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EEG lecture on recommended activities for the induction of attention and concentration mental states on e-learning students

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Abstract. The Computer Science department at Tecnológico Nacional de México-CENIDET, Mexico, with the collaboration of the Psychological department of the University of Castilla-La Mancha (UCLM), Spain, is on a developing process for the creation of an immersive virtual environment through virtual reality (VR) for the e-learning educational area. Such environment, works through electroencephalographic lectures (EEG) from the students, acquired by a Brain-Computer Interface (BCI), to adapt the virtual content to the profile and needs of the student on real-time basis. This system can detect the accuracy of attention and concentration levels on mental states, for the optimum development of the activities requested on an e-learning platform; if the student is not on a suitable concentration level, the system is able to induce the student to the requested mental state.

The present document shows the proposal of different recommended activities that induce the mentioned mental states and the EEG response of each one. As well, the definition of the ideal learning emotional state that will be included as a part of the future works. It is important to mention that such activities are based on psychological researches that are dedicated to measure the levels of attention, concentration and other executive functions.

Keywords: EEG, attention, concentration, E-learning, human computer interaction (HCI), brain-computer interface (BCI), augmented cognition (AugCog)

1. Introduction

At the present, there have been changes in education, including a revolution in the methodology and the used resources [1]. This includes a new type of virtual educational curses also known as e-learning education. These type of curses are based on the presentation of specific information for the effective training, in which it is not necessary to be physically present inside of a classroom, this making possible to have access to this curses literally anywhere just through an internet connection.

Nowadays, the e-learning method is having a constant expansion process that seems to continue in the upcoming years. Despite of the boom in this type of

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training, [1] mentions that we should not fall into the incorrect idea that this type of education is the unique and best solution, since it does not guarantee a better quality or faster- efficient leaning by itself; because it will depend in the cognitive state of the students plus the quality perception inside of the platform [2].

That is why knowing the use of the Communication-Information Technologies is present on the daily activities, diverse possibilities of HCI technologies and researches can help the actual education system, including the e-learning.

To reduce the lack of attention or concentration during the e-learning process, we propose the use of BCI gadgets and the constant EEG lecture, in order to obtain real-time physiological information from student´s mental state during the interaction with the activities proposed by the e-learning platform.

The information generated is taken into account looking for a positive improvement in the levels of attention and a reduction of distractions during the learning process. The above as a result of the knowledge of the non-adequate mental states for the learning process (No attention/No concentration) and the VR system that will realize an activity-change proposal based on the specific learning style that will be previously identified, restoring the attention and interest on the e-learning platform.

This work presents an information analysis linked to the Research Project "Cognitive states exploitation on E-learning environments from Non-invasive BCI".

2. Adequate mental state for learning

2.1. Definition of attention

It has been detected that attention (voluntary or involuntary) consist on a selective process of the necessary information, the consolidation of the eligible action programs and the permanent maintenance control over the course [3], as well as the functions that it has over the human performance.

It is said that [4] the attention process happens when the receptor starts to actively capture what it is looking and listening at, and for instance it starts concentrating partially or totally on it. It usually happens because the individual can divide its attention, reaching the point of doing more than one activity at the same time.

To achieve the mentioned point, the human is capable to acquire and develop, during the course of life, diverse skills and abilities to realize activities in an automatic way, without giving a total attention.

This is call Capacity theory [5] and is referred to the amount of attention given to a specific moment and to the change of the same, depending on the motivation or stimulation that the subject has on a specific moment.

2.2. Attention networks

Attention networks have been defined based on the brain structure. Nowadays, it is known that the attention process at a cerebral level is not unique, but there are different attention networks where there is an intervention of different neuronal circuits and specific brain regions. As per the Posner model, there are three neuronal networks or brain region systems that are interconnected (see Fig. 1) [6].

