Improving Open Distance Learning Efficiency by Non-Invasive Brain Computer Interface

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Abstract

One of the biggest problems of ODL teaching/learning is that lecturers cannot get the feedback from students in time and modify the teaching materials and styles according to the interaction of students. The burgeoning Brain Computer Interface (BCI) created the possibility of assessing the activities of working memory which is closely related to the knowledge accepting (learning, understanding) efficiency. This research aims to build a real-time teaching and learning efficiency assessing system based on the technique of electroencephalograph (EEG, a kind of non-invasive BCI). The activities of working memory is detected by the system when students learning, based on which both sides of lecturers and students, can modify teaching/learning materials and styles. So a relative higher efficiency of knowledge delivery will be created.

Keywords: Open Distance Learning (ODL), Working Memory (WM), Brain Computer Interface (BCI), electroencephalograph (EEG), Study efficiency

1. Introduction

ODL mode usually has a large number of enrolments because of the facility for working students, such as (380,000) ODL students from nations all over the world are studying in University of South Africa (UNISA), the oldest ODL university started from 1873. The differences of education level, education system and knowledge structure among nations lead to students differing in the aspects of knowledge

basic, learning capability, and preferred teaching/learning style. This is one of the biggest challenges for an international ODL institute such as UNISA.

The second challenge is that it is more difficult to build effective interaction between lecturers and students in ODL teaching/learning activities. Most methods used in ODL teaching/learning, such as e-mail, online materials and discussion forums (like myUnisa), DVD, satellite broadcast, and printed materials are half-duplex communication, i.e. up and down communicating channels (teaching/learning processes) are not available at the same time.

The third challenge is that ODL education heavily depends on student's individual study motivation, self-study activities and abilities. Every individual has his/her own signature of thinking, therefore, own preferable way for learning and understanding. This is not the end, studying is a complex process closely related to the personality, emotional factors, environment etc. Therefore, the learning efficiency is affected by these factors as well.

However, ODL puts more emphasis on integration than individuation, such as all students get the same knowledge media (printed, visual, or auditory materials) without considering their individual thinking preferences. Therefore, only average study efficiency can be expected. Based on the fact that EEG techniques are able to detect the activities of the brain especially the working memory, this research aims to develop a learning efficiency detection system to assess the individual thinking preferences. Both lecturers and students are able to be aware the teaching and learning status. Experiments of students' exposures to different study materials, personal situations, and environments can be implemented to identify the individual preferable way to think.

2. Non-invasive BCI technology – EEG

EEG is a method that is used to detect brain activity by "reading" brain signal activity on the outer surface of the brain. Figure 1 illustrates this method where the individual is connected to a recorder wearing an electrode cap that is used to read several frequencies at the same time. Figure 2 [BCI2000 User Tutorial] illustrates how the electrodes will be connected to a student's scalp.
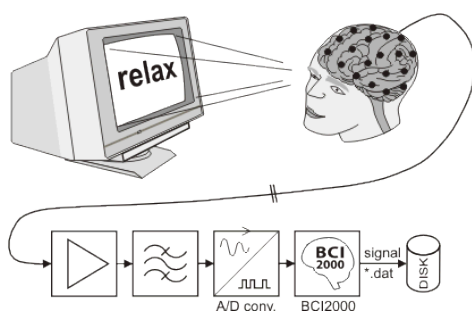

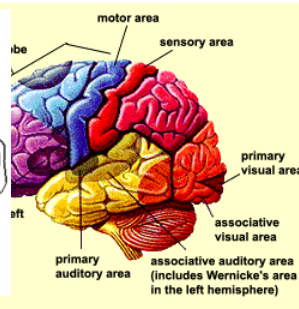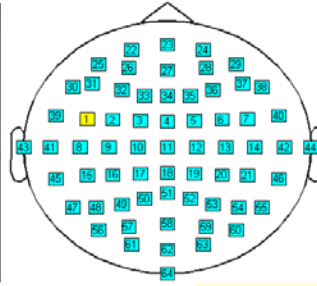Figure 1, the process of EEG based BCI. [BCI2000 User Tutorial]

Figure 2, EEG cap and Electrodes   Figure 3, the brain functional areas

3.   Working memory and EEG

The human brain is made up of various parts, and the part mainly responsible for working memory, reside in the frontal lobe. [zarjam, epps, chen] Figure 3 illustrates the frontal lobe area. It was found that when tasks were performed relating to working memory retrieval and decision making that theta waves showed an increase in activity.

