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E-Learning Research System with Automatic Control of a Learner's Physiological State

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Abstract – The essence of the proposed research system is the creation of e-learning modules that can be tested with different models, scenarios and temporal correlations within presentation of various elements of educational content. During training sessions the system evaluates a learner's response and degree of assimilation section by section, and adapts itself to the user's real-time needs.
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Definition of Distance Education (DE): a field of education that focuses on the pedagogy technological and industrial systems design (Blackboard [1], Moodole [2], eLSe [3], [4]) that aim to deliver education to students who are not physically „on site". Distance educational courses that require a physical for any reason, including the taking of examinations, is considered to be a hybrid or blended course of study.

Definition of e-learning (short for electronic learning): learning that is conducted via electronic media. According to the Glossary of E-Learning Terms, 'e-learning' is education via the Internet, network, or standalone computer. The network allows the transfer of data, through which knowledge and skills are being built. E-learning refers to the electronic process of building knowledge, and includes web-based learning, computer-based learning, virtual classrooms, and digital collaboration. Content is delivered via the Internet, intranet/extranet, audio or video tape, satellite TV or similar technologies (Elearnframe, 2004) (Hall, 1997) [5], Belanger & Jordan (2000) [6], Bannan, B., & Milheim, W.D. (1997) [7].

Cloud computing is the delivery of computing services over the Internet (Hassan) [8], (Grance) [9]. This is an IT term denoting the use of shared resources, software, and information as provided to computers and other devices over a network (the Internet). The term combines concepts such as software as a service (SaaS), infrastructure as a service (IaaS), platform as a service (PaaS), and other modern technologies which in the form of online/browser-accessible business applications meet computing needs while the software and user data are stored on servers.

In other words, the term refers to both the software applications provided in the form of web services, and the access to the hardware and system resources in the data center providing these services. The combination of access to the center's hardware and software is what is referred to as "cloud". „Cloud" is also a metaphor for „the Internet" as it is often depicted in computer network diagrams as an abstraction of the complex infrastructure that lays behind it. In this mode of computer-system organization and operation, the computing resources provided to tenants – such as CPU time and memory – can be optimally allocated and dynamically increased owing to modern virtualization technologies. The cloud tenants who become in turn cloud service providers avoid the need for infrastructure investment, staff

training, software license purchase and even understanding the way systems work for them in the cloud. Open standards are critical for cloud computing development, and many of the fundamental technologies in the field were created by open-source software developers.

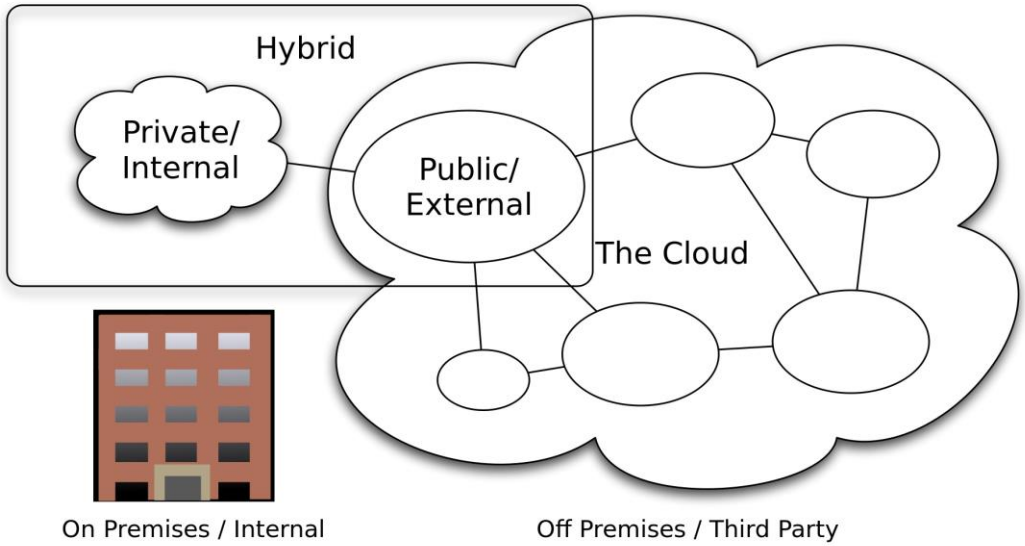

Fig. 1. Private, public and hybrid cloud types.

The essence of the proposed research system is the creation of e-learning modules that can be tested with different models, scenarios and temporal correlations within presentation of various elements of educational content. Also included in the project is the incorporation of real-time monitoring of knowledge acquisition, as well as varying the information transmitting pace, change of media environment – video, audio, text, embedding modules and tools for proactive psycho-physiological influence in order to eliminate stress, stumbling blocks, fatigue and other negative factors that might make the learning less effective. Thus, an element of quality management, optimization of new training modules development, and certification and optimization of the already developed ones are introduced in the educational process. It is also planned to introduce elements of self-learning which can transform the system into an autonomous one with elements of artificial intelligence. The system will maintain a personal database of each registered user for the purpose of study of their personal qualities and personality development throughout the learning process. Owing to the cloud access to the information resources, the learning process and the knowledge&skills certification can take place 24/7 from anywhere, if Internet access is available. It will be enough to use one of the following devices to access the Internet environment: tablet, smartphone, laptop or desktop computer.

