SUSTAINED ATTENTION ON A PRE-RECORDED LECTURE: AN EEG STUDY

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SUSTAINED ATTENTION ON A PRE-RECORDED LECTURE: AN EEG STUDY

by

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LIST OF SYMBOLS

α-	Alpha
β	Beta
kΩ	Kiloohm

LIST OF ABBREVIATIONS

MIT	Massachusetts Institute of Technology
IFJ	Inferior Frontal Junction
fMRI	Functional Magnetic Resonance
PFC	Prefrontal Cortex
Hz	Hertz
ACh	Acetylcholine
mPFC	Medial Prefrontal Cortex
EEG	Electroencephalography
H_0	Null Hypothesis
H_a	Alternate Hypothesis
VHS	Video House System
MP4	MPEG-4 Part 14 Digital Multimedia container Format
JEPeM	Jawatankuasa Etika Penyelidikan Manusia
PIS	Participant Information Sheet
CF	Consent Form
SSE	Sample Size Estimation
ICA	Independent Component Analysis
ASR	Artifact Subspace Reconstruction
FFT	Fast Fourier Transform
ECG	Electrocardiogram
DCLNN	Deep Learning Convolutional Neural Network
FP1	Prefrontal Left

FP2	Prefrontal Right
F7	Frontal Left
F3	Frontal Left
Fz	Frontal Zero (midsagittal plane)
F4	Frontal Right
F8	Frontal Right
T3	Temporal Left
C3	Central Left
C2	Central Right
C4	Central Right
T4	Temporal Right
A1	Auditory (Ear) Left
T5	Temporal Left
P3	Parietal Left
Pz	Parietal Zero (midsagittal plane)
P4	Parietal Right
T6	Temporal Right
A2	Auditory (Ear) Right
O1	Occipital Left
O2	Occipital Right

LIST OF APPENDICES

KEBERKESANAN KULIAH PRA-RAKAMAN PADA TAHAP TUMPUAN: KAJIAN KE ATAS EEG

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Pengenalan: Kuliah secara pra-rakaman adalah komponen penting dalam persekitaran e-pembelajaran; kuliah pra-rakaman haruslah disampaikan dengan kaedah yang paling berkesan bagi menggalakkan proses pembelajaran. Menyediakan kuliah pra-rakaman di pelbagai saluran media adalah strategi yang baik dalam meningkatkan tahap pembelajaran, kepuasan, penglibatan, dan minat pelajar.

Objektif: Tujuan utama kajian ini adalah untuk menilai kesan presentasi slaid berasaskan teks dikenali sebagai aktiviti 1 dan presentasi slaid berasaskan interaktif sebagai aktiviti 2 terhadap perubahan gelombang otak yang boleh mempengaruhi tahap tumpuan.

Metodologi: 30 sampel data EEG dalam format ASCII diuji bagi memenuhi objektif kajian. Sampel data EEG ialah pada kadar 1000hz sesaat. Dalam fasa pra-pemprosesan data, bagi menghilangkan kesan AC dan frekuensi yang tidak diingini. Kajian menggunakan penapis HFF, LFF dan Notch. Diikuti dengan proses mengeluarkan pelbagai jenis kebisingan lain, sama ada berbentuk ekstrinsik atau artefak, dengan menggunakan DWT dan pekali terperinci (d). DWT menguraikan isyarat gelombang menjadi pekali wavelet dan kemudiannya disusun semula. Ujian t-test digunakan untuk menilai kedua-dua kumpulan samada berbeza secara statistik. T-test digunakan untuk menjelaskan kepentingan setiap pemboleh ubah bebas dalam model kajian.

Hasil kajian: Dalam menentukan min beta maksimum dan membandingkannya antara aktiviti 1 dan aktiviti 2 dapatan kajian menunjukkan hanya nilai P yang kurang daripada 0.05, bermaksud kedua aktiviti 1 dan aktiviti 2 mempunyai kesan pada kuliah pra-rakaman ketika nilai t adalah 5.663 dan 7.850. Dengan itu H_o ditolak oleh ujian t-test, penemuan yang sama diperolehi dalam mengenal pasti frontotemporal yang mempunyai maksimum min beta diantara 2 aktiviti, hasil kajian mendapati bahawa hanya nilai P yang kurang dari 0.05, bermaksud kedua-dua frontotemporal pada aktiviti 1 dan aktiviti 2 juga menunjukkan ianya memberi kesan pada kuliah pra-rakaman apabila nilai t adalah 6.013 dan 6.523, yang membolehkan H_o ditolak oleh ujian t-test.

