International Journal of Innovative Computing, Information and Control
Volume **15**, Number **1**, February **2019**
ICIC International ©2019 ISSN 1349-4198
pp. 39–51

EVALUATING ATTENTION LEVEL ON MOOCS LEARNING BASED ON BRAINWAVES SIGNALS ANALYSIS

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Received April 2018; revised August 2018

Abstract. *In recent years, the study of brainwave instruments in academic fields is increased significantly. MOOCs, Massive Open Online Courses, have been widely used since 2011. MOOCs-based teaching is a ubiquitous network and places covered by mobile networks can immediately be used. However, rare of research has explored the relationship between brainwaves and MOOCs-based learning. In this paper, we build a system to measure brainwave signals using the NeuroSky Mindwave Mobile to analyze brainwave data. Participants learn in a MOOCs system and via traditional method. Fourier can represent the brainwaves, and the fast Fourier transform has the symmetry attributes used to find the PSD, power spectral density, values for data analysis. The study finds that using MOOCs-based teaching method could increase the better attention of the participants than the traditional method. On the other hand, MOOCs-based teaching method also gives relaxing learning for the students displayed in their meditation values.*
Keywords: Brainwaves, MOOCs, Brain-machine interface, Portable brainwave instrument

1. **Introduction.** Massive Open Online Courses (MOOCs) [1] were introduced by scholars Canadian Bryan Alexander and Dave Cormier in 2008. However, MOOCs were widely presented and implemented in 2011. In 2011, Stanford University opened three large-scale free and open web-based courses, each with up to 100,000 people. The initial years of MOOCs led to dialogues that pointed out that MOOCs might replace traditional higher education [2]. Although MOOCs could be accessed from all over the world through a platform of the Internet, MOOCs also face challenges in terms of degree credit, credentialing, awarding of degrees from course completion, financing, and quality control parameters of certificates from a higher education governance point of view [3]. [4] measured the performance of MOOCs by measuring students' outcomes using MOOCs teaching methods to compare with traditional teaching methods. MOOCs teaching methods also change according to the situation. According to [5], MOOCs are organized mainly into two types: "cMOOCs" and "xMOOCS" [6]. The cMOOCs are mainly based on connectivity between participants, where students need to participate in the teaching-learning process actively. On the other hand, xMOOCs are primarily based on cognitivist, behaviorism, and social learnings. In this model, outcome measuring tools are also based on students outcomes. However, we propose a measuring method not using student's outcomes but using the brainwaves EEG signals to measure student's attention and meditation while joining MOOCs teaching-learning process.

DOI: 10.24507/ijicic.15.01.39

In this paper, we use MOOCs system to combine with the brainwaves changes to find student learning situations. We will compare two teaching methods in our experiments. One is MOOCs online learning, and the other is traditional teaching, that is, a teacher teaches students in the class. The effect of each teaching method on each tester, such a comprehensive subjective and objective evaluation will be compared to obtain the more accurate and more objective experimental results. The primary contribution of this paper is to identify suitable teaching methods from MOOCs teaching by integrating brainwaves to determine comprehensive and objective learning. Through monitoring brainwave changes, we can understand the practical impact of the teaching methods.

This paper has the correlation with symmetry in the field of computer science and diversity and maps to the field of symmetry and other scientific disciplines and engineering. The brainwaves can be represented by Fourier series for the different types of brainwave waves to affect the meditation and relaxing values. In another side, fast Fourier transform is widely used in many fields such as applications in engineering, sciences, and mathematics. Fast Fourier transform is a function that samples signal over a period and converts it into individual spectral components and divides it into its frequency components [7]. FFT is optimizing the algorithm for the implementation of Discrete Fourier Transformation (DFT). An FFT algorithm computes the DFT function by a sequence, and also could compute the inverse IFFT. Fourier analysis converts a signal from its original domain into the frequency domain and vice versa. With these capabilities. FFT could work on real data with even symmetry. An FFT rapidly computes such transformations by factorizing the DFT matrix into a product of sparse (mostly zero) factors [8]. As a result, it manages to reduce the complexity of computing the DFT. In this paper, we used FFT to find the PSD, power spectral density, values for data analysis.

The remainder of this paper is organized as follows. Related work is presented in Section 2. Section 3 is research methodology. Section 4 is the experiment results and discussion. Finally, we give conclusion and future work in Section 5.

