Use of a Low Cost Neurosignals Capture System to Show the Importance of Developing Didactic Activities Within a Class to Increase the Level of Student Engagement. (Case Study)

CÉSAR PEÑA[1], SURGEI CAICEDO[2], LUZ MORENO[3], MARISOL MAESTRE[4], ALDO PARDO[1]
[1]Mechanical, Mechatronics and Industrial Engineering Department
[2]Special Education and Pedagogy Department
[3]Administration Department
[4]Economics Department
University of Pamplona
Km. 1 way to Bucaramanga, Pamplona, Norte de Santander
COLOMBIA
cesarapc@unipamplona.edu.co, subocavi@unipamplona.edu.co, luz.moreno@unipamplona.edu.co, marisol.maestre@unipamplona.edu.co, apardo13@unipamplona.edu.co
http://www.unipamplona.edu.co

Abstract: - This paper presents a case study which applies a brain-computer interface at low cost for measuring the student level of engagement. These measures are taken during the experiences of a student in a class that involves doing specific didactic activities. This research pretends to promote the use of new technology to measure the impact of didactic strategies in particular cases in a fast way. It could be evidenced that the didactic activity that was selected, caught the student's attention, increasing the level of engagement during its execution.

Key-Words: - Engagement, education, neurosignals, didactics, student, low cost, brain, emotive.

1 Introduction

With the aim of improving people's lives in society, accurate and efficient changes are required, not only in the physical part of the person but also in the ways of learning, that is what really worth, an emotional learning endures lifetime [1], for this reason, a great number of technological developments have been proposed which allow studying the different people's behaviour. Technology has been and will continue being an essential component when supporting the different areas of expertise, providing an improvement in each one of them.

Nowadays, the teacher perceives the necessity of changing his attitudes and abilities to obtain the best of students, in such a way, he aims at studying the different groups of learners from the instruments with the most honest results, given that the questions and assessments that are implemented might be manipulated several times for fear.

For these reasons, there are some methods, that grouping them, can provide great results such as electro-oculography, which is the technique that can perceive the eyes movements, it means, it allows the capture of their directional movements, as well as their blinks [2], this has been implemented in too many activities, a specific example is its use to determine the eyes movements in the activities that are done on the computers during any subject related to chemistry [3]; that is how, this tool could be useful to visualize the eyes movements when students follow with their eyes the explanation in the board and even if they are aware, or otherwise, to know the different position of the place where the approach should actually exist. A second technique is a reading body that can be done through the detection of movements across Kinect, providing great results in recognition body to assess ergonomic positions [4], by the same token, it shows that the body positions can express several emotions such as attention and boredom [5], in the same way, it would be useful to assess the different body movements that teachers make while teaching a lesson. Another technique that allows detecting ergonomic positions is the EMG (Electromyography) [6]. It exists others techniques for obtaining information in order to monitoring some affective state of users. Some useful techniques are: GSR (Galvanic Skin Resistance), BVP (Blood Volume Pulse) and Pupil Diameter (PD) [7].

There are more advanced devices such as electroencephalography and Functional Magnetic Resonance Imaging that are implemented to measure brain activity.

The FMRI is the one that shows through images the areas of greatest consumptions in the brain during an activity or a thought and it is considered appropriate to identify the cognitive processes [8]. Likewise, electroencephalography shows the brain activity by checking the electrical signal emitted by neurons, this technique has been highly useful in medicine, however, there are applications in different areas, one of them neuro-education and marketing [9]. Nowadays, measuring instruments can be purchased at low cost and practical such as the Emotiv Epoc [10] and Insight, NeuroSky, and so on.

2 Problem Formulation

Millennials perceive things differently, they are used to receive too much information and preserve just a little (the one that shocks them). This is due to the fact that they have been in touch with Internet since they were children, which implies almost unlimited access to information. The way in which these new people learn is very different to the way older teachers do. This generation gets bored easily with traditional strategies, which makes necessary to assess which didactic strategies draw still students' attention.

It is highly complicated for an old teacher to notice that some of his activities might be boring for new students, some of them even think that the problem is that new generations do not want to learn, that they are lazy people and among other reasons.

The students in all educational levels show verbal and nonverbal expressions when participating in a class, as well as the expression when watching TV, educational films, working in a computer among other activities [11]. Furthermore, these expressions make that students turn their face when they have to answer a question related to the class, when they are required to go to the board for answering any question or writing on it, the teacher can notice that his students are emotional but they cannot describe these emotions so that the attention in the class can improve, why? Because they do not know how to do it.