Kesimpulan: Kedua-dua aktiviti diuji dengan ujian statistik, berdasarkan penemuan, hasil kajian gagal untuk menerima hipotesis null. Terdapat bukti yang menunjukkan adanya perbezaan pada kedua dua kaedah pembelajaran. Secara rumusnya, kaedah pengajaran harus lebih jelas dalam memenuhi kehendak pelajar, pemilihan kaedah pembelajaran yang betul akan dapat membantu dalam meningkatkan tahap tumpuan pelajar.

Penyelia:
Profesor Dr Putra Sumari

Penyelia Bersama:
Profesor Madya Dr Aswati Hamzah

SUSTAINED ATTENTION ON A PRE-RECORDED LECTURE: AN EEG STUDY

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Introduction: Pre-recorded lectures are an essential component of e-learning environments; these lectures should be delivered in a way that promotes learning. Providing pre-recorded lectures across various media channels is beneficial to improve student learning, satisfaction, involvement, and interest.

Objective: The primary aim of this study was to evaluate the effect of text-based slide presentation as activity 1 and interactive slide presentation as activity 2 on brain wave oscillation changes that affect attention.

Methodology: 30 samples in ASCII format were tested to meet the study objectives. The data were sampled at a rate of 1000hz per second. Data pre-processing removed the effect of AC lines and unwanted frequencies using the HFF, LFF and Notch filters. Different kinds of noise of either extrinsic or artefacts were then removed using DWT and applied over detail coefficients (d) to remove the noise. The DWT decomposed the signal into wavelet coefficients and was reconstructed. A t-test was used to assess whether the means of the two groups were statistically different from each other and to explain the importance of every independent variable in the demand model.

Results: The mean of max beta was determined and compared between activity 1 and activity 2. The findings indicated that the P-value was less than 0.05, which meant that both activity 1 and activity 2 affected the pre-recorded lectures when the t value was 5.663 and 7.850, hence the H_o was refused by the T-test.

Similar findings were obtained for the frontotemporal region, which recorded the highest mean of max beta between 2 activities, and the results also indicated that the P-value was less than 0.05. This implied that both the frontotemporal region in activity 1 and activity 2 affected the pre-recorded lectures when the t value was 6.013 and 6.523, hence the H_o was refused by the T-test.

Conclusion: Both activities were tested, and statistical analysis results based on the findings indicated that the study failed to accept the null hypothesis. There was enough evidence of notable differences in both learning approaches. In light of this, this study concluded that teaching should be more precise on what elements are required to develop student attention. This, in turn, would help teaching with the right choice of method to meet the requirements.

Supervisor:
Professor Dr Putra Sumari

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Lectures remain a common part of the culture in the classroom; for one aspect, it can be argued that lectures today play a much more prominent role in education than before video recorded lectures were used to improve classroom lectures (Schacter and Szpunar, 2015). Therefore, it is necessary for teaching to apply methods that can foster student learning activities (Puspitarini and Hanif, 2019).

Since lectures in the early days were an integral part of education, there has recently been much discussion about the value of lectures and whether they should be improved or entirely replaced by more active learning modes. In a traditional lecture, simple and easy to understand is a must; even though presentation styles vary, the basic structure is how the lecturer gives the lecture. Besides lecturing in the classroom, online learning has been overgrown in recent years. A study stated that video presentations, often referring to as mini-talks, micro-readings, or just video lectures, are becoming increasingly popular among hybrid or entirely online learning styles (Scagnoli et al., 2015). Online learning has become a significant part of education around the world, especially in the United States. According to the National Center for Education Statistics (NCES), online enrollment climbed by 16 per cent between 2012 and 2016. Around 6.3 million students are currently enrolled in online courses, according to the NCES (V. Singh and Thurman, 2019).

As pre-recorded lectures are an integral feature of e-learning environments, pre-recorded lectures should be presented in such a way as to promote learning. Providing pre-recorded lectures across different media channels is a helpful technique, which can affect student learning, satisfaction, interaction, and interest (Costley and Lange, 2017). Despite these challenges, little is known about how students use recorded lectures strategically or integrate these tools into the learning process (Topale, 2016). Although there are various learning methods, the essential part is how to maintain the level of attention while obtaining learning information.

According to the study, attention is aware of here and now in a focal and conscious way. There are several different varieties. However, in most situations, it is involved in collecting another component of the information processing system of a subset of information for further processing (Styles and Elizabeth, 2005). Without a doubt, attention is not a unified or straightforward idea. Nonetheless, an essential feature of attention is indisputably vital to information processing in the brain, despite its various, vague, and sometimes contradictory descriptions. (Lindsay, 2020a).

Although human experience is decided by how people focus their attention, it is apparent that they do not have complete control over such a path. For example, often, a person has difficulty focusing attention on a task, conversation, or a series of events as attention may be defined in its most abstract form as merely an overall degree of alertness or the ability to communicate with surroundings (Lindsay, 2020b). Research undertaken by MIT neuroscience shows how well the brain manages this kind of focused concentration on faces or other objects. The lowest frontal junction (IFJ) is a portion of the prefrontal cortex that controls visual

processing regions conditioned to identify a specific object form (Anne, 2014). Numerous brain areas, including the majority of the visual cortex, the prefrontal cortex, and the thalamic and midbrain nuclei, have shown attention-related changes in visual responses (Moore and Zirnsak, 2017).

