Affective Computing to Enhance E-Learning in Segregated Societies

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Abstract

According to UN Women, to build stronger economies, it is essential to empower women to participate fully in economic life across all sectors. Increasing women and girls' education enhances their chances to participate in the labor market. In certain cultures, like in Saudi Arabia, women contribution to the public economy growth is very limited. According to the World Bank [1], less than 20 percent of the female population participate in the labor force. This low participation rate has many reasons. One of them, is the educational level and educational quality for females. Although Saudi Arabia has about thirty three universities, opportunities are still limited for women because of the restrictions of access put upon them. A mixture of local norms, traditions, social beliefs, and principles preventing women from receiving full benefits from the educational system. Gender segregation is one of the challenges that limits the women access for education. It causes a problem due to the shortage of female faculty throughout the country. To overcome this problem, male faculty are allowed to teach female students under certain regulations and following a certain method of education delivery and interaction. However, most of these methods lack face-to-face communication between the teacher and students, which lowers the interactivity level and, accordingly, the students' engagement, and increases the need for other alternatives. The e-learning model is one of high benefit for female students in such societies. Recognizing the students' engagement is not straightforward in the e-learning model. To measure the level of engagement, the learner's mood or emotions should be taken into consideration to help understanding and judging the level of engagement. This paper is to investigate the relationship between emotions and engagement in the e-learning environment, and how recognizing the learner's emotions and change the content delivery accordingly can affect the efficiency of the e-learning process. The proposed experiment alluded to herein should help to find ways to increase the engagement of the learners, hence, enhance the efficiency of the learning process and the quality of learning, which will increase the chances and opportunities for women in such societies to participate more effectively in the labor market.

1   Introduction

Education is a form of learning in which the knowledge, skills and habits of a group of people are transferred from one generation to the next through teaching, training, or research [2]. The need for education serves different purposes. Creating a platform of skilled and qualified

manpower able to communicate and compete with peers in the global market place, be it the educational, economic, or research industry has always been one essential need for education [3]. According to Rand, the developer of the philosophical system called 'Objectivism', "The only purpose of education is to teach a student how to live his life by developing his mind and equipping him to deal with reality" [4]. Similarly, Noam Chomsky says, "Education is really aimed at helping students get to the point where they can learn on their own" [5]. However, education cannot achieve its goals unless it is efficient.

Efficiency is a way of measuring the level of performance in producing the best amount of outputs from a process that uses a limited amount of inputs. Thus, the efficiency of education is highly dependent on the delivery method. Students learn best when they actively participate in the learning process, when they are engaged and motivated to learn, and when they can build on their existing knowledge and understanding [6].

For as long as the concept of education has existed, there was only one form of education called the traditional education where the teacher has contact with students in a learning environment often called "classroom". The basic technique in this kind of educational setting was oral recitation where students listen quietly to their mates one by one reciting the lesson. The role of the teacher was to assign and listen to these recitations and assess the performance of students usually by oral examination. This kind of education was inefficient to a high extent as it was highly dependent on rote memorization, which is memorization with no effort at understanding the meaning [7].

Progressive education was later introduced as a new approach and form of education that emphasis learning by doing. Progressive learning is more learner oriented. In progressive education, the learner has more freedom to choose what to learn and how to learn by getting involved in hands-on projects, which is a form of what is called Experiential Learning (learning from experience). This form of education is highly engaging for students as it includes a high level of interaction. The learner is more independent, self-motivated, and more involved in collaborative and cooperative learning projects. The increased level of participation of learners in progressive education makes this type of setting much more efficient than the traditional one, and closer to achieving the learning objectives.

Although progressive learning is more learner oriented, the teacher still has an important role. The teacher is expected to be a facilitator of learning – encourage students to use a wide variety of activities, manage their discussions, guide them through the wide variety of materials and asses their performance. In other words, teachers adopt and adapt different tools to help students absorb the materials. Technology is one of these tools. It is used to overcome one or more of the shortcomings of traditional instruction. It combats boredom by adding motivational features that excite learners' interest. Technology in teaching in its early phases denoted the use of traditional media like visual and audio media. However, with the advancement of technology, the traditional media turned digital where the use of computers, interactive multimedia and e-learning turned out to be the main characteristic of the modern educational format.