Any learner's psychophysiological state can be controlled via standard (bracelet) or specialized devices (MEMS [10] and chemical sensors) measuring temperature, blood pressure, pulse, response time, etc. Depending on specific indicators and ratios the system will be able to change or stop the e-learning scenario (e.g. delay it or return it to a previous stage) for the purpose of integrity and completeness of the acquired knowledge. Distance learning effectiveness largely depends on the preliminary analysis of a user's environment, educational goals, strategy selection and last but not least – the assessment of learning outcomes.

In 1956, the renowned American psychologist George Miller in his article [11] "The Magical Number

Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information" [12], [13], [14], revealed the amount of information that can be held in memory after a single access to it. Miller's experiments showed that an average human can memorize up to 9 binary numbers (7 + 2), 8 decimal numbers (7 + 1), 7 letters and 5 non compound words (7 – 2), after seeing or hearing them a single time. Everything centers around the exact number 7. According to Information Theory, each of the above mentioned groups of items corresponds to different amounts of information. 9 binary digits are equivalent to 9 binary digits (bits), 8 decimal numbers are equivalent to 25 bits, 7 letters are equivalent to 33 buts, and 5 words – to 50 bits. From this, Miller concluded that the short-term memory capacity is not limited by the amount of information itself, but by the amount of its constituent pieces, or "chunks". This type of memory has nothing to do with semantic content, neither with external characteristics such as shape, light, correlation between figures, etc. It is only interested in the importance of the information to the long-term memory, which is to evaluate the memorized data and to select the one that might be useful in the future. We can put only 7 coins in the purse, Miller said; our short-term memory is not interested whether dollars or cents – their value will be estimated by the long-term memory. If the memorable elements are more than 7 (up to 9 in the extreme case), the brain breaks their number down to between 5 and 9. Interestingly, a similar rule applies to ants: they can memorize and communicate up to 7 bits of information. Miller came across the magic number 7 through experiments in visual perception; later on, the same result was confirmed in regard to hearing perception.

How does the e-learning research system work?

The educational content is prepared in advance, broken down into sections corresponding to the above mentioned conditions. It can consist of text, audio files, video presentations (demo film or animation, accompanied by a soundtrack) or combinations of the above. These data carriers are stored in a cloud and can be accessed anytime, regardless of where the learner is located. The information can be reproduced by any device – tablet, smartphone, laptop, desktop computer, or interactive TV.

During training sessions the system evaluates a learner's response and degree of assimilation section by section, and adapts itself to the user's real-time needs – for example by adjusting the number of new sections to the degree of assimilation. Upon completion of each block of information, the degree of assimilation is assessed either by testing or collecting feedback data, or even using game approach. Depending on the outcome, the system might also reduce the so-called "windowing" – the number of knowledge elements taught. Upon reaching the most appropriate volume of digestible knowledge blocks, the system customizes this parameter for the learner, so it can be used for further modules design. The same parameter will be integrated into the database in comparison to all other users that are being taught by the system. The analysis will allow the adaptation of the system to the capabilities of the entire group of learners, and will optimize the utilization of the entire volume of knowledge provided by the educational program. Thus, each student will have their own virtual teacher accompanying them throughout the entire learning process while keeping records of their reactions and the assimilated information, and ensuring the quality and quantity of the acquired knowledge.

During the active periods of assimilation of knowledge, the module that controls the learner's psychophysical state can also monitor the surrounding environment (air quality, temperature, comfortability – lighting, noise, other confounding factors, etc.). If the system detects a sign of fatigue, distraction or learning inefficiency, it will apply measures designed for relaxation, concentration, motivation, and proper mental attitude; then the learning process will continue.

By using the functionalities of the above described Experimental E-Learning System (EELS) some of the major problems of distant education can be solved: current and final assessment, self-assessment and feedback. Creating individual user profiles, assessing prior knowledge vs. knowledge acquisition, and monitoring student behavior will significantly enhance educational quality and effectiveness. The complexity of the applied methodology can vary from collecting feedback to creating dynamic content, tailored to the specific needs of a learner during the course. Even learners' heart rate and brain activity can be monitored throughout the sessions.

The training modules largely use music to raise learners' IQ and increase focus, memory, and concentration. Music has positive effects on spatial-temporal reasoning, mathematical abilities, linguistic skills, and emotional intelligence. With its 60 bpm beat pattern, Mozart's and Baroque music activate both the left and right brain putting them in the Alpha diapason – a state of sublime feelings and mental peace. The simultaneous left and right brain action maximizes learning and retention of information. Learning activates the left one, while listening to music activates the right one. Music also Increases the levels of psychological arousal, *i*mproves motor activity and coordination, and reduces muscular tension as well as the feeling of fatigue.

EELS results will be reported in the future publications of the research team that developed the system. After a detailed analysis of individual learning outcomes achieved with the use of EELS, the project will allow for the creation of virtual personal robo-teachers who will provide effective and high-quality education. This will be the beginning of the series of "Robofessors" who will assist humankind with the most important process for its development: skill and knowledge acquisition, while making maximum use of modern Information and communication technologies (ICT).

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