That the very first neuronal tests of feature-based attention in humans revealed that reacting to colour, form, or motion selectively (instead of just splitting attention throughout images) resulted in enhanced activity in different visual areas, which were likely associated with accessing certain aspects (Corbetta et al., 1990). Neuronal responses to visual stimuli are often higher when attention is directed to a neuron's receptive field than when attention is directed elsewhere (Moore and Zirnsak, 2017).

Consequent fMRI studies discovered that when subjects tended to colour and motion, activity in cortical areas was feasibly associated with colour and motion output (T. Liu et al., 2003). The ventral pathway processes visual properties crucial for colour, pattern, and object discrimination and recognition, whereas the dorsal pathway extracts elements of visual stimuli related to actions on those objects, such as visually directed grabbing, reaching, or foveating (Luo and Maunsell, 2019).

That large number of studies compared attention with attention to some other aspect. As a result, determining whether triggering was caused by improved processing of the accompanied component, reverted processing of the unattended attribute, or either one is challenging (Polk et al., 2008). Neurophysiological data also supports the idea that prefrontal cortex (PFC) is integral to cognitive function. Such studies have shown that neuronal activity patterns in prefrontal cortex (PFC) subregions are associated with the attention state (Schall, 2002) and, the prefrontal

cortex (PFC) is considered to constitute the highest stage of neural integration and to be devoted to representation and production of actions (Le Merre et al., 2021).

Over a decade of electrical brain signal recordings have shown that activity in various EEG frequency bands (Gola et al., 2013). Electrical brain signals have sparked a lot of interest in clinical and experimental uses of neural interface technology. The electrode, which serves as the brain interface, is the most important feature in activating neural cells or recording neural processes (Im and Seo, 2016). Electroencephalography (EEG) is an electrophysiological monitoring technique that records the electrical activity at the surface of the brain using electrodes placed on the scalp. EEG records electrical signals from the brain in the form of voltage fluctuations inside the brain's neurons (Nanditha and Persya A, 2017). It is now strongly known the fluctuations or oscillating control is essential in both regional and long neural mass communication transmission (Engel and Singer, 2001). Neuronal oscillations are ubiquitous in the brain, but they vary in strength and frequency depending on their location and the exact nature of their neuronal generators (Arnal et al., 2016; Mantini et al., 2007; Samogin et al., 2020). Neuronal fluctuations are being found in a wide range of mechanisms, including vision and selective attention (Bauer et al., 2012) and, these fluctuations were also discovered to be correlated across brain regions and are thought to reflect fluctuations in neuronal activity between functionally connected areas of the brain (Krishnan et al., 2018). Oscillating neural activity normally regulates a number of distinct frequencies, that include the delta, theta, alpha, beta, and gamma bands (Buzsáki, 2009). Growing evidence of the importance of neural oscillations in cortical processing, where neural oscillations are now assumed to play a substantial role in binding and information

transfer between brain areas, encouraged the decision to focus on generating activity. (American Psychological Association, 2017; Roopun et al., 2008). Study by Lee and colleague, previous findings on neural correlates of attention have recorded percussive activation in the beta frequency range, suggesting that top-down beta patterns, produced in complex cognitive regions (Lee et al., 2013b), as a study found that as attention shifts, the brain decreases the probability of high-power beta events, attention and perception have distinct associations with alpha and beta. Changes in averaged alpha power occur sooner after sustained attention cues than shifts in beta power, and beta has a stronger linear relationship (Shin et al., 2017). An attractive future approach would be to quantify the likely fleeting nature of alpha and its ties to beta occurrences. Beta band rhythms (15–29 Hz) are a frequent activity pattern in the brain. Beta oscillations and their synchronization between regions are linked to various tasks, including sensation, attention control, and motor planning and initiation (Sherman et al., 2016a).

The capacity for concentration and attention is a crucial barrier which the brain needs to overcome. Although it is understood that maintaining attention magnifies synaptic impulses in the brain to brace for essential knowledge, it is unclear how well the brain reaches this stage of preparation. A well-accepted hypothesis in the neuroscience field seems to be that brain cells predict stimulation and sustain as a state of preparation.

For this, study findings will give rise to improvements in teaching and learning methods. Even though the field of teaching and learning is ever-changing, the primary objectives will make a huge difference. Therefore, this study aims to evaluate the effect of text-based slide presentations and interactive slide

presentations on brain wave oscillation changes that affect attention are seen as a necessity.