The function of the attention networks can be summarized as [7]:

1) Alert: a network that allows reaching and keeping an alert state level. For example, when a student gets surprised about the results obtained during an experiment.
2) Orientation: this network allows orientate the attention and selecting the origin of the sensorial stimulus. For example, when the student is searching for something specific during a class, it can be information related to the homework to do an activity.
3) Executive attention: the executive link is directly related with all the control process inside of the voluntary behavior, also allows the regulation of thoughts, emotions or actions. For example, when the student is trying to solve the assigned activities as a part of the laboratory class.
4) In the other hand, it is well known that there is other unconsents mechanisms to keep attention and also it is believed that there are important for the creative resolution of problems.
5) In learning terms it is said that humans are capable to remember easily what happens at the beginning of a class [7], it means, the first minutes has to be used to propose new topics of knowledge instead of do overviews of previous topics.

In [8] there are mentioned different studies that demonstrated that the student capacity to stay focused has an average duration of 10 to 20 minutes. For that reason [7] recommends a split of the class time

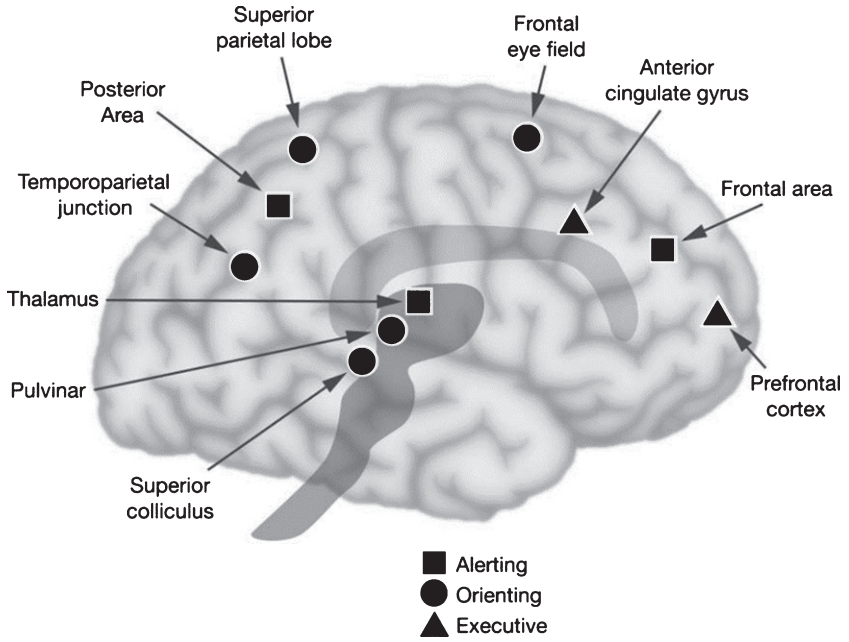


Fig. 1. The anatomy of 3 attentions network; Alert, orientation and execution [6].

into 15 minute blocks, facilitating the process and information consolidation through the continuous practice, then facilitate time for analysis through teamwork, and finally, use the end to make an overview of the primordial topics.

2.3. Types of attention

The attention process is not a unique mental process. There are 3 different types of attention that helps the human to focus on their activities and actions to achieve a determined goal. These 3 types of attention are: Selective, Divided and Sustained.

2.3.1. Selective attention

This type of attention consists on centralize one aspect of the environment of one determined stimuli. When this action occurs, usually other aspects of the environment are generally neglected. This kind of attention is considered as a synonym of concentration and effort [9].

2.3.2. Divided attention

This type of attention is referred to the amount of stimulus that the human is capable to attend at the same time, or how many tasks can be realized with the same efficacy level as when only one task is done [9].

2.3.3. Sustained attention

Is defined like the amount of time that a person can take to realize one monotony task and the capability to attend one determined stimuli source without losing the quality of the information process [9].

2.4. Definition of concentration

The term concentration can be defined as the capacity to focus on one specific idea, object or activity in a selective way, without the introduction of external elements. In some cases can be defined as an instant and natural mental power, where the individual do not propose to focus but it happens directly [10]. At [11] it is defined like the capacity of focusing in one or two important stimulus, while is deliberately suppressed the conscious of other distractive stimulus.