Another observation made by [zarjam, epps, and chen] "*It reveals that as the task difficulty increases, the AMIN of the EEG signal tends to increase, and therefore each load level is clearly distinguishable from other levels.*"

4. Study efficiency and working memory

Working memory is a set of processing resources of limited capacity which are involved in information maintenance and processing (Imbo and Vandierendonck, 2007), which is the information remembrance and manipulation ability.
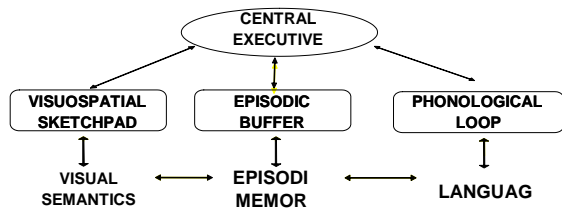

Figure 4: The model of working memory (Baddeley, 2000)

The model for working memory consists of various interlinked resources as illustrated by Baddeley (2000) in Figure 4, with each resource playing specific roles as follows: (i) Central executive (CE): this is responsible for the attentional control of subsystems, manipulation of information, planning, strategy selection, and inhibition of the slave subsystems; (ii) Phonological loop: this constitutes two separated components, which are responsible for storage and rehearsal of verbal information; (iii) Visuospatial sketchpad: this is responsible for separate storage and rehearsal of visual and spatial information; (IV) Episodic buffer: it integrates information from other subsystems and is responsible for episodic long-term memory.

Students with high working memory capacities are likely to handle problem-solving studies efficiently as opposed to those with low working memory.

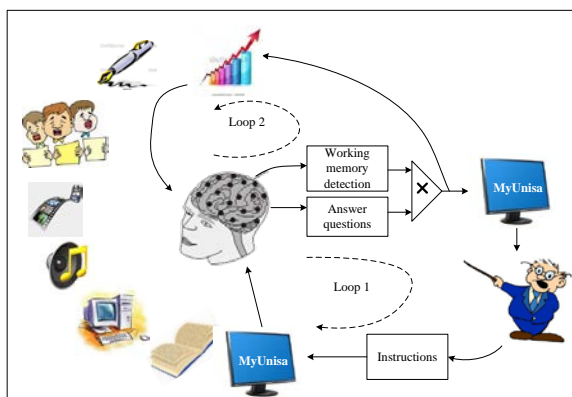## 5. Thoughts for ODL study efficiency assessment via EEG

Figure 5, Study efficiency improving system based on EEG

Figure 5 depicts the study efficiency improving system. It has an experiment based structure. A tester wears the EEG cap which is connected to a computer for brain signal capturing and working memory activity detection. The tester is exposed to series pre-designed experiments, i.e. different materials and study methods. After each experiment, the tester is supposed to answer few questions related to the materials used. The performance of knowledge delivery denoted as P1, i.e. the marks that the tester gets, is categorised into 5 levels (level 1 to level 5). The working memory activities denoted as P2 are assigned to a level between 1 and 5. The result of P1 multiplying P2 is considered as the study efficiency which is sent to the lecturer via the ODL teaching/learning system, such as MyUnisa. So the lecturer provides instructions or modifies study materials to the tester (student) according to the study performance. This is marked as Loop 1 in Figure 6. Another loop (Loop 2) is demonstrated in Figure 6 as well, which feedback the study efficiency directly to the tester, so he/she could aware the most efficient study method.

Materials: Printed visual materials, online visual materials, audio materials and video materials. All these materials must contain the same content. The materials are new for students and partitioned into short segments.

Study methods: Reading in silence; reading aloud; writing; taking notes when reading; listening; listening and writing down; listening and speaking out; watching; watching and speaking; watching and taking notes.

6. Acknowledgement