

An Approach to Assess Stress in E-learning Students

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Abstract: On-line collaboration is becoming more and more common in education and with organisations. Many institutions encourage the use of E-learning platforms, as a complementary tool to support learning or, as in many cases, as the primary tool to do it (possibly the only one). It is believed that the sole use of such a platform can in itself be a cause of stress for students.

Stress is a normal part of studying, but if not managed in the proper way, stress can grow, become a problem and greatly influence learning success. This is particularly true when in an E-learning environment, where students typically may work alone, thus more susceptible to stress.

Stress detection in an E-learning environment thus becomes a crucial factor to success, with E-learning students. Estimating, in a non-invasive way, the students' levels of stress, and taking measures to deal with it, is then the goal of this paper. We do not consider the use of dedicated sensors (invasive) such as special gloves or wrist bracelets because we intend not to be dependent on specific hardware and also we believe that such specific hardware can induce for itself some level of stress. Our work focuses on the developing of a new module to incorporate in Moodle E-learning platform, to accommodate stress detection in E-learning students.

Keywords: Stress, E-learning, Moodle

1. Introduction

As the teacher's role gradually loses its substance in an E-learning environment, some issues must be carefully examined, so that the educational processes guided by software applications (Intelligent Tutoring Systems for instance) will incorporate the best facets of the human experts (Almeida et al, 2008), (Rodrigues, Novais and Santos, 2005).

When a student attends an electronic course, the interaction between student and teacher, with all its non-verbal interactions is lost, thus the aware of feelings and attitudes by the teacher becomes more difficult. In that sense, the use of technological tools for teaching, with the consequent teacher-student and student-student separation may represent a risk, as a significant amount of context information is lost. Students' effectiveness and success in learning is highly related to their mood to do it, that is, students' emotions like self-esteem, motivation, commitment, and others are believed to be determinant in students' performance. Affective states and learning styles also greatly influence students' learning.

These issues should be taken into account, when in an E-learning environment, in our opinion. In a traditional classroom, the teacher can detect and even forecast that some negative situation, for instance stress, is about to occur, and take measures accordingly, to mitigate such situation. When working alone, such actions are impossible, and it is even more difficult to overcome that stress.

In that sense, its analysis in an E-learning environment assumes greater importance. Using sensors as in (Peter et al, 2005) could be a solution for stress detection, however, we believe that the use of visible sensors, induce themselves some sort of stress. In our work, we will try to get useful information from keyboard strokes, mouse movement, touch screen and web cams to generate important information about students' current mood to learn. We are trying to develop a highly modular approach, agent based, easily adaptable to other domains, able to estimate the level of stress of human users in a non-intrusive way. Our goal is to develop a dynamic stress estimation model that, while making use of this context information, will adapt strategies in order to shape the models used by human experts. In fact, teachers frequently make changes in their strategies when

they detect significant changes in the state of their students (Rodrigues, Fdez-Riverola and Novais, 2011). With this approach we expect to see the advent of environments whose main objective is to capture context information that can be used by teachers to achieve better and more satisfactory outcomes when in an E-learning environment.

2. Stress

Stress can play an important (usually negative) role in education, even more in E-learning. So, specially, we are currently working on the estimation of the levels of stress. Stress has spawned a vast body of research in both the health and occupational literature (Carneiro, Novais and Neves, 2011). In fact, some research areas on the topic of stress can be identified, namely (Mulligan, 2011), (Jones and Kinman, 2001): (1) stressors (the environment causes of stress), (2) intervening variables and (3) strains (the outcomes of stress).

Stress can be defined as 'when the perceived pressure exceeds your perceived ability to cope' (Palmer et al, 2003). Stress is an abnormal condition that disrupts the normal functions of the body or mind. In other words, human stress is a state of tension that is created when a person responds to demands and pressures (Gardell, 1982).

Stress is thus always perceived; a situation is stressful for an individual – not for all individuals. Given a particular situation, one student may feel it like a stressful one, whilst another student may feel it like an enjoyable situation. No two people are affected in exactly the same way, or to the same degree, but it is likely that in some part of life we experienced some stress situation. Indeed stress is now the second greatest cause of absence from work in the EU (back pain is the greatest) (BT, 2002). Stress can affect the body, thoughts, feelings, and behaviour of a person.

Stress is an abnormal condition that disrupts the normal functions of the body or mind. In other words, human stress is a state of tension that is created when a person responds to demands and pressures. In students, and even more in E-learning students, if we don't carefully manage study load and other commitments, stress can grow, become a problem and prevent study success.

