next measurements: M – Menu Error; R – Repeat task; F- Frustrations; S – Selection error; O – Uses online Help, E – Other errors, H - Help calls, *-Subjective Satisfaction (5-very high, 4-high, 3-average, 2-low, 1-very low).

This methodology and the inspection techniques has been used in several different research projects and it produced valuable information for the design of the subsequent studies and proved as viable methodology and technique.

We have chosen Empirical evaluation method and contextual inquiry, interviewing and observing users in context, in which a prototype is constructed and tested by users in real-world environment iteratively.

5 Results and analyses

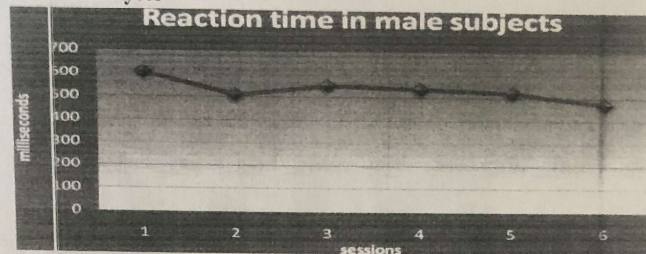


Figure 5. Reaction time in male subjects

MALES T-test showed significant changes of the reaction time between RT 1 and RT 6, ($p < 0.009$), RT 1 and RT 2, ($P < 0.0$) and RT 5 and RT 6, ($p < 0.02$)
The number of omissions is much greater after the first task. Interpretation: Difficult task or the students feel tired.

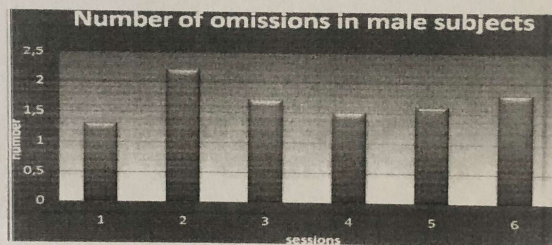


Figure 6. Number of omissions in male subjects

No changes in the time of performance. After a few worse results, the students manifested improvement of the total time for performance (adaptation in the test situation)

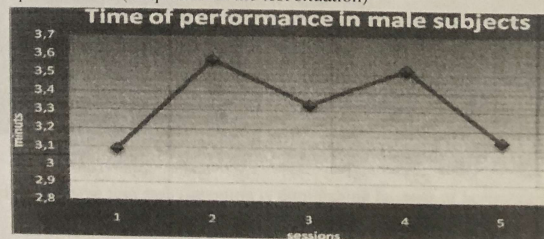


Figure 7. Time of performance in male subjects

The commission's number is much greater after the third task (they are bored or tired, or the task is to hard?)

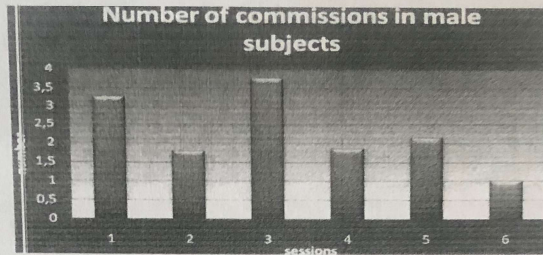


Figure 8. Number of commissions in male subjects

No changes in heart rate (it must be under 10% for success) They didn't understand the self-regulation through sympaticus/parasympathicus balance

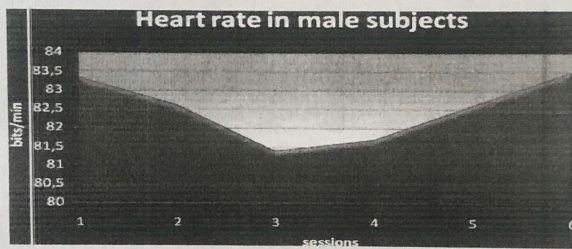


Figure 9. Heart rate in male subject

2) FEMALES: The t-test showed significant changes of the reaction time between RT 1 and RT 6 $p < 0.03$ in females.