3. Conditions for the induction of the cognitive states of concentration and attention

From the physiological point of view, inside of the affective mental states identified as the optimum ones for the generation of attention and/or concentration, there has been detected that the happiness + stress emotional state is the most optimum for the

Table 1
Definition of happiness [12]

Happiness	
Characteristics	– Happiness improves the positive reception and interpretation of the diverse environmental stimuli. Is not a fleeting sensation as pleasure, but it pretends an enduring emotional stability (Delgado, 1992).
Instigators	– Achievement, successful attainment of the pretended goals. – Congruence between what we desire and what we have, between expectations and actual conditions in comparison with the others (Michalos, 1986).
Physiologic activity	– Increase of the hypothalamus, septum and tonsil nucleus (Delgado, 1992). – Increased heart rate, although cardiovascular reactivity is lower than in other emotions, such as anger and fear (Cacioppo y Cols., 1993). – Increased respiratory rate (Averill, 1969).
Related cognitive process	– Facilitates the empathy, and will favor the emergence of altruistic behaviors (Isen, Daubman y Norwicki, 1987). – Promotes cognitive performance, problem solving and creativity (Isen y Daubman, 1984), also memory and learning (Nasby y Yando, 1982). – However, this relation is paradoxical, since in very intense states of happiness can slow the execution and even overlook any important element for the resolution of problems and can interfere with the creative thinking (Izard, 1991).
Function	– Increase the capacity to enjoy different aspects of life. – Generates positive attitude towards oneself and the others, improving empathy and altruism (Isen, Daubman y Norwicki, 1987). – Establishes nexus and facilitates the interpersonal relations (Izard, 1991). – Sensations of vigorousness, competence, transcendence and freedom (Meadows, 1975). – Facilitates cognitive and learning process, also curiosity and mental flexibility (Langsdorf, Izard, Rayias y Hembree, 1983).
Subjective experience	– Pleasant state that is desirable, creating a wellness sensation, increasing self-esteem and confidence (Averill y More, 1993).

realization of activities and as a memory learning motivator.

It is also important to mention that such emotional states cannot go to extreme points, it is necessary to keep the levels in a neutral point to not increase the individual arousal (excitation/activation) levels, because it can generate an opposite effect of attention/concentration if not.

Next, a brief definition of happiness and stress emotional states:

3.1. Happiness

Inside of [12] it is shown the description of happiness and how different authors have been defined the characteristics and behavior or such state (See Table 1).

3.2. Stress

At [13] stress is defined as per the analysis and input of Robert Hook on 3 basic concepts: load, stress and tension. In which the load is referred to the external weight forces; stress is the structure used to apply the weight and tension on the deformation of the structure, produced by the conjunction of load and stress. He said that in the past, the stress was seeing as a one-dimensional concept, it means, like a continuous process with an up and down movement, a superficial analogues concept [14].

In the other hand, the physiologist Hens Seyle [15] suggests 2 types of stress: distress (pain, anguish) and eustress. Where distress is destructive, identified by anger and aggression, making it prejudicial for health, and eustress is a cognitive type, characterized for emotions associated to emphatic concern to the others and with positive efforts that can be beneficial to the community, also identified by the health protection of the individual [13].

In [16] we defined three types of psychological stress:

1) Damage/lost: Is related to the prejudice or loss that has already occurred.
2) Threat: Is related to the damage or loss that is about to happen, that is possible or probable in a short-term period.
3) Challenge: Consists in the sensitivity that apart of the difficulties found in the process of reaching the goal can be overcome with enthusiasm, persistency and self-confidence.

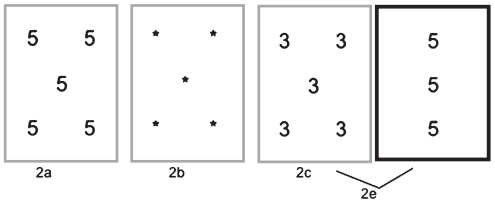


Fig. 2. (a) Lecture Activity FDT [18]. (b) Counting activity FDT [18]. (c) Election activity FDT [18]. (e) Alternation activity FDT [18].

4. Base of activities to generate the concentration and attention mental states

TEA editions, is an entity with purpose of the certification, edition and creation of tests of psychological evaluation exams. Having more than 400 edited psychological tests in their catalogs, among which are some of the most international recognized ones [17].

Some of the certified and commonly used tools for the evaluation of the executive functions, attention and concentration, among others are described below. For the purposes of this research there have been analyzed as proposals for induction of cognitive states for attention and concentration. It is important to mention that for the experiments application there were some adaptations on the techniques used.