Stress adds challenge and opportunity to life. Without stress, life would be dull. Too much stress, however, can seriously affect your physical and mental health.

Recurring stress can:

- Reduce your self-esteem and confidence;
- Reduce your memory and ability to understand;
- Decrease your ability to study;
- Create self-blame and self-doubt.

In terms of health it is important to find the optimal level of stress that can be managed effectively. In E-learning systems, it is also very important to manage stress, and keep it within controllable levels. Stress and the way people respond to it is unique to each of us, and thus for each E-learning student. What one person may find relaxing, another will find stressful. For example - public speaking is routine for some people, whilst others view it as a difficult task and are extremely uncomfortable with it. The key to stress reduction is identifying the strategies that fit to a person as an individual. This becomes a critical factor when in an E-learning environment. Treating each student as an individual, in such environments would be a major step to improve academic success.

The best way to deal with unhealthy stress is to recognise it and when stress is growing above some perceived acceptable level, take some appropriate actions. Events themselves are not necessarily stressful; it is the way in which each individual interprets and reacts to an event that induces stress.

2.1. Signs of stress

The signs of stress can be divided into four categories. For each category a person can experience some symptoms. Table 1 shows that symptom for each category (Melinda et al, 2012).

Not all of these symptoms are prone to be detected in an E-learning environment, especially if we assume that no intrusive sensors will be used to detect such symptoms. A few ones though can be detected, and the way to do it will be further discussed.

Table 1 – Stress categories

Thoughts	Feelings	Behaviour	Physical symptoms
Self-criticism; Difficulty in concentrating or making decisions; Forgetfulness or mental disorganization; Preoccupation with the future; Repetitive thoughts, Fear of failure.	Anxiety; Irritability; Fear; Moodiness; Embarrassment.	Stuttering or other speech difficulties; Crying; Acting impulsively; Nervous laughter; Snapping at friends Teeth grinding or jaw clenching; Increased smoking, alcohol or other drug use; Being prone to more accidents; Increased or decreased appetite.	Tight muscles or muscle spasms, Cold or sweaty hands; Headaches; Back or neck problems; Sleep disturbance; Stomach pain and diarrhoea; Frequent colds and infections; Tiredness; Rapid breathing or pounding heart; Trembling; Dry mouth.

2.2. The Importance of Stress

Stress can affect the body, thoughts, feelings, and behaviour of a person. In that sense, its analysis in an E-learning environment is of utmost importance.

The environmental causes of human stress and its manifesting features have been object of research in various disciplines of knowledge. Psychologists define emotions, and in particular stress, as positive or negative reactions to situations consisting of events, actions, and objects; they demonstrate that high stress level is accompanied with the symptoms of faster heartbeat, rapid breathing, increased sweating, cool skin, feelings of nausea, tense muscles, among other manifestations, identified in Table 1, (Ortony, Clore and Collins, 1988). Computer scientists find that facial expressions have a systematic, coherent, and meaningful structure that can be mapped to affective states (Beatty, 1982), (Picard, Vyzas and Healey, 2001).

There are several studies on these topics to develop stress detection systems. Physiological measures such as EMG, ECG, respiration, and skin conductivity are exploited to detect stress in a car driver, being possible to incorporate person-specific information (Picard, Vyzas and Healey, 2010). In (Kataoka et al, 1998) a skin temperature measuring system was developed for non-contact stress evaluation.

Despite all the existing work, it is still a challenging task to develop a practical human stress monitoring system. Several difficulties can be enumerated: (1) the expression and the measurements of human stress are person-dependent and even time or context dependent for the same person; (2) the sensory observations are often ambiguous, uncertain, and incomplete; (3) the user stress is dynamic and evolves over time; (4) the lack of a clear criterion for feasible stress states greatly increases the difficulty of validating stress recognition systems.

In an E-learning environment, the ability to recognize common stress symptoms and, ideally, the real causes, is crucial to understand the underlying factors that conduct the students' success. Our current work focuses on modelling a system that is able to recognize human stress from its external symptoms. We aim to develop a non-invasive real-time system that monitors students' stress in an E-learning environment (like Moodle).

3. E-learning and Moodle

Currently, education organizations cannot exclude themselves from information society, and are always confronted with new technological challenges. Schools are faced with a new technological paradigm, a new kind of public and new demands from society.

Education organizations have tried to address these challenges by investing in organization, management, market research, and in human and technological resources. New pedagogical tools, such as E-learning platforms and Intelligent Tutoring Systems have been also subject of attention.