Taking these aspects into account, it is created the necessity of implementing any technique that allows knowing what students really do towards a didactic strategy. For a teacher, it would be fairly important to know quantitatively (approximately) if these activities that are done in the class generate any type of interest such as: enthusiasm, interest, engagement, attention in students or on the contrary if they are getting stressed or bored with these activities.

The teaching and learning process, the strategies and the didactic ways of teaching topics in any area of expertise are highly important to draw students' attention, reason why it is necessary to implement creative methodologies which help to increase students' motivation towards the learning process; therefore, they aid to improve the students' academic performance [12].

3 Problem Solution

In order to improve the teachers' perceptions towards the classes they teach, it is proposed the use of techniques based on the capture of neurosignals, in this way, the teacher might try the implementation of a didactic strategy and measure some emotional states of the students.

This process will allow verifying the impact of the didactic strategy from the point of view of the students, considering that this verification is really useful given that the perception of the activities differs from teachers and students.

On the other hand, the emotional analysis to the students provides quantitative measures which allow estimating approximately several states including the level of engagement, attention, stress and focus.

3.1 Neurosignals capture

Neurosignals correspond to the register of brain bioelectrical activity. Neurosignals are extracted by means of electrodes connected directly to the scalp, non-invasively. The idea is to obtain alpha (8-13 Hz), delta (0-4 Hz), beta (14-60 Hz) and theta (4-7 Hz) waves at different points in the brain. Subsequently several signal processing algorithms are performed to obtain specific patterns. In general terms, different types of events can be distinguished: cognitive, expressive and emotive depending on the place of origin of the signals in the brain and the type of generated patterns. In [13] and [14] it is presented the principal concept of this technique.

Engagement is experienced as alertness and the conscious direction of attention towards task-relevant stimuli. It is characterized by increased physiological arousal and beta waves along with attenuated alpha waves. The opposite pole of this detection is referred to as "Boredom" [15].

A means of measuring the students' emotional states can be through a brain-computer interface. As it is known, this is a type of technology which used to be really expensive, however, its great growth in the last years and the collaborative projects that have been carried out globally [16], are factors that have reduced significantly its price.

The EEG is one of the most reliable physiological signals used for detecting the emotional states of human brain [17], Some emotions can be detected with an accuracy of 96% [18]. Nowadays, it can be found in the world trade at low cost which allows its implementation in a large number of apps. Some of the BCI (Brain Computer Interfaces) more known are: Emotiv EPOC [19] Neurosky [20], InteraXon Muse [21], Emotiv Insight and Imec EEG headset [22]. The field of application of these types of devices is very extensive; some apps have been created in Neumarketing [23], human-machine interaction [24], mental workload estimation [25], analysis of multimedia materials [11], control of mobile robots [26], drowsiness detection [27], [28], [29], and so on.

For this project the interface Emotiv Insight (See Fig. 1) was selected, given that it allows capturing the objective emotional state, besides being one of the cheapest BCI, it is easy to obtain. This last characteristic will allow in the future that teachers in under-resourced institutions can imitate this type of experiments.

Fig. 1, Emotiv Insight device

This device has an interface, which allows checking three types of events:

- Capture of facial expressions such as smiles, frown, grit the teeth, and so on.
- Cognitive recognition, which allows estimating when a person is thinking about anything in particular, like pushing an object to a specific way.
- Perception of emotive states as: interest, excitement, focus, engagement, stress and relaxation.

Fig. 2, Interface for capturing the emotive states

For the development of the experiments that have been proposed, it is implemented the interface of checking of emotional states.
In this way, it is pretended to measure the students' states while a teacher is teaching a lesson with his strategies and his didactic methods to teach those topics. In the Fig. 2, it is possible to appreciate an example of the capture of neurosignals for recognizing the students' emotional states.

3.2 Experimental approach

It is highly difficult to know if an activity is appropriate for all the students, actually, the activity can get different results if it is implemented by different teachers, these results depend on a large number of factors such as: age, gender, social level, institution, origin, initial state of mind, the moment in which the experiment is done, and so on. A comprehensive study would involve an extensive work with a vast number of participants leading to several years of work. However, in this research it is pretended to develop very specific cases in which teachers can implement a strategy in a fast way and verify if this one works properly.

The experiment, which is proposed, consists of teaching a class about a specific topic (diversity) and it includes the development of a traditional didactic class; in this case an exercise of a word search arises. The main idea of this experiment is to know if this kind of activity increases or not a student's level of commitment towards a class. This case study relates to a student, who is 21 years old; he is studying business administration in third semester.