4.1. Five digit test

This is a multilingual test that measures the speed and efficiency of the person evaluated, with the main purpose of exploring brain dysfunction [18].

This test consists of 4 tasks with a different level of cognitive difficulty in which the first part presents a number lecture and asterisks count in order to measure simple and automatic processes through the count and reading. While in the election and alternation part there is the measurement of processes that requires an active mental control.

1) Reading: In this section, boxes are shown (Fig. 2a) and the user is requested to say the number that it is reading.
2) Counting: Inside of this activity the user is requested to mention the number of asterisk that are observed inside of the box (Fig. 2b).
3) Election: For this activity it is necessary to count the numbers placed inside of each box. It is necessary to remind the user to mention the amount of numbers show inside of the box instead of mention the numbers observed (Fig. 2c).

Fig. 3. The anatomy of 3 attentions network; Alert, orientation and execution [6].

4) Alternation: This activity is the most complex one, because it requests full attention from the users in order to follow the instructions and react to the stimuli as expected. In this section is requested to count the amount of numbers as it has been done before, and when a box with a heavy line is detected it is necessary to say the number presented inside of that box (Fig. 2e).

4.2. D2 test

The D2 is a type of test that pretends to know the concentration capacity used for a specific activity, and the level of selective attention. It measures the processing speed, instruction tracking and follow up, and the performance in tasks of discrimination of similar visual stimuli [19].

D2 has resulted especially useful for basic research, also in clinical, neuropsychological, educational, human resources and sport psychology fields, making it one of the most important and relevant tests for attention in Europe [17].

In order to realize this task, is it necessary an attentive inspection from the users side, from left to right the content included on each line, and then mark any "D" that appears with 2 small lines (two on the bottom, two under or one on each side) with a limit time of 20 seconds per line.

It is important to mention that the previous (the correct stimulus) are known as *relevant elements*. The other combinations (the "P" with or without lines, and the "D" without any line) are considered as *irrelevant,* because there is no need to be marked [19]. Example showed on Fig. 3.

4.3. Faces, difference perception test

This test has been created to score perception aptitude related to differences and similarities of stimulating patterns that are partially organized [20]. See example on Fig. 4.

4.4. Visual Patterns Test, a test of short term visual memory

VPT is a test utilized to measure the visual memory capability [21, 22]. Describes the short-term visual

Fig. 4. FACES example [20].

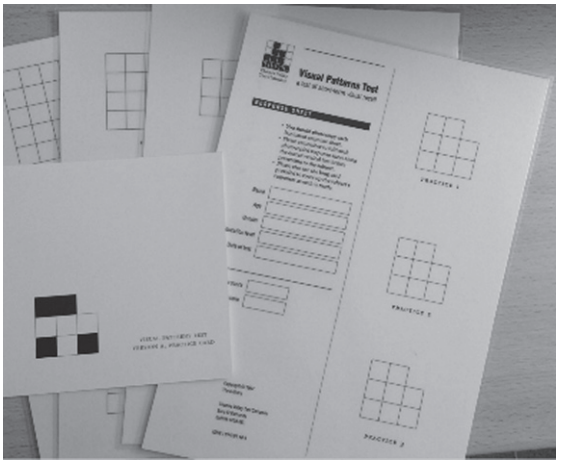


Fig. 5. Visual Patterns Test [21].

memory (STVM) as the capacity to retain visual information (letters, figures, colors, etc.) during a short period of time.

This test does not have a specific time for application; the only instruction is to show to the subject the pattern cards only for 3 seconds, and then, the subject need to reproduce the picture on the application sheets. An example is showed on Figs. 5 and 6.

4.5. STROOP, Color and Word test

This is a test generated by [23] that is based in the STROOP effect discovered by John R. STROOP that refers to the interference that is produced to the subject when it is required to indicate the ink color that one specific word has been typed that is not similar to the word itself [24], this test allows to measure the execution of a controlled process of a new task, while there is an impediment of intrusion of an automatic task. It means, prevent the semantic interference produced as a consequence of the human automation for Reading activities, that happens when the meaning of the word interferes with the task of mention, for example, the ink color used to write the word [25]. See an example on Fig. 7.

