A New E-learning System Focusing on Emotional Aspect Using Biological Signals

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Abstract. E-learning is the computer and network-enabled transfer of skills and knowledge. It is widely accepted that new technologies can make a big difference in education. Although the advantages of e-learning over person to person teaching are still under debate, the latter is considered to be superior with respect to teaching effectiveness. One reasons for this advantage of human expert tutors is their ability to deal with the emotional aspects of the learner. In an e-learning system, emotions are important in the classroom. We thus proposed a new e-learning system that focuses on affective aspects. Our system equips sensors to measure biological signals and analyzes user emotions for the improvement of the e-learning system's effectiveness.

Keywords: E-learning, Emotions, Affective aspects, Biological signal.

1 Introduction

E-learning can mean a variety of different things to different people, but it is essentially the computer and network-enabled transfer of skills and knowledge. It can be self-paced or instructor -led and includes media in the form of text, image, animation, streaming video, and audio [1]. E-learning can have many benefits. In times of recession, the case for e-learning becomes much stronger. Key benefits include low cost, fast delivery, self-paced, less travel time, personalized and convenient scheduling, and lower environmental impact.

Thus, many universities have applied electronic communication for e-learning systems to enable people to learn anytime and anywhere, to deliver content and methods that build new knowledge and skills linked to individual learning goals, or to improve performance.

In e-learning systems, emotions are important in the classroom in two major ways. First, emotions have an impact on learning. They influence our ability to process information and to accurately interpret what we encounter. For these reasons, it is important for teachers to create a positive, emotionally safe classroom environment to provide for optimal learning. Second, learning how to manage feelings and relationships constitutes a kind of "emotional intelligence" that enables people to be successful [2].

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Learners are free to learn at their own pace and to define personal learning paths based on their individual needs and interests. E-learning providers do not have to schedule, manage, or track learners through a process. E-learning content is developed according to a set of learning objectives and is delivered using different media elements, such as text, graphics, audio, and video. It must provide as much learning support as possible (through explanations, examples, interactivity, feedback, glossaries, etc.) in order to make learners self-sufficient. However, some kind of support, such as e-mail-based technical support or e-tutoring, is normally offered to learners [3].

Biological signals are electrical or magnetic signals generated by some biological activity in the human body [4]. Biological signals have widely different sources, such as electrocardiography (ECG) originating from the heart, and electroencephalography (EEG) generated by the brain, making them very heterogeneous.

E-learning does not require a classroom, but it does require an understanding of how learning takes place. In this study, we focused on the emotional aspect of the e-learning system using biological signals. The purpose of this study is to design learning environments and tools that avoid inappropriate affective states, such as boredom, anxiety, or anger.

2 Literature Review

Daniel, the author of Emotional Intelligence, argues that the emotional quotient (EQ) is more important than the intelligence quotient (IQ) [5]. The issue is for e-learning to recommend ways in which to keep e-learning from being boring. We recognize that e-learning is different from face-to-face instruction lacking a trainer to address the emotional component and we provide some very sensible advice on how to keep e-learning relevant.

Khan developed a framework for e-learning that contained the following eight dimensions [4]:

- The pedagogical dimension of e-learning refers to teaching and learning. This dimension addresses issues concerning content analysis, audience analysis, goal analysis, media analysis, design approach, organization and methods, and strategies of e-learning environments.
- The technological dimension of the e-learning Framework examines issues of the technology infrastructure in e-learning environments. This includes infrastructure planning, hardware, and software.
- The interface design refers to the overall look and feel of e-learning programs. Interface design dimension encompasses page and site design, content design, navigation, and usability testing.
- The evaluation for e-learning includes both assessment of learners and evaluation of the instruction and learning environment.
- The management of e-learning refers to maintenance of the learning environment and distribution of information.

- The resource support dimension of the e-learning Framework examines the online support and resources required to foster meaningful learning environments.
- The ethical considerations of e-learning relate to social and political influence, cultural diversity, bias, geographical diversity, learner diversity, information accessibility, etiquette, and legal issues.
- The institutional dimension is concerned with issues of administrative affairs, academic affairs, and student services related to e-learning.

This framework provides a new e-learning system.

Kittanakere et al. summarized the main goals of e-learning systems, identified by different researchers, as below [6]:

- Focus on active learning.
- Accommodate various learning styles.
- Explicitly place the responsibility for learning on the students.
- Develop written and oral communication skills.
- Clarify the role of the teacher as facilitator and mentor.
- Provide better coverage of material.
- Develop a sense of self-confidence and independence in students.
- Include a teamwork experience
- Encourage peer review.
- Develop interpersonal communication skills when students are geographically apart.
- Support the entire educational process when students are apart both geographically and temporally.
- Learn to handle time management including the meeting of deadlines.