1.2 Study Rationale

Recent e-learning techniques are becoming common in academic settings, as universities seek to preserve technical credibility while still providing students and staff with more efficient educational tools. E-learning tools can help with an agile, self-directed active learning (Ruiz et al., 2006). The term "e-learning" refers to the use of various types of information and communication technology (ICT) and electronic devices in education. It is a catch-all term for any teaching and learning activity that makes use of any electronic device or network, fully or partially. E-learning refers to the move from traditional education or training systems to more personalised and adaptive ICT-based education systems (Guragain, 2016). E-learning allows students to learn in a flexible and individualised manner, allowing for on-demand learning and lowering the cost of learning. Several basic technologies that can aid in the design and implementation of e-learning systems are emerging, resulting in a far-reaching impact on learning in the new millennium. Universities, colleges and institutions worldwide, as we know, need to educate their teachers for the change. This is how, as our society's culture shifts in reaction to technology advances, educational institutions and teachers must adapt. They must adapt their attire, conduct, and teaching abilities, as well as adapted to the new and integrate novelty into their daily work (Cioruța et al., 2021). Nevertheless, the technology's misuse could be educationally detrimental whether it deviates from constructive

learning, contributes to wasteful work time usage, or encourages study methods that discourage effective implementation of lecture material.

Pre-recorded lecture is amongst the most common e-learning technologies available for today. It allows students to reflect lectures whenever they choose, mostly with the option of stopping the video or changing the speed where it is presented. Nevertheless, there's genuine concern within scholars that delivering registered lectures has a negative effect on students. While the extensive use of e-learning platforms like as pre-recorded lectures is justified (Ruiz et al., 2006). According to study, the mixed online learning strategy is the most practical way to adapt. Integrated learning scheme during defined class hours, teachers and students meet online using video conferencing software and deliver synchronous online lectures on the subject (real-time). During the lectures, students can ask questions verbally or via live text chat (Ds et al., 2020). The extent to which students embrace it or lead effective learning effects are yet to be shown (Traphagan et al., 2010). According to early studies, interactive online activities in a blended learning course have an impact on student learning outcomes (Nguyen, 2017). Pre-recorded material's versatility may motivate students to spend hours with each video, pausing and agonizing over the details (French and Kennedy, 2017). There are many situations when giving a lecture is inappropriate, but there are also times when it is quite acceptable. When done correctly, lectures may be a very efficient and effective teaching tool. In the case of the pre-recorded lecture, the recordings allow students to go over their notes repeatedly. As a result, the teacher may be spared of lengthy slides and death by PowerPoint (MacKay et al., 2021). Deliver facts that as the existence of recorded lectures seems to have had a negative impact on lecture

attendance, however several other studies have provided evidence to the contrary (Martin et al., 2013). Likewise, it is unclear how much impact pre-recorded lectures on educational objectives. There is some proof that utilizing pre-recorded lectures results in higher scores (Danielson et al., 2014; Traphagan et al., 2010). Lecture recordings, it should be emphasized, have been found to have a substantial impact on how students process and comprehend information. As a result, video editing software had to be used (Ds et al., 2020). Some studies suggest that using pre-recorded lecture somehow doesn't improve learning outcomes, and doesn't give positive effect on performance (Franklin et al., 2011; McNulty et al., 2012), or maybe related to poor performance (McNulty et al., 2009). While the study also stated that pre-recorded lectures at home improve student time management, freedom to watch and the flexibility of pre-recorded lectures at any time (Shiau et al., 2018). Pre-recorded lecture types differ in terms of multimedia elements and other features used in content presentation (Scagnoli et al., 2019). Having listened to something like a lecture is a type of sustained attention activity (Young et al., 2009). The ability to pay attention is critical to having successful online learning experiences. Six main types of attention are described in the literature on essential attention theories: divided, focused, selective, shifting, spatial, and sustained (Kokoç et al., 2019). A study has shown that as we concentrate our attention, the electrical activity of the brain neocortex is shifted. Neurons stop signalling one another in sync and begin to fire outside from aligned, the cholinergic process in the brain is considered to have a significant importance in provoking this desynchronization. The cholinergic system is made up from bundles of specific neurons that replicate then produce acetylcholine, a signalling molecule (Science News, 2008). As we focus our

attention, the electrical activity of the brain's neocortex changes. Neurons cease to communicate in sync with one another and begin to fire out of sync. Individual neurons can respond to sensory input in a variety of ways as a result of this. The cholinergic system in the brain is known to have a significant role in causing this desynchronization. Regarding attention, this cholinergic system functions as a master switch, although accumulating evidence suggests that it also allows the brain to determine which sensory information is the most salient (S. R. Williams and Fletcher, 2019).