These investments are very expensive; schools cannot afford to have unsuccessful students. As a consequence, the students' careers must be closely followed. Schools should have devices to evaluate their students' learning state, i.e., they should possess means to keep their students' descriptions up to date, that way being able to follow and diagnose, if not in real time, at least periodically, the learning paths, to avoid failures as much as possible. (Almeida et al, 2008).

MOODLE (Modular Object-Oriented Dynamic Learning Environment) has a number of interactive learning activity components like forums, chats, quizzes and assignments. In addition, MOODLE includes a logging module to track users' accesses and the activities and resources that have been accessed. Administrators and teachers can extract reports from this data. By having a modular type design, the platform can be enriched with different plug-ins, designed to meet specific needs of a specific set of users.

In (Fdez-Sampayo et al, 2009) a new module for on-line platform Moodle course management is presented. The main feature of this work is the ability to process the log files automatically generated by the tool, in order to obtain information about the degree of student participation in various activities available in each course.

LMS, such as Moodle, are very successful in e-education but they do not accommodate full fledged adaptively (Graaf, 2006). Pedagogical concerns when building such systems are not always present, but some attempts have been made. In (Rodrigues, Novais and Santos, 2005) a framework is proposed to mitigate some of these known problems. In (Rodrigues, Fdez-Riverola and Novais, 2011) affective issues and mood assumption (where mood denotes students' determination to learn) are discussed, and new approaches to develop a new module for Moodle, that tries to incorporate in it students' affective states and mood to learn. In this work we have been discussing the influence of stress in E-learning students. As stated before, stress plays an important role in students' success, so we focus our attention on a new module, to dynamically detect stress.

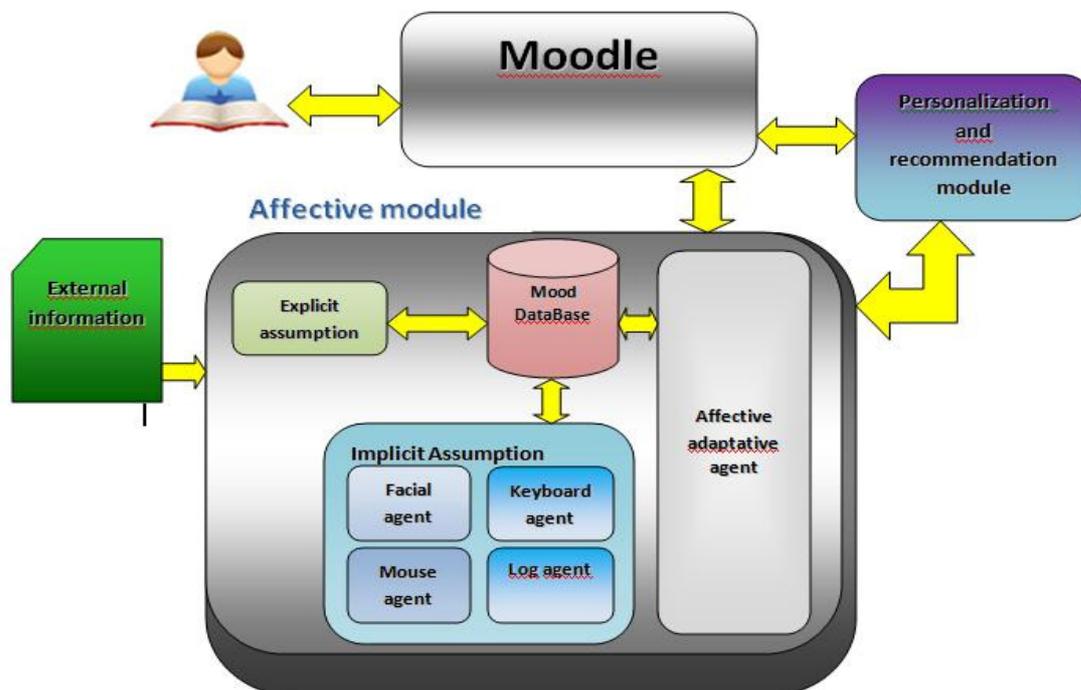


Figure 1 - Framework proposed in (Rodrigues, Fdez-Riverola and Novais, 2011)

4. Stress Detection and Prediction

In ((Rodrigues, Fdez-Riverola and Novais, 2011), a framework is presented to detect students' mood to learn, taking into account some affective states. Starting with figure 1, we can detail the implicit assumption module, focusing only on students' stress detection. The implicit assumption module is upgraded with a new sensor, the accelerometer, widely available in smartphones and tablets, which are now widely used to access E-learning platforms.