The lesson is planned for 40 minutes approximately, however it must be stressed that it is necessary to include an initial discussion which explains to the student the use of the device that captures neurosignals, proper permits are required for this process and where it is calibrated. Besides, it is necessary to distract the student for a moment through a conversation so that he can forget that he is being tested, (Habituation to the device phase) with this process, wrong data caused by student's anxiety is avoided.

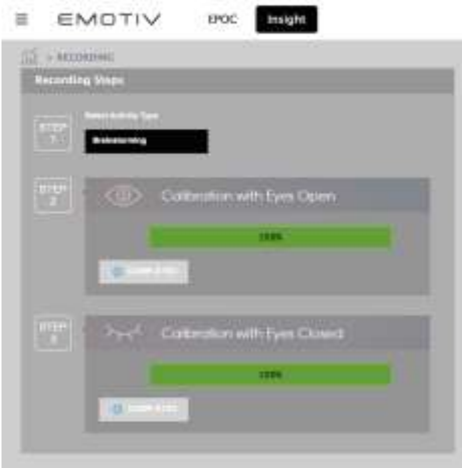

Fig. 3, Calibration of the Emotiv device

In the Fig. 3, it is possible to appreciate the calibration of the system; this process consists of locating properly the sensors on the student's head in order to ensure a good connection. Subsequently, the neurosignals are taken and the student is asked to maintain his eyes open, thirdly, the calibration takes place with eyes closed.

Once the capture of the emotional states begins, these states usually show: high levels of interest, excitement and stress from the student, the reasons of these states are explained by the student's anxiety at being tested, after this, it is necessary to begin a direct conversation with the student in order to distract him until he shows similar signals as it is shown in the Fig. 4. Another strategy which reduces students' anxiety is to tell them that results will help to assess teachers and also it will include the implementation of more neurosignals devices with their classmates.

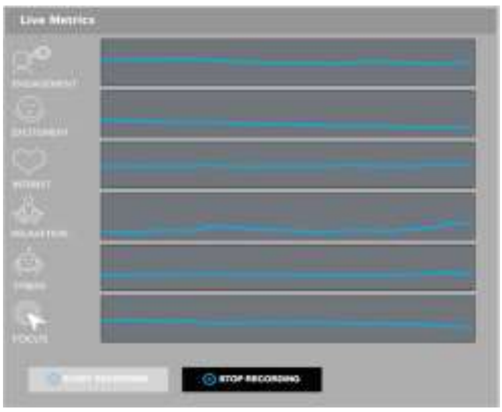

Fig. 4, Emotive states of the student after becoming familiar with the device.

In the Fig. 5, the timeline presents the planning of the lessons and schedules for the events related to the capture of neurosignals. It is possible to appreciate that once the process of habituation to the device ends the beginning of the class takes place. In the first place, the teacher gives the didactic activity to the student so that he can do it, however, as the student does not have prior knowledge that is required for the activity, he will not probably do it. In the second part of the class, the teacher explains extensively the topic. Subsequently, in the third part of the lesson; the teacher gives time to student so that he can complete the didactic activity. As last step, the feedback process is carried out.

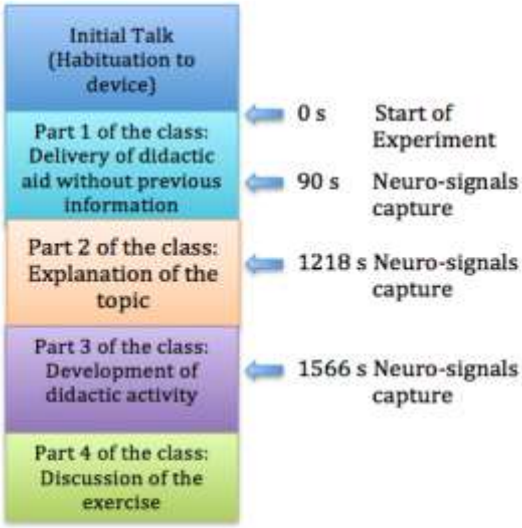

Fig. 5, Event scheduling of the experiment

During the first three parts of the class, some captures of neurosignals are checked in order to differentiate the student's level of engagement in each phase. On the right side of the Fig. 5 it is possible to see the time provided for the captures. These captures were carried out in the middle of each activity in order to avoid residual states from the prior activities.

3.3 Discussion

This section presents the findings related to the captures of neurosignals for each one of the phases previously described. In the Fig. 6, it is possible to appreciate the student's level of engagement when doing the activity without prior information. It is possible to see clearly how the student obtained a high level of engagement despite he did not have too much prior knowledge. In the Fig 7, it is evidenced the learner's level of engagement in the middle of the explanation, level that actually descended in regard to the first part of the class.