The processes that enable acetylcholine to access the neocortex are still poorly understood to influence cognitive functions and behaviors. Although initial micro dialysis findings in the medial prefrontal cortex (mPFC) identified a lengthy acetylcholine rise during attention-related efficiency tasks (Passetti et al., 2000). The hypothesis is indeed consistent with evidence that cholinergic neurons originating in the basal forebrain are heavily involved in attentional processes. These projections cause acute increases in acetylcholine (ACh) in the medial prefrontal cortex, which facilitates cue detection and is required for effective task performance (Peeters et al., 2020).

The low alpha and high beta spectrum is a power of attention, in addition, it characterises strong abilities, in particular, during the pre-stimulus cycle, demonstrates an intense emphasis and projects improved efficiency within ongoing task (Gola et al., 2013). As beta waves are associated with waking and attentional states, such as when one's attention is focused on the outside world or when one is addressing actual concerns (Blandon et al., 2016). This spectral power or brain wave can be measured, as EEG measures brain activity by detecting and amplifying faint

electrical signals, known informally as brainwaves, that are continually emitted by the brain. These electrical signals are how our brain communicates activity and synchronizes it across various anatomical regions. Variations in activity on the brainwave are indicators of changes in cognitive processing. At some point, investing inattention can also facilitate brain cognitive processes and coding, letting learners to do better academically (Smithson et al., 2013). Adequate sustained attention is the crucial point that students focus on learning content and improve their performance in e-learning environments (C. M. Chen et al., 2017). Since attention with self-reporting methods was difficult to quantify, several studies using electroencephalography (EEG) to assess improvements in attention condition (J. C. Y. Sun, 2014). Despite the significance of sustained attention throughout an online learning activity for effective teaching, assessing whether students keep their attention during an online learning activity is highly difficult due to the lack of supervised procedures to monitor their attention states (C. M. Chen et al., 2017). Studies found that EEG data sets was effectively used to identify learners' behavioural patterns and learning habits, as well as their association (Deenadayalan et al., 2018), Since attention is difficult to measure using self-report instruments, past research employed electroencephalography (EEG) as a tool to measure changes in attention states (J. C. Sun et al., 2018).

Although we do not understand much about how the brain functions, we do know that the brains are constantly involved, constantly processing, and reacting to a multitude of internal and external signals, both consciously and subconsciously. For instance, if we can look inside student's brains as they learn by engaging in a classroom and non-classroom activity, what could we see? Each of the student's

brains arrives with a total of 86 billion neurons in hundreds of brain regions with specific functions (Azevedo et al., 2009). Learning is assumed to take place at synapses, which are the connecting points between neurons. Nevertheless, synapses alone preserve memories of just the most fundamental responses. Learning and memory necessitate the integration of data from numerous brain regions. This action changes the physical structure of myelin, the insulating substance that surrounds the wiring that links neurons. Myelin, it turns out, plays a vital role in learning by altering the speed of information transmission through neural networks. (R. Douglas Fields, 2020). Such neurons bind to each other to form neural circuits, generating an estimated 100 trillion contacts (R. Williams, 1988). To be most effective during the learning phase, the task of the students must excite their interest and motivate them to pay attention. The brain's processing of instructional material provided in various formats is poorly understood (Venezia et al., 2017). While according to study Learning during the audiovisual version was specifically predicted by a combination of more activity in the dorsal prefrontal cortex (Pujol et al., 2019).

That's why knowing how the brain work and maintaining the information received will helps the student to learn. Chen and Lin state that appraises recorded lectures online just before an exam improves the accomplishment of students, whereas viewing recorded lectures online immediately after a class meeting does not show any significant impact (J. Chen and Lin, 2012). In terms of learning, media can have a considerable impact on how students acquire and perceive information. In e-learning contexts, ineffective media use contributes to issues with interest, engagement, and motivation, which finally leads to a lack of comprehension. (Costley and Lange, 2017).

As for this, successful educational programs should be structured to essentially keep students attentive, it is the basis for maintaining memory and knowledge. And therefore, findings from the study indicate that the need to improve online learning methods, especially on pre-recorded lectures. The level of student engagement during learning is a very important factor. The question of how to maintain a level of attention while learning requires a solution especially in the e-learning concept of learning.

The finding of this study will redound to the benefit of the student whether they were from primary school, secondary school, or college and university students. They were considering that science and technologies have played an essential role in the world of academics today. In the eagerness of our passion for practising online learning, some should consider whether this method is proficient in maintaining a high degree of student concentration and attention throughout the process.

As for today, the impact of Covid-19 has made us think, how to move on, to another level of education. As the world and society have turned to a new norm of living.