Fig. 2 gives a general overview of the proposed approach. Each student interacts With Moodle from his/her own real environment, when attending a course. This environment is equipped with sensors and devices that acquire different kind of information from the student in a non-intrusive way. While the student conscientiously interacts with the system and takes his/her decisions and actions, a parallel and transparent process takes place in which this information is used by the Dynamic Stress Recognition Module. This module, upon converting the sensory information into useful data, allows for a contextualized analysis of the operational data of the students. This contextualized analysis is performed by the Dynamic Stress Recognition Module. Then, the student profile is updated with new data, and the teacher responsible for that course receives feedback from this Module. Also the student gets useful information about his/her levels of stress, for instance, he/she can get the information to have a coffee break, due to high level of detected stress, or, in advance, when the predictive level of stress is too high, the student could get the information to do something else for a while, in order not to achieve that predicted level of stress.

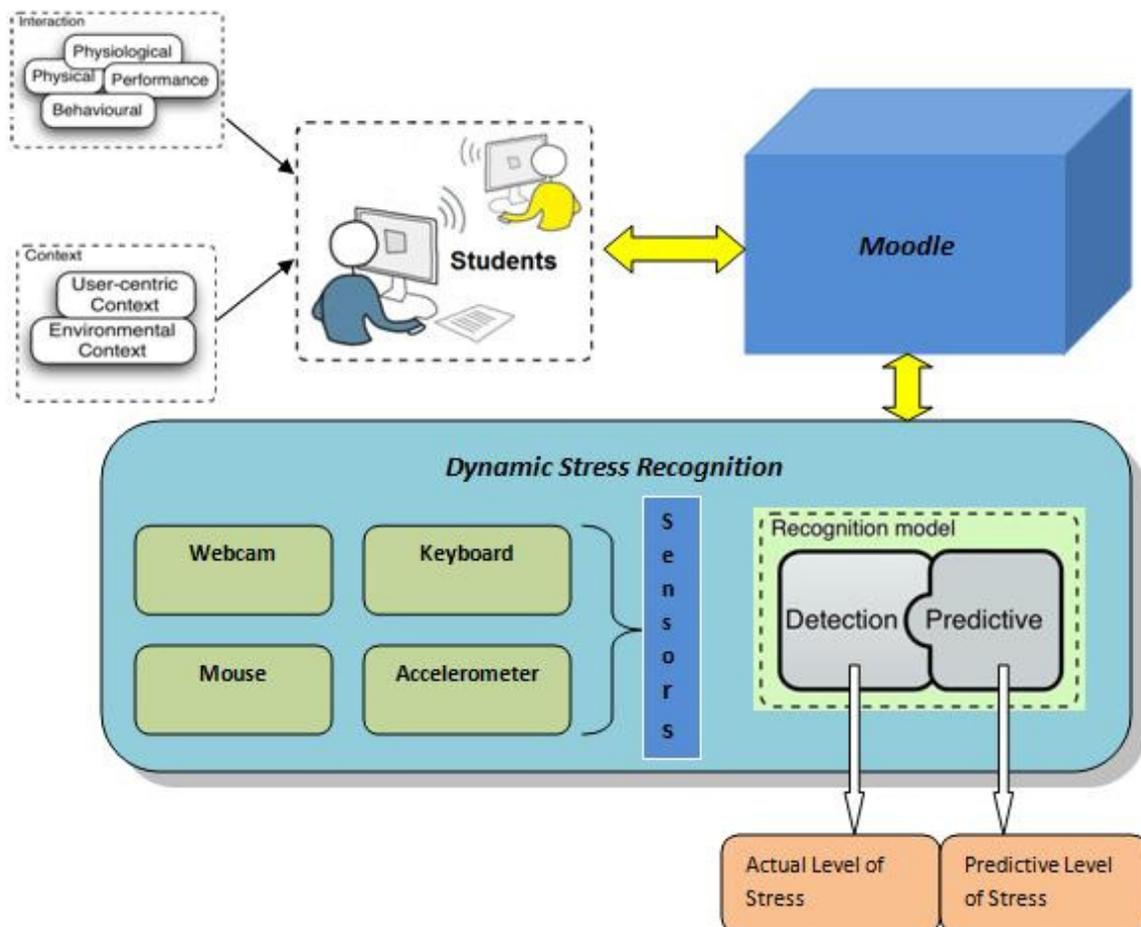


Figure 2 – General overview of the Dynamic Stress Recognition Module

The described system, tries to get as much as possible information from the student, with non intrusive devices that are widely available when students enrol in an E-learning platform. In fact, web cam, keyboard, mouse and accelerometer are devices from which we can obtain useful information.