E-learning refers to the use of electronic media and information and communication technologies in education. Bernard Luskin, a pioneer of e-learning, advocates that the "e" should mean "exciting, energetic, enthusiastic, emotional, extended, excellent, and educational" in addition to "electronic" [8]. E-learning can be used for distance learning, which is a way for delivering education and instruction to students who are not physically present in a traditional setting such as classroom. It has two modes of delivery, either synchronous or asynchronous.

In synchronous learning, all participants should be present at the same time. Different technologies can be used for delivery such as web conferencing, videoconferencing, instructional

television, direct-broadcast television, internet radio, live streaming, telephone and VoIP. On the other hand, asynchronous learning does not require the presence of the students at the same time. They can access the course materials on their own schedule. Mail correspondence, message board forums, email, interactive media, video and audio recording are different examples for technologies used for this mode. Moreover, a recent distance learning technology called MOOCs is used to teach online a massive number of students with minimal involvement by professors. MOOC, which stands for "massive open online courses" can be either synchronous or asynchronous. E-learning usually does not require face-to-face interaction between the students and the instructor. However, it can be mixed with campus based education, and this is known by blended learning or hybrid learning.

According to Gardner [9], not all people have the same abilities, thus not all of us learn the same way. Students learn in different ways and usually have their own styles and preferences for learning. This theory is supported by research on what is called Learning Styles [10].

Learning styles refers to a cluster of psychological behaviors to determine how an individual perceives, interacts with, and responds emotionally to learning environments. Most learning style theorists have settled on four basic styles:

- *The Mastery Style Learner.* Absorbs information concretely; processes information sequentially, in a step-by-step manner; and judges the value of learning in terms of its clarity and practicality.
- *The Understanding Style Learner.* Focuses more on ideas and abstractions; learns through a process of questioning, reasoning, and testing; and evaluates learning by standards of logic and the use of evidence.
- *The Self-Expressive Style Learner.* Looks for images implied in learning; uses feelings and emotions to construct new ideas and products; and judges the learning process according to its originality, aesthetics, and capacity to surprise or delight.
- *The Interpersonal Style Learner.* Like the Mastery learner, focuses on concrete, palpable information; prefers to learn socially; and judges learning in terms of its potential use in helping others.

Learners develop and practice a mixture of styles as they live and learn. Teachers should be able to analyze students and recognize their different abilities and learning styles in order to design and plan lessons in a way that helps all students absorb and process information efficiently.

E-learning may be a luxurious choice for some, but for others it may be the preferable or the only possible route to education. This may be the case in segregated societies, like the one in Saudi Arabia, where female students have limited face-to-face interaction with their instructors due to gender segregation. E-learning is indeed the future of education in today's global world; however, its major drawback is the absence of a physically present instructor capable of observing learners and interacting with them according to their needs. This research aims at developing an affective E-learning framework for all-female settings in gender segregated-societies such as Saudi Arabia, by applying a multimodal system (e.g. facial expressions) that measures and senses the learners' reaction to the materials used during the learning process. By doing so, women and girls' education will enhance their chances to participate in the labor market, hence, building stronger economy.

2 Learning engagement

For all kinds of education: traditional, progressive, e-learning or blended learning, the major challenge is how to achieve maximum efficiency of the education process and keep learners

engaged during the learning process. According to Bangert-Drowns and Pyke, truly engaged learners are behaviorally, intellectually, and emotionally involved in their learning tasks [11].

The first step in engaging learners is determining their interest level. According to Schmoker, there are evidences to detect [12]

- paying attention (alert, tracking with their eyes),
- taking notes,
- asking / responding to questions, and
- reacting (laughing, crying, shouting, etc.).