The global suspension of educational institutions will cause major (and potentially unequal) disruptions in student learning, delays in internal assessments and the cancelation of or replacement of public certification exams by an inferior alternative. Most nations have (righteously) decided to close- down schools, colleges, and universities. The crisis precipitates the political debate about closing schools and holding them open (reduction of touch and lifesaving). Home education is not just a huge impact towards the families' stability, but also in the children’s cultural and academic lives, e-learning and teaching are evolving at an unproven and

unprecedented. Student assessments also move electronically, with a lot of trial, error, and uncertainty for all (Simon and Hans, 2020).

1.3 Study Objectives

1.3.1 General Objective

To evaluate the effect of text-based slide presentation and interactive slide presentation on brain wave oscillation changes that affect attention.

1.3.2 Specific Objective 1

To determine mean of the max beta-band oscillation during a pre-recorded lecture and compared between text-based slide presentation and interactive slide presentation.

1.3.3 Specific Objective 2

To identify frontotemporal region that having the highest mean of max beta band signal during pre-recorded lecture of text-based slide presentation and interactive slide presentation.

1.4 Study Hypothesis

H_o There is no difference in score of max beta-band oscillation that occurs during text-based slide presentation and interactive slide presentation.

H_a There is a difference in score of max beta-band oscillation that occurs during text-based slide presentation and interactive slide presentation.

H_o There is no difference in score of frontotemporal max beta-activity during text-based slide presentation and interactive slide presentation.

H_a There is a difference in score of frontotemporal max beta-activity during text-based slide presentation and interactive slide presentation.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

More and more organizations are beginning to phase out live lectures in favour of pre-recorded lectures to disseminate information effectively, such as using class time for active learning (Cardall et al., 2008). Today's higher education is increasingly reliant on pre-recorded lectures as a source of learning rather than live lectures, but whether pre-recorded lectures can effectively replace live lectures remains unknown (Hadgu et al., 2016a). In this transition from live to recorded lectures, whether pre-recorded lectures can replace live lectures is an important question. The interest is became this notion (Cardall et al., 2008). Asynchronous online forums and distributing pre-recorded lectures on a learning management system are ways of making online learning more like classroom learning. Pre-recorded lectures may contain, but are not limited to, video, PowerPoint slides, audio recordings, and lecture notes. However, despite pre-recorded lectures add classroom-like education, users may be dissatisfied with the lack of engagement with pre-recorded lectures. As an alternative to pre-recorded lecture, live online lecture offers affordances similar to a face-to-face classroom because the teacher and students can meet and share discourse and feedback in real time (Al Amer, 2018). For years, higher education lecturers and students have tried to record lectures for reference, easy access, and distant educational purposes. With technological developments, what began as audio recordings on cassettes and video home system (VHS) videos gradually evolved into digital lecture recordings. In recent years, student reliance on

mobile lectures has increased exponentially (Beldarrain, 2006; Hadgu et al., 2016b). Of course, another convenient way of content distribution in a pre-recorded lecture, whereby the lecturer recordings a lecture outside of the classroom and distributes it to students in a multimedia medium, like as MP4, accessible remotely from anywhere (Shah et al., 2013). In terms of flexibility, convenience, and educational efficiency, pre-recorded video lectures surpass live ZOOM lectures, according to a study. Learning through video lectures, on the other hand, is contingent on students' willingness to work through the material independently. Lack of motivation and clear deadlines for viewing video course materials might lead to a accumulation of workload that is difficult to manage before exams (M. Islam et al., 2020). Because of the exponential rise of technology, scientific study of its effect on our cognitive experiences is a new area of interest (Risko et al., 2013). For online classes conducted via pre-recorded video lectures, visual stimulation along with media-rich audio is a significant advantage (Fleming et al., 2019). To explain how different educational experiences impact the learning process as well as what cognitive externs result when the classroom context is changed, one should first identify which cognitive processes are likely to be affected (Abdous and Yoshimura, 2010). To improve students' performance, online instructors need to be more organized and communicative (Tanis, 2020). Online interactive learning, such as with problem solving activities, is preferred over traditional approaches (Sato and Haegele, 2018). To ensure that the students gain the knowledge intended, the recorded lectures should be as effective as possible (Schacter and Szpunar, 2015). According to previous studies, persons who have never provided or attended an online course are more skeptical than those who have and are always open to their potential (Allen et al.,

2016). Through present, when evaluating classroom environments, studies have extensively concentrated on cognitive ability (Abdous and Yoshimura, 2010). The question of how online learning affects students' cognitive ability is still unresolved. (Flogie et al., 2018). Although applications in the intelligent learning environment that provide sufficient learning retention using artificial mentoring systems have challenges responding not only to learners' knowledge but also to their emotional states and the learning environment (Herder et al., 2017). Attention might be another aspect that can be influenced by changes in the classroom culture (Unsworth et al., 2012). Although the effects of a well-designed classroom have been recognized, there has been little studies on the influence of environmental changes on behaviour and learning (Ortiz, 2017). There's a common perception that students today have shorter attention spans than previous generations. Very little evidence, however, supports this claim.