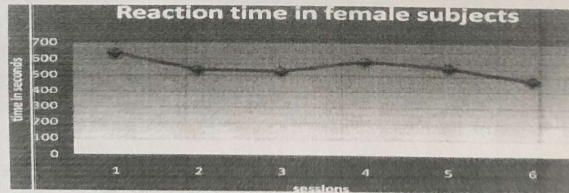


Figure 10. Reaction time in female subject

Omissions are greater after the four task (attention is diminishing because of boring or tiredness)

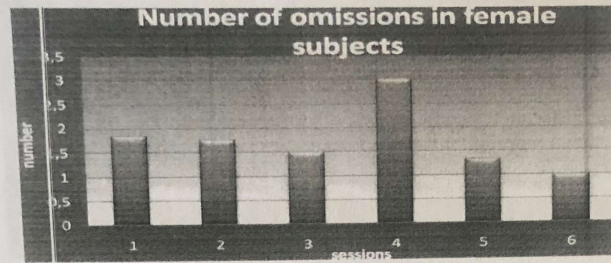


Figure 11. Number of omissions in female subjects

The greater impulsive reaction (commissions) after the 5-th task could be interpreted with the feeling of boring / fatigue. Statistical analysis showed significance at the level $p < 0.03$.

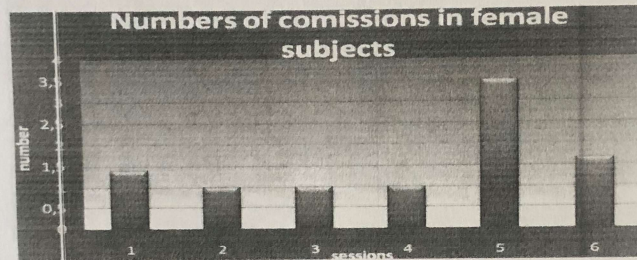


Figure 12. Number of commissions in female subjects

Heart rate is more flexible in girls, but they still didn't succeeded great changes

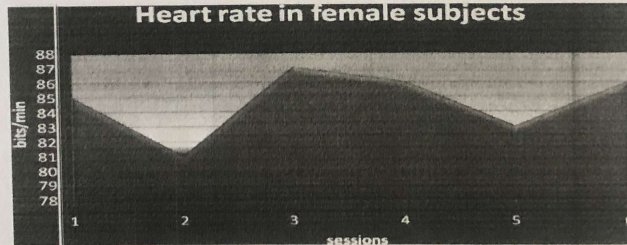


Figure 13. Heart rate in female subjects

WHOLE GROUP Testing are given below:

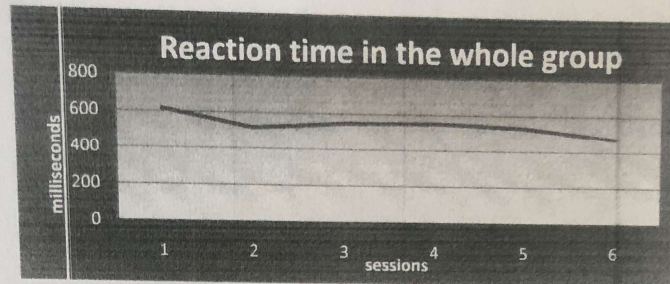


Figure 14. Reaction time in the whole group

T-test showed significant results for: RT 1 and RT 2 ($p < 0.004$), RT 5 and RT 6 ($p < 0.009$) and finally RT 1 and RT 6 ($p < 0.0005$).

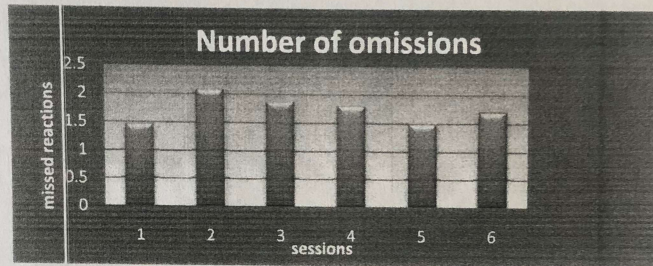


Figure 15. Number of omissions

Number of omissions in the second session is much greater than in the assessment which means "difficult task/ distractibility/ lower attention".

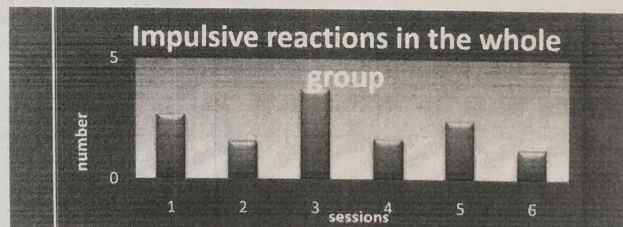


Figure 16. Impulsive reactions in the whole group

The impulsive reactions (low attention/distractibility) are accentuated after the third session (practical issue of the e-learning method).