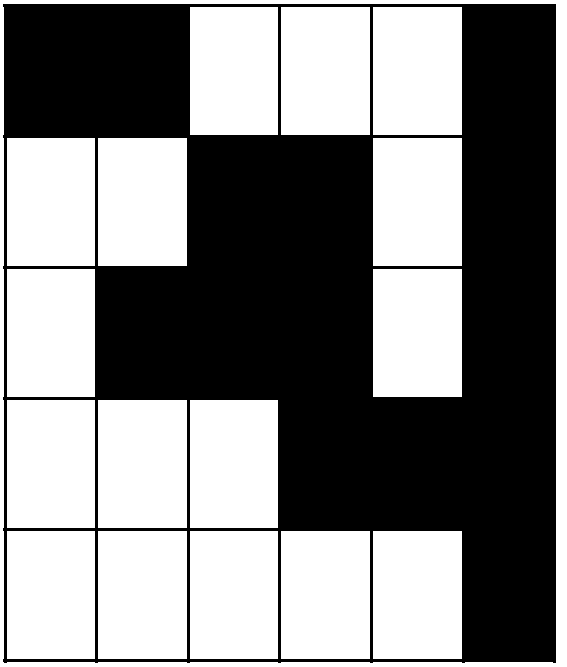


Fig. 6. Patterns showed to the subject [21].

RED	BLUE	GREEN	RED	BLUE
XXX	XXX	XXX	XXX	XXX
RED	BLUE	GREEN	RED	BLUE

Fig. 7. Example of the different sections of the STROOP test [23].

4.6. TRAILS

This test has a duration between 8–10 minutes, and it is conformed by 4 exercises that allows to evaluate the components included in the executive functions like the capacity to plan, work memory, mental flexibility, alternation, sustained memory, perspective memory, perception process speed and the fluency of the motor reaction [26].

1) Trail 1: The subject needs to join the circles in an ascendant way, with numbers from 1 to 25.
2) Trail 2: The subject needs to join the circles in a descendent way; the numbers are from 25 to 1.
3) Trail 3: The subject evaluated needs to join the circles with numbers in an ascendant way, but now also needs to alternate the colors blue-yellow-blue-yellow... the numbers are from 1 to 20.

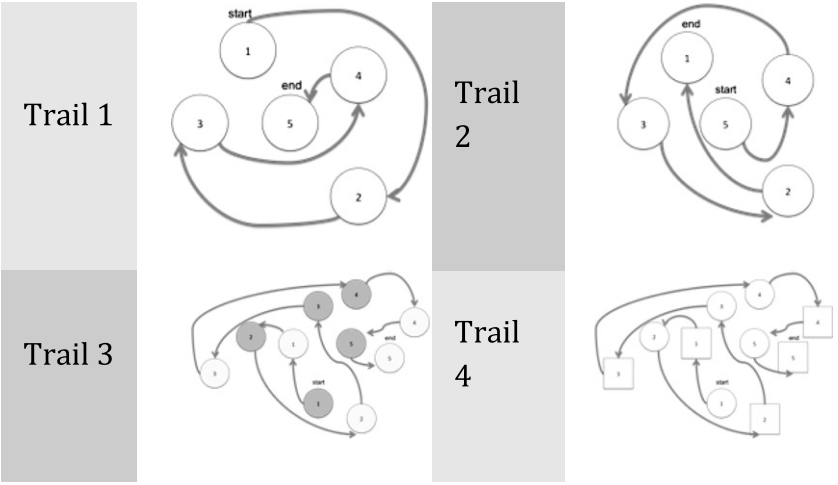


Fig. 8. Trails examples [26].