2. **Related Work.** To enable the results of EEG signals to be better identified, several studies have used integrated learning (Ensemble Learning). Müller-Putz et al. [9] applied a visual evoked potential (Steady State Visually Evoked Potential, abbreviated SSVEP) Brain-Computer Interface (BCI) to achieve control of 8 Hz LED lights and 13 Hz LED lights by staring. Tai et al. indicated that attention and meditation values are caused by low alpha and low beta of brainwaves [10]. Chen et al. also had a paper about the bus drivers fatigue measurement based on EEG waves [11]. However, few papers focus on exploring the relationship between learning effectiveness and brainwave evaluation. This study builds a system that can detect brainwaves and incorporates the innovative teaching methods of MOOCs. Neurosky Device has been used in many research [12,13], their brainwave validity and reliability have already been discussed in many studies and research fields. Based on [14], Neurosky device is already tested as credible instruments and the results of prefrontal cortex brainwave's accuracy almost the same 32 points brainwave instruments.

This study explores the significance of MOOCs-based teaching [15] by observing changes in brainwaves. We collected five English teaching films and built a system that can immediately monitor the interface, in which participants can use an interface button to respond to the films. Later, the system records the event and marks the degree of change in the brainwaves and records the time interval of the event. At the same time, the system also captures the brainwaves of the participants, which not only reduces experimental processes but also saves more times to make the preliminary results more reliable.

MOOCs-based pedagogy is compared with general, traditional education to verify the teaching effectiveness of the MOOCs-based pedagogy, as shown in Table 1.

In different sensory states, healthy people show different frequencies of brainwaves. These measured brainwaves are often influenced by actions and thoughts and have specific reactivity [16]. The EEG [17] is the most commonly used fundamental wave to describe the brain frequency band division and the different types of brainwaves that reflect brain mental states. According to [18] and the International Federation of Clinical Physiology for Clinical Neurophysiology [19], brainwaves are issued by the physiological signal. Figure 1 shows the Alpha, Beta, Theta, Delta waveform legend [20].

Based on the frequency range, brainwaves are classified into five categories: 1) Delta activity (δ wave): The frequency is below 3 Hz and its amplitude is about 20-200 μV. Delta wave usually occurs when sleeping and not awake, or under deep anesthesia or hypoxia, or with brain lesions in patients. 2) Theta activity (θ wave): The frequency is between 4 Hz and 7 Hz. In general, it presents a smaller amplitude. Theta wave mainly occurs in child's top lobe and temporal lobe. When adults are under emotional pressure,

Table 1. Traditional teaching and MOOCs-based teaching differences

Methods / Project	MOOCs-based teaching	Traditional teaching
Knowledge source	Professional knowledge defined in the field of expertise	Professional knowledge defined in the field of expertise
Teaching methods	Mixed teaching, autonomous learning, peer cooperation	Banking model of education
Requirements	Technology equipment, network	Classroom space
Educational purpose	Use of science and technology to promote students to self-learning. Users can have equal competitiveness.	Cultivate talent in line with social needs.

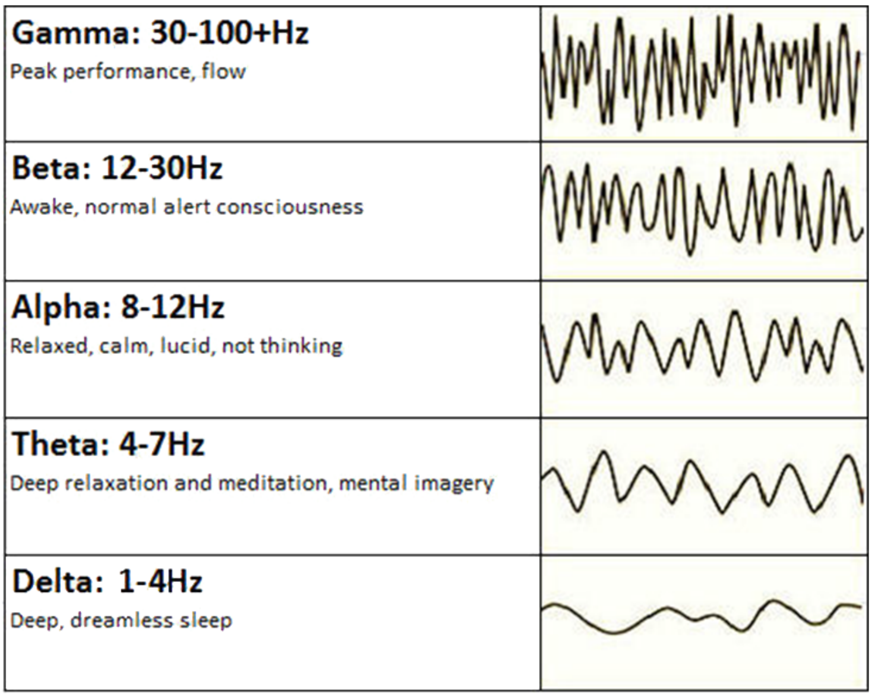


Figure 1. The waveform of brainwaves [20]