However, when selecting devices the main requirement is that they have to provide as much information about the user environment as possible. Moreover, the user has to feel comfortable with them.

The level of stress of the students is to be estimated in this work; therefore the focus is on devices capable of acquiring data related to stress. The following sources of information (from now on designated sensors), acquired from the respective devices, are:

- **Touch pattern** - the touch pattern represents the way in which a student touches the device and represents a variation of intensity over a period of time. This information is acquired from touch screens with support for touch intensity;
- **Touch accuracy** - a comparison between touches in active controls versus touches in passive areas (e.g. without controls, empty areas) in which there is no sense in touching. This information is acquired from touch screens;
- **Touch intensity** - the intensity of the touch represents the amount of force that the student is putting into the touch. It is analyzed in terms of the maximum, minimum and mean intensity of each touch. This information is acquired from touch screens;
- **Touch duration** - this represents the time span between the beginning and the end of the touch event. This data is acquired from devices with touch screens;
- **Amount of movement** - the amount of movement represents how and how much the student is moving inside the environment. An estimation of the amount of movement from the video camera is built. The image processing stack uses the principles established by (Castillo et al., 2011) and uses image difference techniques to calculate the amount of movement between two consecutive frames (Fernandez-Caballero et al., 2010);
- **Acceleration** - the acceleration is measured from accelerometers in mobile devices. It is useful for building an estimation of how much the student is moving and how he is doing it (e.g. is the student having sudden movements?). Moreover, information from the accelerometer is used to support the estimation of the intensity of touch.
- **Mouse movement** – the amount of mouse movement represents the pattern in which the student moves the mouse, low amplitude quick movements of the mouse may indicate a high level of stress. These data are acquired from the mouse;
- **Mouse clicks** – the amount of mouse clicks and its frequency is useful for building an estimation of how much the student is moving around the screen and where he/she clicks. It is similar to the first four topics enumerated (pattern, accuracy, intensity and duration). These data are acquired from the mouse;
- **Keyboard strokes** – frequency and intensity of the use of the keyboard. Frequently backspaces may indicate frequent errors, high keyboard stroke may suggest experienced user (student) as opposed to low keyboard strokes. Stroke intensity (if keyboards allow it) may also be considered. These data are acquired from the keyboard.

In the proposed system we expect to realize that sensor values are influenced by stress in a significant way. Thus, changes in the level of stress result in changes in the readings from the sensors. When a student is stressed, he/she touches the interface in a different way, performing different movements, with less touch accuracy, and so forth. An E-learning environment built with these devices and the described functionalities could provide information about the context and state of the student.

We aim to measure accurately the influence of stress in a non-invasive and non-intrusive way of E-learning students by analyzing key features in their interaction with technological devices. This work has been done in other research fields (Carneiro et al., 2012), (Novais et al, 2012).

A prototype of this system is being developed, aiming to produce a module to incorporate in Moodle that dynamically recognizes Stress in E-learning students. A test group of secondary school students will be used to obtain and validate the data obtained by the sensors. First they will be confronted with some questions, with absolutely no constraints (no time limit, internet available, etc), that is, perfectly stress free. Secondly the same group will be submitted to some recognized stress factors, such as time limit, noise, etc. We then shall analyse the data obtained and hopefully, validate the assumptions of our work.

5. Conclusions

Throughout this paper, we have introduced the importance of E-learning platforms for organizations, to cope with present society challenges. The optimization of resources leads towards the massive use of E-learning platforms with all the widely known problems that come with it. Students' success rises as a critical issue nowadays. Stress was identified as one of the major factors that can contribute to students' failure. Starting with some previous work regarding an affective module to incorporate in Moodle, a Dynamic Stress Recognition system was proposed, to detect and predict students' levels of stress. The work here proposed uses all around available technology to act as sensors, that is, stress detection is made via non-intrusive ways. Keyboard, mouse, touch screen and accelerometer are used to extract students' data about their interactions with the platform. Massive amounts of data are obtained this way, and we aim to estimate an optimal level of stress for a given student, detecting and predicting variations and acting accordingly. A prototype is being developed, to be tested in secondary students. Research made in other fields, regarding stress detection suggests that our work is heading the correct way. After this work has been validated, we expect to develop a module to be incorporated in Moodle.

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