Table 2
PANAS results

Item	M	SD	Asymmetry	Kurtosis
Motivated	3.7	1.059	0.042	–1.238
Annoyed	1.7	1.252	1.555	0.788
Excited	3.1	1.101	0.388	–1.236
Bad attitude	1.1	0.316	3.162	10.000
Firm	3.8	1.033	–0.272	–0.896
Guilty	1.8	1.135	1.048	–0.394
Fearful	2.5	1.354	0.839	–0.468
Aggressive	1.8	1.317	1.913	3.607
Enthusiastic	3.6	1.265	–0.692	0.588
Proud	3.3	1.767	–0.417	–1.706
Irritable	1.1	0.316	3.162	10.000
Alert	3.6	1.075	–0.322	–0.882
Ashamed	1.2	0.422	1.779	1.406
Inspired	3.4	1.430	–0.889	–0.160
Nervous	2.7	1.567	0.403	–1.285
Decided	3.5	1.179	0.255	–1.440
Be aware	3.8	1.033	–0.272	–0.896
Restless	2.7	1.337	0.334	–0.852
Active	3.7	1.059	–0.659	–0.406
Insecure	2	1.247	1.718	3.418

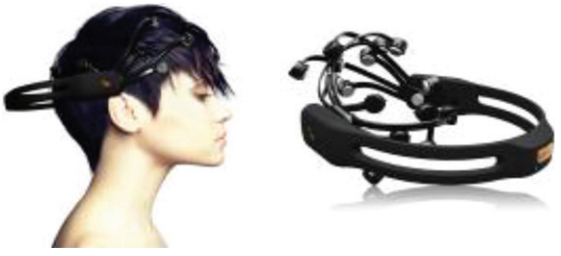


Fig. 9. EMOTIV EPOC Device.

4) Trail 4: The subject has to join the numbers in a descendant way (1 to 20), alternating the figures circle-square-circle-square. . .

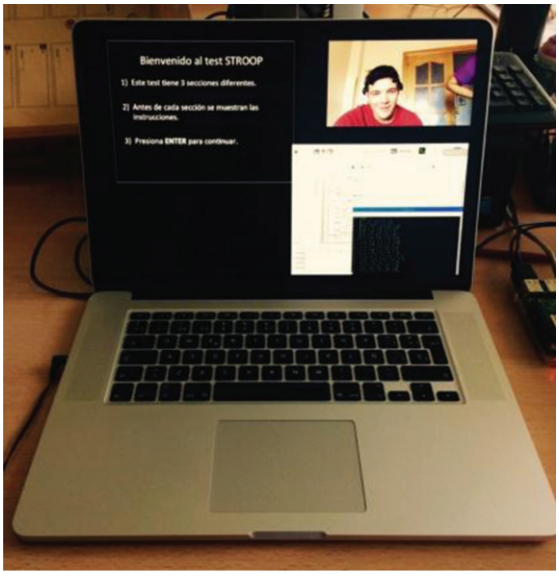


Fig. 10. Video Recording.

Table 3
Total instances

Activity	Total instances
Faces	3708
STROOP	2598
5D	3357
D2	2443
Trails	7278
VPT	3747

There is an example of each one of the paths in Fig. 8.

Table 4
Faces data result

Activity	Total Instances	Training 80% Instances	Percentage of attention/ concentration Training	Validation 20% Instances	Total percentage of attention/ concentration detected on validation
Faces	3708	2966	99% 2931 Instances	742	99.7% 740 Instances

Table 5
STROOP data result

Activity	Total Instances	Training 80% Instances	Percentage of attention/ concentration Training	Validation 20% Instances	Total percentage of attention/ concentration detected on validation
STROOP	2598	2078	83% 1729 Instances	520	88% 458 Instances

Table 6
Five digit data result

Activity	Total Instances	Training 80% Instances	Percentage of attention/ concentration Training	Validation 20% Instances	Total percentage of attention/ concentration detected on validation
5D	3297	2637	93% 2455 Instances	660	85% 562 Instances

Table 7
D2 data result

Activity	Total Instances	Training 80% Instances	Percentage of attention/ concentration Training	Validation 20% Instances	Total percentage of attention/ concentration detected on validation
D2	2443	1954	93% 1816 Instances	489	94% 460 Instances

Table 8
Trails data result

Activity	Total Instances	Training 80% Instances	Percentage of attention/ concentration Training	Validation 20% Instances	Total percentage of attention/ concentration detected on validation
Trails	7278	5774	99.9% 5750 Instances	1504	99.9% 1497 Instances

5. Experiment method

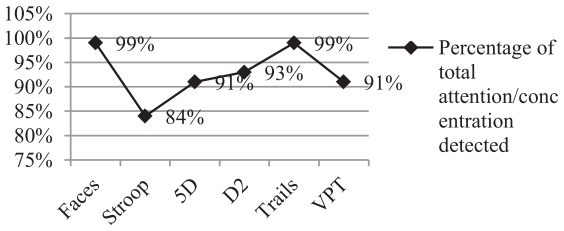
The experimentation time took place with a population between 20 and 35 years old, with a 15.38% of females and 84.61% of males. The participants were 15.38% of Romanians citizen and 84.61% of Mexican citizen.