a small number of Theta waves will appear. However, there is no regular type, and they may occur in a sleepy or highly relaxed state. This band is essential to be analyzed because of many other brain disease patient exhibit θ waves. 3) Alpha activity (α wave): The frequency is 8-13 Hz, and the amplitude is about 20-200 μV. For most people, the brain Alpha wave is generated in the sober, quiet and relaxed state. To improve Alpha wave activities, people need to close their eyes and feel relaxed. 4) Beta activity (β wave): The frequency is 13 Hz or more, but rarely higher than 30 Hz. Studies have shown that Beta waves are influenced by tactile, auditory, and emotional stimuli and controlled by self-effort. 5) Gamma activity (γ wave): The frequency is between 31 and 50 Hz. In recent years, researchers have found that this wave is related to user's attention, raising awareness, happiness, and reducing stress. The meditation has a connection with human cognition and perceptual activity related to gamma wave [21].

3. **Research Methodology.** In this paper, we will develop a system which integrates brainwave signal, digital audio, and video teaching material into an interface using Microsoft Visual C# [22]. The system can record user brainwaves and observe changes in brainwaves while collecting focus, relaxation, and other brainwave values. The user can click on interface button whether like video[1] fragment or not while watching the film or music. These operations obtain a large amount of data and reduce the research time. Since it is located with the participants at the same time and space, the system minimizes external environment changes. The participants' brainwaves and subjective buttons make the relationship test reliable and make the research process smooth and save time.

The system detects the brainwaves using the output of NeuroSky Mindwave Mobile. The brainwaves are detected by dry single electrode detection located at the forehead. The supporting API receives and reads the signal values using Bluetooth transmission.

3.1. **Research objectives.** The system objectives are: (1) To provide indicators to facilitate the use of participants. Researchers can easily understand the situation of the participants; (2) To provide a useful tool from brainwaves to show the user's learning situations; (3) To compare the learning meditation for MOOCs and traditional teaching module.

The importance of subjective assessment is also common in domestic and foreign research, such as Lee [22] and Li et al. [23]. These works use questionnaires and other measurements to assess the participants' responses. Table 2 shows a comparison of the advantages and disadvantages of the single point, multi-point, and subjective measurement.

From Table 2, the results are reliable whether using the subjective measurement method to understand the participant's feelings or objective measurement method to obtain the participant's physiological data.

3.2. **Experimental method.** In the experiment, we use Microsoft Visual C# program to construct a set of online instantaneous brainwave detection functions and combine the system with MOOCs-based teaching. The experiment has an objective evaluation combined with a questionnaire and other subjective methods to evaluate the accuracy and reliability of the experimental results. Figure 2 shows the flowchart of the system operations. The first step is to calibrate headset with calibration EEG recorder. After their brainwaves are stable, we begin the step of the acquisition of EEG signal. Students join both traditional and MOOCs teaching system, and their brainwaves are recorded for

[1]https://www.youtube.com/watch?v=GJO8taptpCA&index=6&list=PLh_r1ikybJkwJbqbwg_cWhNAvRwy2FBoD.

Table 2. Comparison between objective and subjective measurement

Project		Advantages	Disadvantages
Objective measurement	Brainwave single point measurement	The measurement process is simple.	Data is not objective.
	Brainwave multi-point measurement	Data is more complete.	The measurement process is complex, time-consuming, and costly.
Subjective measurement	System self-click measurement	Subjective measurement reflects the experience of participants. The method is simple but needs a large number of tests.	Subjective feelings and objective measurement could generate contradictory results.