In face-to-face teaching, experienced teachers recognize the engagement level of the students and react accordingly. They change their teaching method during the class to grab the students' attention. For example, the teacher can change from a presentation method to a discussion one, ask a challenging question, tell a story, or play a game. Mixing different teaching methods and strategies in the teaching process engages students and efficiently achieves the set educational goals. This strategy can be adoptable in the traditional and progressive education forms, where the teacher has direct contact with students and can recognize their engagement level. However, in some cultures, where education is segregated based on gender as a result of social regulations, face-to-face teaching is not applicable. For example, in Saudi Arabia, this segregation causes a problem at the level of higher education due to the shortage of female faculty throughout the country. To overcome this problem, male faculty are allowed to teach female students under certain regulations and following a certain method of education delivery and interaction. One of these methods involves the use of closed-circuit television (CCTV) for transmitting a male faculty's lecture delivered to female students [13]. Another method involves teaching in a special lecture room divided by a dark one-way see – through glass barrier, where the students may view the professor, but not the other way around [14].In very rare cases, male professors can teach female students directly and without barriers. However, in many of these cultures female students cover their faces in the presence of male instructors. The absence of face-to-face communication in such cases, lowers the interactivity level and, accordingly, the students' engagement, and increases the need for other alternatives. The e-learning model is one of high benefit for female students in such societies. However, recognizing the students' engagement is not straightforward in the e-learning model, where there is no direct contact between the instructor and the learner. In e-learning, the physical activities that demonstrate engagement like taking notes or tracking teacher with eyes are not applicable; instead, activities related to the usage of computers like focus on the display, strike on the keyboard, click on the mouse, and stay on the web page are good indicators of engagement. However, more indicators are needed to measure the level of engagement more accurately. Therefore, the learner's mood or emotions should be taken into consideration to help understanding and judging the level of engagement.

3   Emotions

Emotion refers to a shaking of the organism as a response to a particular stimulus (person, situation or event), which is generalized and occupies the person as a whole [15]. Usually, it is very brief in duration, which makes it different than "mood". Mood is a feeling that tends to be less intense than emotion and often lacks a contextual stimulus [16]. Both emotions and moods are encompassed under the umbrella of "affect", which is a generic term that covers a broad range of feelings that people experience [17].

Emotions should be characterized and distinguished from other states. Through time, different scholars proposed different classifications of emotions. For example, Rene Descartes

classified emotions as "love, hate, desire, joy, sadness, and admiration" [18]. Other scholars (Spinoza, Hobbes, Jorgensen, and Tomkins) identified other categories of emotions (ibid.)

In modern research, psychologists tried to categorize basic emotions according to facial expressions. Ekman developed a list of basic emotions that are not culturally determined, but universal. These basic emotions are "anger, disgust, fear, happiness, sadness, and surprise" [19]. Emotions are best treated as multifaceted phenomena consisting of the following components: behavioral reactions (e.g. retreating), expressive reactions (e.g. smiling), physiological reactions (e.g. heart pounding), and subjective feelings (e.g. feeling amused) [20]. From an educational point of view, emotions can be classified into positive and negative emotions. Positive emotions encourage students to engage and achieve, such as joy (enjoyment of learning), hope and pride. In this case, Csikszentmihalyi's model of "flow" can be applied; in which there is a zone where people can concentrate their attention so intensely on solving a problem or doing things that they lose track of time [21].]. Such flow is optimal experience that leads to happiness and creativity. If the task is not challenging enough or too challenging, negative emotions such as anger, anxiety, shame or boredom affect the efficiency of learning.

Research shows that a slight positive mood does not just make the student feel a little better but also stimulates a different kind of thinking, characterized by a tendency towards greater creativity and flexibility in problem solving, as well as more efficiency and thoroughness in decision making [22].

4   Emotion recognition

Different techniques and measurement tools are applied to recognize emotions. These tools can be grouped into three areas: Psychological, Physiological and Behavioral [23]

4.1   Psychological tools

These tools are derived from clinical psychology. They apply verbal and non-verbal descriptions of emotions and can be classified into: Verbal self-reporting (e.g. questionnaires, interviews) and Non-verbal self-reporting (e.g. photographs). These tools are inexpensive and non-invasive; however, different factors affect their reliability and should be taken into consideration such as consciousness. Users are often reluctant to disclose their inner feelings to researchers out of embarrassment [24].