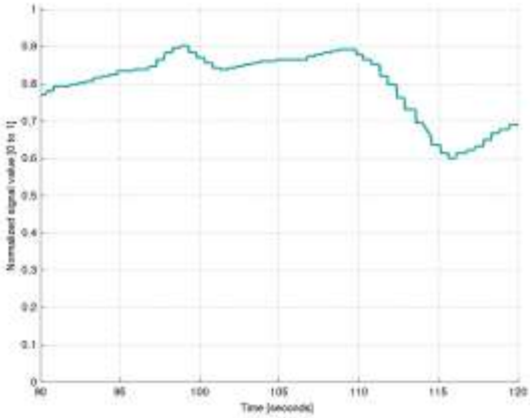

Fig. 6, Level of Student Engagement when he is doing the didactic activity without previous information (Time: 90 seconds).

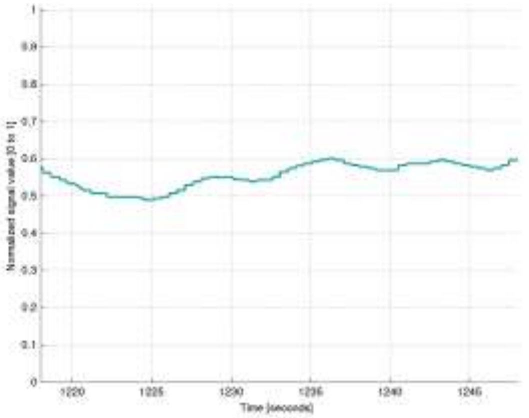

Fig. 7, Level of student engagement during a normal class segment (Time: 1218 seconds).

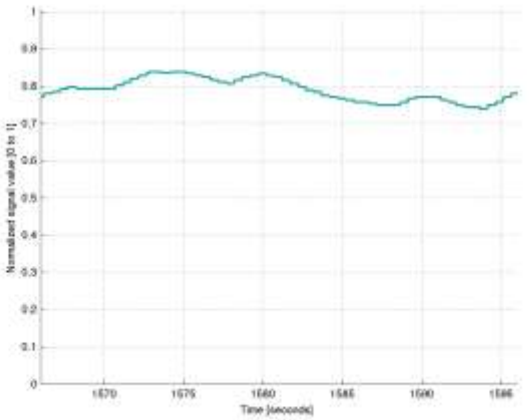

Fig. 8, Level of student engagement while he is developing the didactic activity with previous information (Time: 1566 seconds).

In the Fig 8, the level of engagement is presented when the teacher gives time to do the didactic activity once again. It is possible to see how the level rises once more to similar values to those of the first part of the class.

When analyzing quantitatively the data, it was possible to appreciate that the student definitely obtained high and similar values while doing a didactic activity. In the Fig. 9, the average levels of the students during the first three parts of the class are shown. The average level for the first and third part, which corresponds to the development of the didactic activity, got average levels of 0.8011 and 0.7908 respectively, whereas the average levels related to the explanation of the topic was 0.5545.

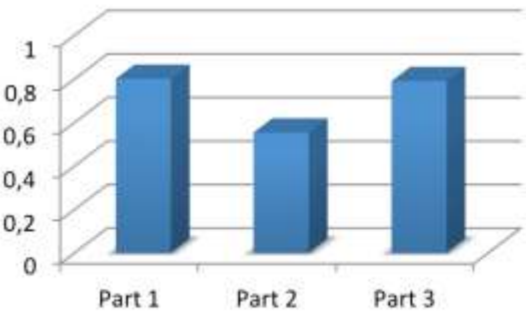

Fig. 9, Engagement mean level of the student during the class

It must be stressed that the student showed interest on doing the didactic activity, actually, before the teacher completed the explanation, the student tried to solve the exercise several times. This case study demonstrates that the selected didactic activity (Word search) can draw student's attention and rise his level of engagement during a class. It is relevant to know this result, taking into account that this didactic activity is very traditional. This one is especially implemented in low school levels, reason why it is interesting to know how it still affects university students.

4 Conclusion

According to the findings in this case study, it is possible to conclude than a brain-computer interface allows capturing quickly emotional states in students in order to assess quantitatively the estimated impact of a didactic strategy or activity in a particular case.
Despite older teacher differ in terms of likes and teaching-learning process with regards to their students; they can do activities, which draw learners' attention.

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