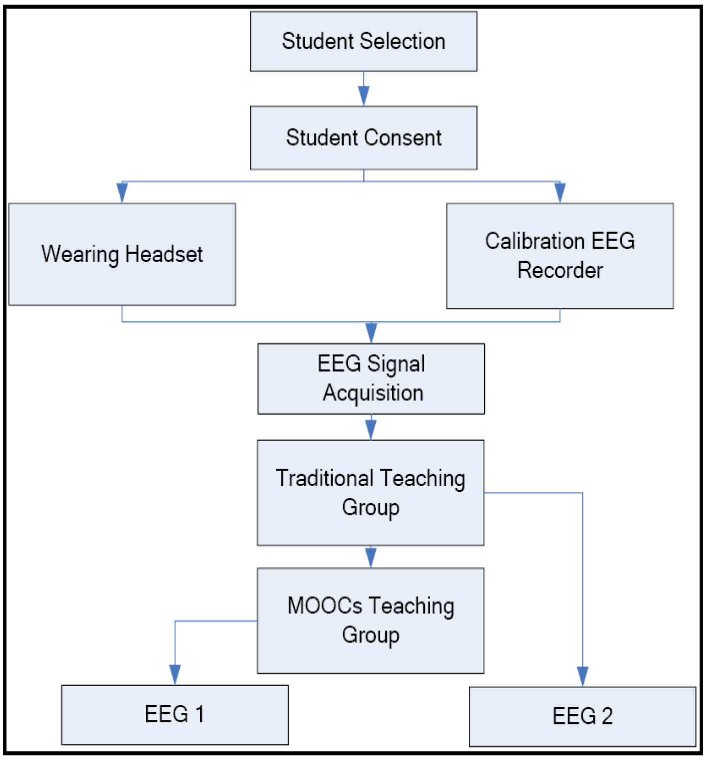


Figure 2. Flowchart of the system operations

both teaching methods. The EEG1 group is the result of MOOCs teaching system and the EEG2 group is the result of traditional teaching method.

In MOOCs-based teaching research, we have an online real-time detection function to record the system self-click measurement and to detect the state of the participant's brainwaves. The system also tests the group's attention to provide an interface which offers an unlimited number of instant click ratings. The buttons are "Good", "Question", and "Disagree", which represent user's (user's) feeling. "Good" is feeling good, "Question" is feeling fair, and "Disagree" is feeling bad. The three buttons are used merely to the experiment process and to record the degree of brainwave changes. It also accurately records the time interval of the event. The combination of EEG signals is saved to the cloud for statistical analysis so that the brainwaves of the participants can immediately be evaluated and results are obtained. The processing can shorten the experiment time and minimize the time and space differences and control time variables. The system is implemented in a notebook so that it can create a ubiquitous learning environment. Learners can use the portable notebook anywhere.

All of the participants were students from the language school. There are 15 testers, seven females and eight males, whose average age was 19.4 years old. Figure 3 shows the study procedure. The 15 students join both of teaching methods.

Figure 3 shows our measurements of the EEG between the two groups. The measurement interval is ten minutes for each group, to enable them to experience the teaching method. The participants then have three minutes rest time, after which one minute is used for calibration. The other ten-minute interval is used for testing the MOOCs-based teaching method. For EEG2 traditional teaching environment we call Tra-Testing, and for MOOCs teaching environment we call M-Testing.

Figure 4 shows raw data of brainwave from a user. The electrical potential from raw data of brainwaves is supplied directly for analog filtering with 512 KHz digital sampling every second. Analog data could be transformed into digital format using Fast Fourier Transformation (FFT) [24]. A Fourier series decomposes a periodic signal $x(t)$ regarding an infinite sum of sin and cosines (or complex exponentials) [26]. Mathematical equation