Table 9
Visual pattern test data result

Activity	Total Instances	Training 80% Instances	Percentage of attention/ concentration Training	Validation 20% Instances	Total percentage of attention/ concentration detected on validation
VPT	3747	2997	91% 2729 Instances	750	96% 717 Instances

Table 10
Response for attention/concentration induction

Activity	Total Instances	Instances of attention/ concentration	Total percentage of attention/ concentration detected
Faces	3708	3582	99%
STROOP	2598	2187	84%
5D	3297	3017	91%
D2	2443	2276	93%
Trails	7278	7247	99%
VPT	3747	3446	91%



Graph 1. Percentege of total attention/concentration detected.

5.1. Affective state

To start with the experimentation process, the PANAS test was applied with the main purpose of knowing the positive affect level, that is the one that represents the pleasant emotionality part, distinguished by the motivation, energy, desire, feelings of dominance, success; but at the same time the level of negative affection, that represents the unpleasant

Table 11
Total data result

Activity	Total Instances	Training 80% Instances	Percentage of attention/ concentration Training	Validation 20% Instances	Total percentage of attention/ concentration detected on validation
All	21845	17180	99.2% 17048 Instances	4665	99.6% 4649 Instances

Table 12
Validation of visual patterns test

Activity	Training 84% Instances	Percentage of attention/ concentration Training	Validation 16% Instances VPT	Total percentage of attention/ concentration detected on validation
Faces STROOP 5D D2 Trails	19325	99% 19177 Instances	3747	96% 3592 Instances of VPT

Table 13
Validation of trails test

Activity	Training 68% Instances	Percentage of attention/ concentration Training	Validation 32% Instances Trails	Total percentage of attention/ concentration detected on validation
Faces STROOP 5D D2 VPT	15792	98% 15549 Instances	7278	99.58% 7248 Instances of Trails

Table 14
Validation of D2 test

Activity	Training 89% Instances	Percentage of attention/ concentration Training	Validation 11% Instances D2	Total percentage of attention/ concentration detected on validation
Faces STROOP 5D VPT Trails	20627	99% 20461 Instances	2443	99.79% 2438 Instances of D2

Table 15
Validation of 5D test

Activity	Training 86% Instances	Percentage of attention/ concentration Training	Validation 14% Instances 5D	Total percentage of attention/ concentration detected on validation
Faces STROOP VPT Trails D2	19774	99% 19527 Instances	3296	99% 3276 Instances of 5D

Table 16
Validation of STROOP test

Activity	Training 89% Instances	Percentage of attention/ concentration Training	Validation 11% Instances STROOP	Total percentage of attention/ concentration detected on validation
Faces VPT Trails D2 5D	20472	99% 20232 Instances	2598	99% 2575 Instances of STROOP

and discomfort dimension, represented by feelings like lack of interest, boredom, sorrow, guilty, anguish, shame, and envy [27].

The PANAS test consists of 20 words describing different emotions (Motivated, Annoyed, Excited, Aggressive, among others) and where the evaluated should indicate, using a Likert scale of five positions (1 “Little or nothing” to 5 “extremely”), how it feels about of the emotions mentioned.

Applying the Cronbach’s alpha (1), the degree of reliability for positive affect questions was determined as (PA) $\alpha = 1.06$ considered excellent and for

Table 17
Validation of faces test

Activity	Training 84% Instances	Percentage of attention/ concentration Training	Validation 16% Instances Faces	Total percentage of attention/ concentration detected on validation
VPT				
Trails		99%		99.6%
D2	19362		3708	
5D		19203 Instances		3695 Instances of Faces
STROOP				

negative affection (NA) $\alpha = 0.79$ as acceptable. The obtained following results, were based on the analysis performed in [28], see Table 2.

$$\alpha = \frac{K}{K-1}\left[1 - \frac{\sum s_i^2}{s_t^2}\right] \tag{1}$$

5.2. Emotiv epoc BCI device

To obtain the EEG lectures, it was necessary to place the Emotiv device to the participants. Then, its brain activity was acquired through the 14 electrodes placed on the Emotiv Epoc device [29]. The Emotiv SDK was used to filter and interpret the obtained lectures (Fig. 9).