Zhang and colleagues stated as previous studies have pointed out, inadequately designed e-learning platforms can lead to resentment among learners, confusion, and less interest. A few e-learning services, for instance, just offer text-based learning material, which can lead to student boredom and disengagement and prevent themselves from receiving a meaningful clarification of a topic. Many interactive-based e-learning platforms are becoming accessible as multimedia technology improves. Such programmes incorporate and display learning content in a variety of media formats, including text, picture, sound, including video (Zhang et al., 2004). The use of modern technologies to enhance human learning. Indeed, technology-enhanced learning methods have become increasingly widespread in the higher education sector (Schweighofer, 2017).

As the question occurs, what are the situation if the lecture took place as a pre-recorded lecture? Is there any method that the lecture can use to maximize the attention of the student during the process? As the traditional, way of learning, recognition of facial expressions may be used to consider their level of focus. In a typical classroom environment, teachers lead classrooms and track and engage students to evaluate their understanding and development. Considering the increasing popularity of e-learning environments, determining the degree of attention during online learning has become significant (H. R. Chen, 2012). Readiness in online learning platforms is critical for users to be able to follow the learning process effortlessly and correctly (Rahardjo and Terbuka, 2021). Institutions must determine their preparedness for e-learning (Wahdiniwaty and Nugraha, 2018). The ability of students to actively participate in e-learning, as well as the availability of a conducive online learning environment, are both crucial to the success of e-learning programs and courses (IE et al., 2018).

Attention management is essential to the success of a wide range of study endeavours. An order to manage the awareness of oscillating attention phases, to retain effective states, and to rebound efficiently through attention deficits are all essential in tasks involving awareness and response (Bogart and Pope, 1994). The number of daily interruptions to which we are subjected has increased dramatically because of the increased use of technological advances in our daily lives, affecting our performance when performing our tasks or any other situation that requires concentration and attention. The use of technology in our organizations, together with the resulting media multitasking, creates a situation in which our brains are easily intimidated by interruptions, prohibiting us from staying focused and, in the

present situation. (Was et al., 2019). This is critical in higher education where students attend lectures with their mobile phones and computers on the tops of their desks, meaning that they get distracted by almost all of the notifications that they receive (Vizcaíno et al., 2019). Furthermore, it has been demonstrated that technology contributes to increased stress levels and a decrease in time and spatial awareness, while people, including students, prefer to fragment the attention provided with what they do (Elliott-Dorans, 2018; Patterson and Patterson, 2017).

A study by Bradbury states the conventional lecture has come under fire in the new atmosphere of curriculum change because of its perceived lack of efficacy. Many organizations have decreased their lessons to 15 minutes in duration based on the "common wisdom" and "common understanding" that the participation of students in lectures decreases by 10–15 minutes (Bradbury, 2016). According to the current study, attention was lower towards the end of the teaching session than at the start. Furthermore, attention was significantly greater in the morning than in the afternoon. For good attention capacities, morning hours are preferable to afternoon hours (H'mida et al., 2019).

As stated by McKeachie and Brewer in their book, they often recommended on teacher tips indicate that student attention wanders during a passive lecture when interactive techniques are used to draw student attention. They recommend splitting lengthy lectures with interactive approaches (McKeachie and Brewer, 2002). According to a study by Warkar and Asia, students preferred interactive lectures (84%), shorter duration (70%), self-study (45%), and clinical orientation (68%).They valued audiovisual aids (95%), applied physiology (85%), regular evaluation (54%),

and students preferred self-directed learning, brief lectures, and the use of multimedia, interactions, and clinical orientation (Warkar and Asia, 2016).

The fourth industrial revolution, sometimes known as the digital revolution, has resulted in a massive transformation in the world (Collins and Halverson, 2018). Currently, the use of digital technology has occurred in all aspects of life and various age groups.

Traditional teaching approaches typically allow teachers to analyse the gestures of students to evaluate whether they are studying attentively. This system, however, is often unreliable and increases a teacher's burden. As electroencephalography (EEG) evolves, assessing their EEG responses will reveal if they are attentive or unattended throughout instruction (N. H. Liu et al., 2013). One of the scientific technologies utilised to analyse human brain activity was electroencephalography (EEG). Since student learning involves brain activities such as information input and processing, utilising EEG to assess students' learning status is an appropriate alternative (Ni et al., 2020a).

Currently, an increasing number of academics are utilizing electroencephalography (EEG) as a data collection tool for academic research, and they have produced a number of study outcomes (Shadiev et al., 2017). Since it was difficult to measure attention using self-reporting tools, many studies have used electroencephalography (EEG) as a tool to measure changes in attention status. Attention was the most commonly used evaluation index of portable EEG technology in education research (Jiahui Xu and Zhong, 2018a).