4.2   Physiological tools

These tools depend mainly on the use of sensors to measure subject's physiological reactions. They are based on recording electrical signals produced by the brain, heart, muscle, and skin. Examples of these tools are [25]:
- Electromyogram EGM: measures muscle activity
- Electroencephalography EEG: measures brain activity
- Electrodermal Activity EDA or Skin Conductance SC: measures hydration in the epidermis and dermis of the skin
- Electrocardiogram ECG: measures heart activity
- Electrooculogram EOG: measures eye pupil's size and movement
- Blood Volume Pulse BVP: measures blood pressure

4.3   Motor-behavioral tools

These tools measure behavioral expressions and changes in physical body states that reflect people's emotions. Traditional devices can be used within these tools like a PC camera,

microphone, mouse, and keyboard, in addition to sensors and special software. Examples of these tools are: Speech recognition, Hand tracking–body posture, Facial expressions, etc.

5   Proposed affective e-learning platform

The intended research aims to investigate an affective e-learning model in a specific culture. The research will be conducted in Saudi Arabia, in particular Effat University. Effat University is a private non-profit institution of higher education for women in Saudi Arabia, established in 1999. The University has three colleges: College of Engineering, College of Humanities and Social Science, and College of Business. A total of 2346 students are currently enrolled in Effat University – 53 % in the College of Engineering. The University employs 149 faculty members, 26 % of whom are male faculty. This research will be conducted on students attending the College of Engineering where a high level of interaction is needed to teach the practical components of courses. A pilot study will be carried out on a small group of students before the main study to identify the feasibility of the investigation and detect and solve any possible difficulties. In the pilot study we will also be testing the validity of the affective recognition software by using sensors to measure arousal, and visual engagement with the material. The pilot study will be conducted at the University of Westminster with its brand new state-of-the-art Cognitive Development Laboratory, which hosts a Tobii TX300 eye- tracker, a 64-channel Neuroscan and Biosemi Active2 EEG system.

5.1   Participants

Six groups of students in their first year of study will be recruited to participate in the study. Three groups from the University of Westminster will participate in the pilot study (n=15: 5 students for each group). The other three groups will be recruited from Effat University in Saudi Arabia where the main study will be conducted (n=75: 25 students for each group). Students will be randomly selected, the age is approximately matched between the groups (age range will be 18–22). Each group in the pilot study and the main investigation will be taught using one of three approached: face-to-face, e-learning, and affective e-learning.

5.2   Methods

The three groups in the pilot study and the main study will be taught according to the following plan: Group A will be taught by a male faculty using the traditional face-to-face approach, Group B will use an e-learning approach where they have complete control of materials delivery, and Group C will use the proposed affective e- learning approach, where the system will control materials delivery following the student's emotions. All groups will be assessed in the same way at the end of course and the results of their assessment will be evaluated and compared taking into consideration the approach adopted in teaching.

5.2.1   Phase 1 – Teaching

The selected topic will be taught to the three groups using the three approaches as follows: Group A: Will use the traditional face-to-face approach. An instructor will be involved. Group B: Will use only the e- learning approach. No direct contact with the instructor. Group C: Will use the affective e-learning approach. Although, there will be no direct contact with the instructor, but the process will be monitored remotely to ensure smooth running of the process. The same materials used with group B will be used with group C; however,

the system will control the delivery of the materials according to the user's emotions and attention, which will be recognized using the proposed facial expression recognition system.

5.2.2   Phase 2 – Assessment

An assessment will be conducted to examine and assess the performance of the three groups. Assessment will be divided into three stages: Baseline assessment, Formative assessment during the learning period, and Summative post learning assessment.

5.3   Analyses

SPSS software will be used to compare outcome measures between the 3 groups using two way ANOVA (time of assessment x group) with appropriate tests of pairwise comparisons. Correlational analysis will also be used to determine which factors at baseline correlate with final module performance including demographic variables and learning style classification. If time permits, a further assessment test will be carried out a few months following the end of the module to establish the efficacy of affective e learning on longer term retention.

6   Conclusion

Learners have different emotions and different learning styles. In traditional education, they respond to the teaching methods in visible ways. Teachers thus often alternate delivery methods in an effort to meet all learning styles. E-learning, on the other hand, provides individual learners with the same content and instructions, regardless of their learning styles. Designing an e-learning system that will recognize the emotion(s) of the learner, which can be a result of his/her learning style, and apply different content or different teaching methods for each learner may engage the student in a better way hence enhance the efficiency of the education process. Such a model will highly benefit e-learning systems.

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