5.3. Video recording

In the other hand, the BCI lectures, the solving activity and the face of the participant were video recording for later analysis (Fig. 10).

6. Obtained attention/concentration results

The EEG lecture obtained during the experiment, corresponds to 23,071 seconds divided between each of the 6 proposed activities where (see Table 3):

Through the analysis of each of the repository data generated by participant solving each activity, in contrast to what was recorded at the videos and the solution of the activities, it was possible to detect the existence of a pattern of EGG behavior in almost all taken lectures. To do this analysis, only the Beta and Alpha waves were taken, because they are related to the state of attention/concentration and problem solving.

In order to determine the threshold of the EEG data related to the searched cognitive state, it was used the WEKA software with the unsupervised classification and clustering algorithm of K-means, which was configured to use the of Euclidean distances (2) to generate 4 clusters certain from the centroids and the closer neighbors. The analysis was divided into 3 experiments.

$$d_{ij} = \sqrt{\sum_{p=i}^{k} \left(x_{ip} - x_{jp}\right)^2} \tag{2}$$

6.1. Experiment 1 training and validation EEG data per activity

The first experiment consisted of taking the EEG data repository generated by all the participants divided into each activity, with this it was possible to create random training sets of 80/20 where the training was performed with 80% of the total data and validated with the remaining 20% (see Tables 4–9). With this we were able to determine which activity is the one that most generated the cognitive state sought.

According to the study, the activities with the best response for attention/concentration induction were Trails and Faces (Table 10).

It can be observed that STROOP activity has the lowest positive induction response in attention/concentration, but with an acceptable level in the generation of this cognitive state (See Graph 1).

6.2. Experiment 2 training and validation of total data

For the second experiment a new generation of clusters and validation was realized, but this time the using of the total of the data obtained in the application of all the tests was required.

To do this it was necessary to create a new set of random training of 80/20, where the training was realized with the 80% of the total data and validated with the remaining 20% (see Table 11). With this we were able to know the threshold and behavior of

information with the use of all instances, regardless of the type of activity applied.

6.3. Experiment 3 training and validation of all repositories data less one

For the third experiment a new generation of clusters and validation was realized but this time using the total of the repositories data obtained by activity less one, that is, the repository of training data was generated with the total EEG data obtained from 5 of the 6 tests and was validated with the data generated by the test subtracted (see Tables 12–17).

7. Conclusions

The data that have been generated with the experiments performed, have been used to identify the EEG behavior lectures by attention/concentration stimuli.

The K-means classification and clustering technique has given good results in the intention to identify the threshold that must be taken into account for the later classification of EEG lectures in real time.

The activities selected for each of the tests have shown a higher degree of induction of the apt cognitive state for learning, attention/concentration, and through them it has been possible to identify this cognitive state, despite the ethnological differences presented by the subjects, although some do not dominate the Spanish language and be from different nationalities to the Mexican one, we have been able to detect that the EEG behavior is very similar in all the cases.

It has also been possible to detect that another emotional state that occurs in some people is anxiety, which can interfere in the same way with the mode that the activities are executed. As mentioned in this document, the fit emotional state is happiness + stress, but in neutral limits and anxiety on the other hand, falls into a state of high degree of stress or excitement. That is the reason why a series of new experiments has been started, in which the objective is to detect if the student is in an emotional state of anxiety, to apply a series of new activities (mindfulness), in order to obtain a neutral and apt state to continue with the activities.

On the other hand, it was possible to observe through the videos and the oral expressions of the participants, that the applied activities generated a sensation of challenge to the individuals, for these reason, another experimentation to be applied is the use of the gammification during the application of activities, to identify how efficient is the use of this technique by attempting to generate cognitive attention/concentration status.

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