Many of the above goals reflect the advantages of e-learning systems over traditional learning approaches. Another advantage is that they are scalable. The number of learners that an e-learning system can handle with individual attention is much more than that can be accommodated in a classroom setting.

Kittanakere et al. introduced the design of an emotion sensitive e-learning system that gives emphasis to the complete learning process and is very cost effective. The system categorizes a learner's emotional state as follows: Happy, Neutral, and Sad. This motivates thinking about incorporating emotional aspects of teaching in e-learning systems to make them more intelligent. An intelligent e-learning system should be able to adapt to the knowledge, learning abilities, and needs of each learner. This would give them the feel of individual care, which would assist in the learning process.

Kaiser and Oertel also integrated an emotion recognition sensor system (EREC) into an e-learning system [7]. The system used EREC for emotion detection by the affective component, that EREC developed at the institute of genetics and development of rennes (IGD-R), consisting of a sensor glove, a chest belt, and a data collection unit. The affective component is based on Russell's circumplex model of emotion, a dimensional approach for classifying emotions.

Shen et al. also applied heart rate (HR), skin conductance (SC), blood volume pressure (BVP), and EEG brainwaves to detect learner emotions [8]. The results for emotion recognition from physiological signals achieved a best-case accuracy (86.3%) for four types of learning emotions. This affective e-learning system included only a subset of the factors that could be taken into account to assess a learner's emotional reactions in e-learning.

From the literature reviews, designing a system that focuses on user emotions using some biological signals is very promising. Therefore, we propose a new e-learning system design that avoids inappropriate affective states such as boredom, anxiety, or anger.

3 Design of E-learning System

Distance education and e-learning are becoming an increasingly important part of higher education. This type of education can take place over the Internet, through which the instruction and educational content are delivered [9].

We propose a new design of an e-learning system using biological signals that are affective to the learner and closer to actual classroom learning.

3.1 Overall System Design

In this section we discuss the overall design of the e-learning system (Fig. 1). This system uses an LMS (learning management system) for delivering, tracking, and managing education and a web server that provides the user with easy access via a web browser on a personal computer. While using our system, biological sensors measure user biological signals as EEG, ECG and eye tracking to detect user emotions.

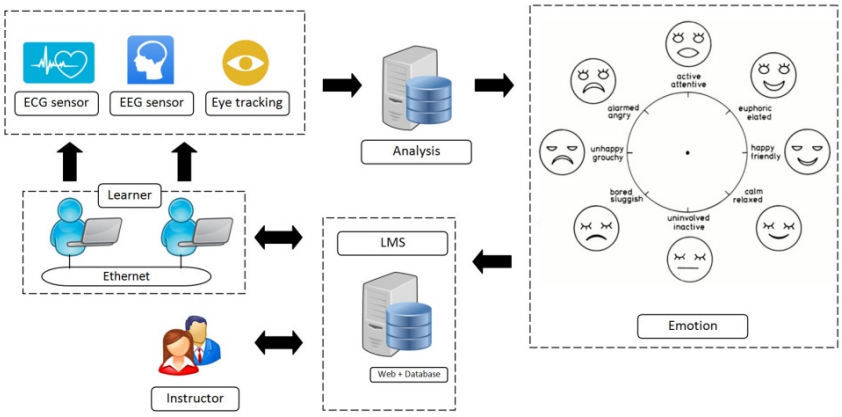

Fig. 1. The proposed e-learning system

3.2 Framework for E-learning

We used an e-learning framework [10] with eight dimensions (Fig. 2). These dimensions encompass various online learning issues, including pedagogical, technological, interface design, evaluation, management, resource support, ethical, and institutional. Various factors discussed in the eight dimensions of the framework can provide guidance in the design, development, delivery, and evaluation of flexible, open, and distance learning environments.

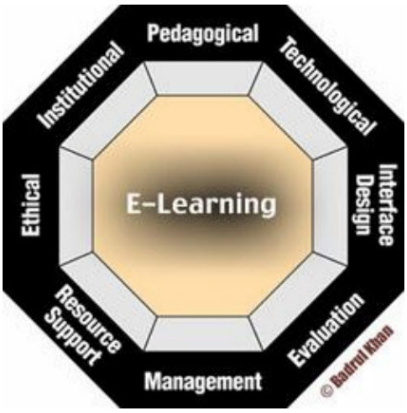

Fig. 2. Badrul Khan's e-learning Framework (Source: Khan, B. H., p.1)

3.3 Framework Design

The framework design of our e-learning system using biological signals consists of eight modules: I/O devices, learning management system (LMS), learner, instructor, server, and biological sensors. It analyzes learner emotions, as shown in Fig. 3. The details are described below:

I/O Devices. There are five I/O devices: speaker, monitor, touch screen, keyboard and mouse.

Learner. The learner is an individual who takes up e-learning by registering to the e-learning system. The learner can choose any of the courses provided by the system.