The brain comprises billions of neurons, half of which are supporting and promoting neuron development. These neurons are highly associated through

synapses, which act as inhibitory or exciting activity gates. Every synaptic activity induces a strong electrical impulse, called postsynaptic potential. Create an electrical field large enough to propagate throughout tissue, bone, and skull. Ultimately, the head surface can be measured (Farnsworth, 2018).

As the brain's persistent on howl or commotion, the electroencephalography (EEG), includes a relatively broad frequency range (Niedermeyer, 2005). Beta activity is a good predictor of mental function, and abnormal beta activity indicates mental and physical impairments. Beta brain waves relate to conscious precision, intense attention, and problem-solving abilities, such as beta training it is used to improve focus and attention (simulation of increased beta 12-14 Hz), reading ability (simulation of 7–9 Hz), and introduce positive improvements in school performance. It also enhances computing performance and cognitive processing (Egner and Gruzelier, 2004; Liberati et al., 2018).

A study by Gola and colleagues found that, the beta amplitude of EEG recordings reported in older and younger occipital regions is linked to visual attention as measured by increases in beta activity corresponding relevant responses and a lack of beta activity modifications preceding erroneous response (Gola et al., 2013). According to the studies, attention is stronger when students initiate activities rather than when teachers initiate activities, as seen by lower alpha power and higher beta and gamma power during student-initiated activities. Electroencephalography EEG data revealed different patterns in student attention when compared to standardized categorization of attentional actions (Grammer et al., 2021).

The frequency of beta changes as the task progresses. A slowly accumulating evidence clearly indicates that beta activity may be significant not just in

sensorimotor but also in cognitive functions, owing to its relationship with attentional processes (S. Khan et al., 2021).

Although associations between beta and performance suggest a crucial role in brain function, beta rhythmicity might not be important per se but instead may be an epiphenomenal consequence of other important processes. Discovering how beta emerges at the cellular and network levels is crucial to understanding why beta is such a clear predictor of performance in many domains. A major, unresolved point of debate concerns the locus of beta generation. One prominent view is that beta is generated in basal ganglia and thalamic structures and that neocortical beta is an entrained reflection of these inputs. Alternatively, beta may emerge within the neocortex as a consequence of internal dynamics or that beta in early-sensory neocortical areas could be driven in a top-down manner from frontal cortex during attentive states (Lee et al., 2013a; Sherman et al., 2016b).

When attention is directed towards a task, the left inferior frontal gyrus relates to vigilance in beta frequency bands. The study found that the left prefrontal and temporal areas play an important role in the control of sustained attention. The area has the potential to be utilized to track physiological and psychological changes during attentiveness (S. M. Khan et al., 2021a). Beta waves first described by Hans Berger were associated by him with focused attention. The beta rhythms come in ranges: beta 1 (13-20 Hz), beta 2 (21-30 Hz), and gamma (30-60 Hz). Several hypothesized activities for beta rhythms have been proposed, including coordination among various representations in the cortex, inhibition of movement and motor planning, maintenance of the established order, decision-making signaling, and concentrating action-selection network functions (Kropotov and Press, 2016).

Improves resting alpha and beta oscillations in frontoparietal networks believed to be involved in top-down attention and executive control. Animal and human studies have shown that beta-band enhancement reflects the engagement of frontoparietal networks, which are thought to be involved in top-down attentional control (Knowles and Wells, 2018; Swann et al., 2009).

Table 2.1 Electroencephalography (EEG) Frequency (Chang et al., 2016; Jaswal, 2016; Read and Innis, 2017)

Type Of Brain Wave and Frequency	**Human Mental Stage**
Delta wave 0-3hz	– Associated with drowsiness, sleep, and states of altered consciousness
Theta wave 4-8hz	– Theta brainwaves occur most frequently in sleep but often predominate in deep meditation. Appears to serve as a carrier wave for and modulator of the other oscillations and is associated with the cessation of pleasurable activity
Alpha wave 9-12hz	– The Alpha is the condition of resting within the brain. Alpha waves aid mental balance, soothing ness, alertness, mind/body integration, and learning – Alpha activity is associated with inhibitory control in the brain. Alpha activity is most prominent during relaxation and is inversely

	related to brain activity
Beta wave 13-38hz	– Beta activity occurs when one is alertness and is related to the regulation of processing states – Modulated by attention. beta power might reflect attentional fluctuation in time

The task-oriented study and interpretation of brain activity are a big concern in the application of Electroencephalography (EEG) signals these days. Corresponding attempts were made here to predict brain function based on an interpretation of the power spectrum (KumarAhirwal and D londhe, 2012). Electroencephalography (EEG) can have significant implications for researching brain activity and promoting experimental field design (Magosso et al., 2019).

2.2 Conceptual Framework

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