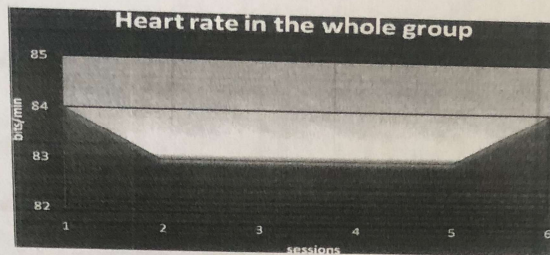


Figure 17. Heart rate in the whole group

All students didn't succeed to learn how to manage the autonomic nervous system. Heart rate stays unchangeable.

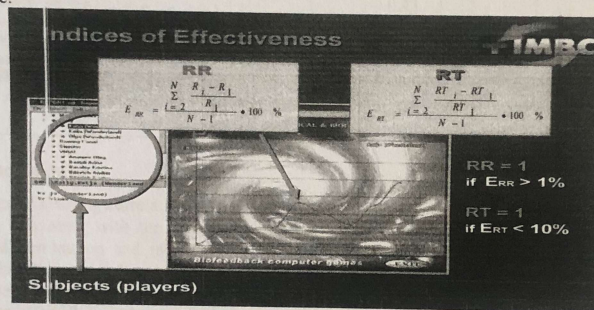


Figure 18. Indices of effectiveness

The overall testing strategy for Usability testing was divided into: One-on-one testing and a group testing using the Co-discovery technique (working together) and active intervention technique (the observer is actively participating and assisting). We defined one class of users. In addition, we conducted performance measurement test to quantify usability requirements such as time to complete a task, time to learn, rate of errors and subjective satisfaction. All the participants have tested the software. After the usability test we had collected a great deal of data from the participants we had. In order to handle those data we have used the triangulation technique from Dumas and Redish (1999), where we look at all data at the same time to see how the different data supports each other.

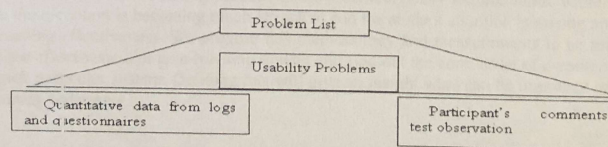


Figure 19. (Triangulation technique) Dumas and Redish (1999) p.310

We tabulated the data for the performance measurements using the next usability attributes: time to learn, speed of performance, rate of errors, Subjective satisfaction, and Frustration for the both classes of users Experts and novices.

Table 1. Usability research

| Usability Attribute | Measuring instrument | Value to be measured | Current Level average | Worst acceptable | Planned target level | Best possible |
|---|----------------------|------------------------------|-----------------------|------------------|----------------------|---------------|
| Time to learn | Task Scenario | Time to complete task | 217.8 s | 360 s | 180 s | 150 s |
| Speed of performance | Task Scenario | Time to complete task | 67 s | 120 s | 80 s | 45 s |
| Rate of errors | Task Scenario | Number of errors | 0.43 | 2 | 1 | 0 |
| Subjective satisfaction | Task Scenario | Satisfaction degree of users | 3.94 | 2 | 4 | 5 |
| * number. Subject satisfaction scale: very high | | | high | average | low | very low |
| | | | 5 | 4 | 3 | 2 |
| | | | | | 1 | |

6 Conclusion

This study found a strong correlation between the two e-learning indicators: e-content and attention. Such findings are consistent with the idea that e-learning content (e-content) is the main vehicle behind knowledge dissemination and increased learning and it is primarily dependent on learners' attention. Measuring the attention and e-content through the realised tests we have concluded that the attention is dropping after the first task and later after the second task is again increasing. Rey Auditory Verbal Learning Test (RAVLT) showed highly organized ability for learning new knowledge as well as attention and concentration, which can be seen from the progression in the obtained new knowledge. Female subjects are learning much faster than the male subjects. No changes in the time of performance. After a few worse results, the students manifested improvement of the total time for performance (adaptation in the test situation). The commission's number is much greater after the third task (they are bored or tired, and the task is too hard). Omissions are greater after the fourth task (attention is diminishing because of boring or tiredness). The greater impulsive reaction (commissions) after the 5-th task could be interpreted with the feeling of boring / fatigue. Statistical analysis showed significance at the level $p < 0.03$. Based on this evaluation of e-learning effectiveness we concluded that the attention curve in the beginning after the first task is falling because of the e-content heavy requirements, while later is raising again while the e-content is becoming much attractive and the student attention is raising and with this the overall e-learning effectiveness. We propose this methodology and measurements to be realized in order to evaluate the effectiveness of an e-learning system and find out the correlation of e-content and attention curve for each particular system. Defining this will give an insight what can be improved on either of one of the e-learning indicators.

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