Instructor. The instructor is an important element of this system that creates and designs courses, content, tests, quizzes, and evaluations.

Server. The servers are the web server, LMS, and database that provide services to other computer application programs (and their users) in the same or other computers.

A web server is simply a computer program that dispenses web pages as they are requested. The machine the program runs on is usually also called a server and the two references are interchangeable in everyday conversation. Our design uses an internet information server as a web application server.

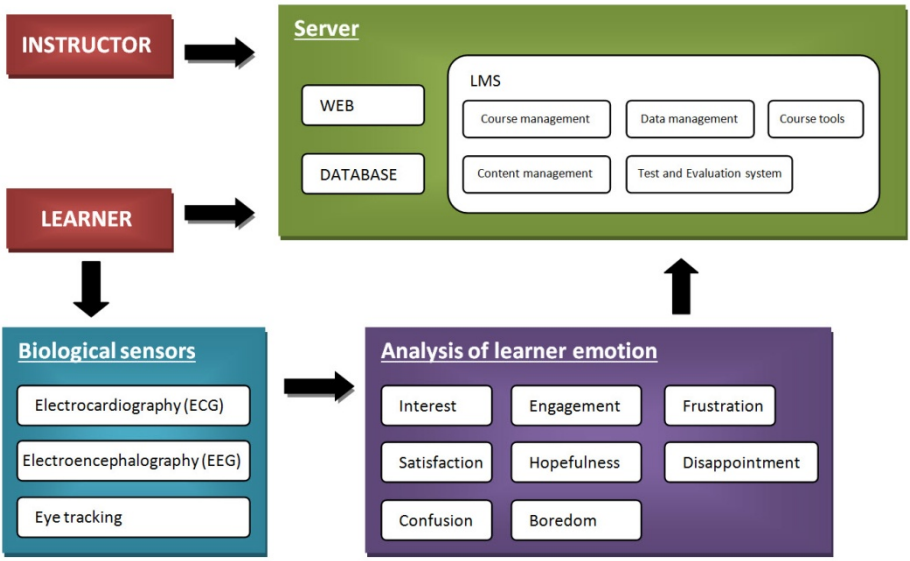

Fig. 3. Framework design

A database server is a computer program that provides database services to other computer programs or computers.

An LMS is a software application or Web-based technology used to plan, implement, and assess a specific learning process. Typically, an LMS provides an instructor with a way to create and deliver content, monitor student participation, and assess student performance. An LMS consists of the following five parts:

- Course management can help store, organize, and communicate the information for a course. It consists of three user groups, such as learner, instructor, and administrator, that can access the system anytime and anywhere.
- Content management includes tools for creating and helping the content.
- The test and evaluation system manages the exams, quizzes, and tests in the database system, such as directions and interactive quizzes, integrated tests, and quizzes to evaluate the learner.
- Course tools are used to help and guide each user.
- The data management system manages the files and folders of each user.

Biological Sensors. Learner emotions were measured with ECG, EEG, and eye tracking biological sensors. An EEG sensor measures voltage fluctuations from electric ions within the brain's neurons. An ECG sensor measures the heart's electrical activity over a period of time. ECG signals can be interpreted as heart rate in beats per minute (BMP). Eye tracking is a device for measuring eye positions and eye movement.

Analysis of Learner Emotion. We devised this design system to understand how learners' emotions evolve during the learning process, so as to develop learning systems that recognize and respond appropriately to students' emotional changes. We used Russell's 'circumplex model' to describe the user's emotion space [11], as shown in Fig. 4. The basic set includes the most important and frequently occurring emotions during learning, namely, interest, engagement, confusion, frustration, boredom, hopefulness, satisfaction, and disappointment.

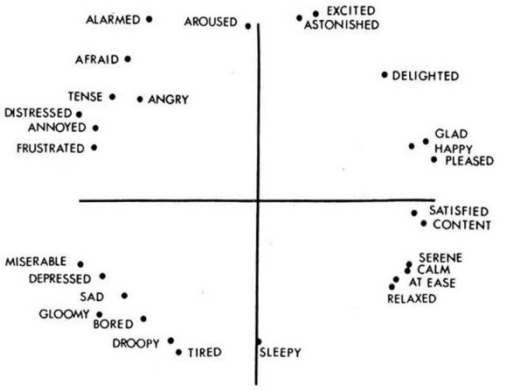

Fig. 4. Russell's 'circumplex model' (Source: Russell, J.A., p. 1168)

4 Conclusion

We have described our approach to designing a new e-learning system that focuses on emotional aspects. ECG, EEG, and eye tracking biological sensors were used for measuring learner emotion. The proposed e-learning system's aim is to avoid inappropriate and affective states such as boredom, anxiety, or anger.

In future work, we will perform experiments and improve our system. In addition, we will conduct further research on learner motivation and determine what is most effective for student learning.

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