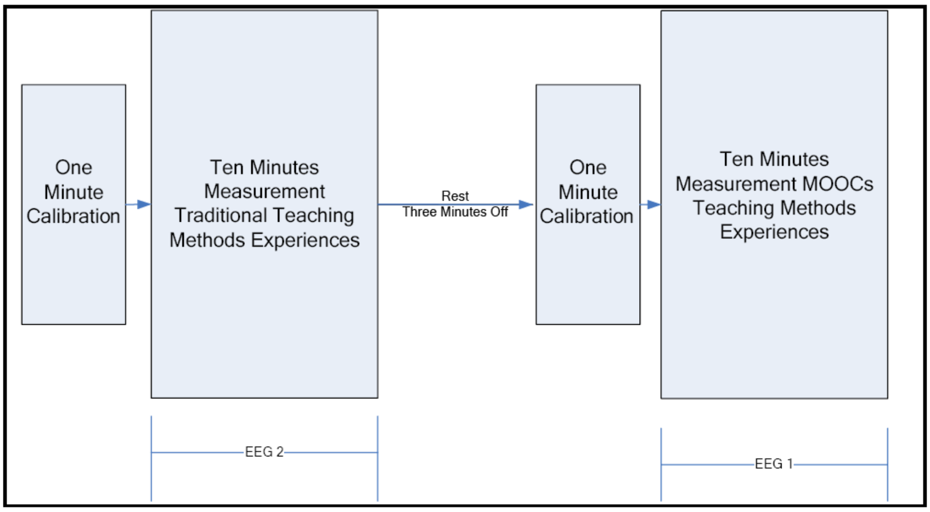


Figure 3. The flowchart of EEG measurement

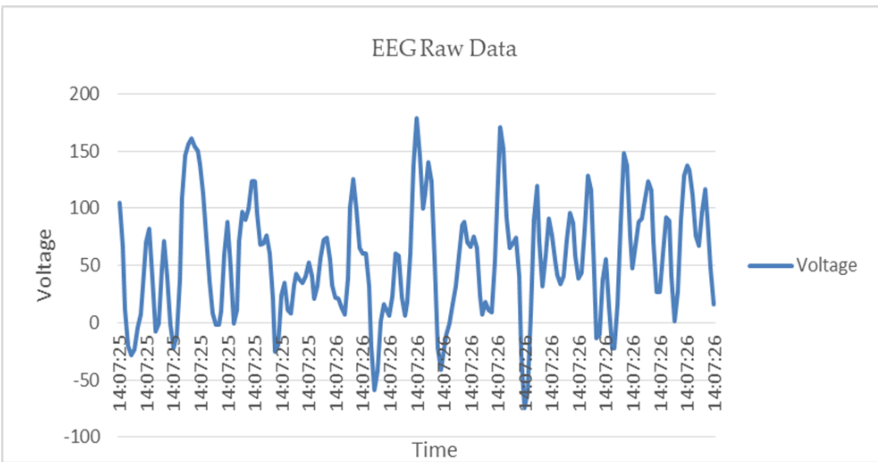


Figure 4. Raw data signal

of a Fourier series is presented by following Equation (1):

$$x(t) = \frac{a_0}{2} + \sum_{k=1}^{\infty}(a_n \cos(\omega kt) + b_n \sin(\omega kt)), \tag{1}$$

where signal $x(t)$ is integration able on an interval $[0, T]$ and is periodic with period T, t is a time variable, ω is an angular frequency and a_0, a_n, b_n are Fourier coefficients. Based on [25], we use the same parameters to calculate the Fourier coefficients. Fourier series can also be presented as (2):

$$x(t) = \sum_{k=-\infty}^{k=\infty} c_n \cdot e^{j\omega kt}, \tag{2}$$

where coefficient c_n is obtained from (3):

$$c_n = \frac{1}{T}\int_0^T x(t)e^{-j\omega kt}dt. \tag{3}$$

Fourier series could be generalized for infinite domains. The form is Continuous Fourier Transform (CFT). This function could be used to transform signals between time and frequency domain. CFT is presented as (4):

$$F(\xi) = \int_{-\infty}^{\infty} x(t)e^{2\pi j\xi}dt \tag{4}$$

Then the inverse CFT (to transform signals between frequency domain and time domain) can be written as (5):

$$x(t) = \int_{-\infty}^{\infty} x(t)e^{2\pi j\xi}d\xi \tag{5}$$

If the signal is periodic, the CFT is represented exactly by Discrete Fourier Transform (DFT) and $\xi = \omega/2\pi$ in cycles/second or Hertz (Hz, KHz, MHz, GHz, etc.), instead of ω in radians/second. FT transforms the sequence of N complex numbers $x_0, x_1, x_2, \dots, x_{N-1}$ (the time domain) into an N-periodic sequence $X_0, X_1, X_2, \dots, X_{N-1}$ (the list of the coefficient of a finite combination of complex sinusoids, ordered by their frequencies). It is according to the DFT Equation (6):

$$X_k = \sum_{n=0}^{N-1} x_n e^{-j2\pi kn/N} \tag{6}$$

The averaged spectrum and power measure for brainwaves were calculated. Figure 5 shows overall PSDs, power spectral density, value for one of the users. For every user, the power spectrum of the signal was computed using the FFT. The equation for FFT is given in Equation (7).

$$X(k) = \sum_{k=1}^{N-1} x(n)W_N^{kn} : k = 0, \dots, N-1 \tag{7}$$

$$W_N = e^{-i\frac{2\pi}{N}},$$

where k has N complex multiplications. A random signal usually has finite average power and is characterized by an average power spectral density as in Equation (8).

$$PSD_f(w) = \lim_{T\to\infty} \frac{|F_{X_T}(w)|^2}{2T}, \tag{8}$$

where $|F_{X_T}(w)|^2$ represents the FFT signal output from test tester, and T represents the time of total input signal. For every brainwave bands $W =$ Attention, Meditation, Delta,

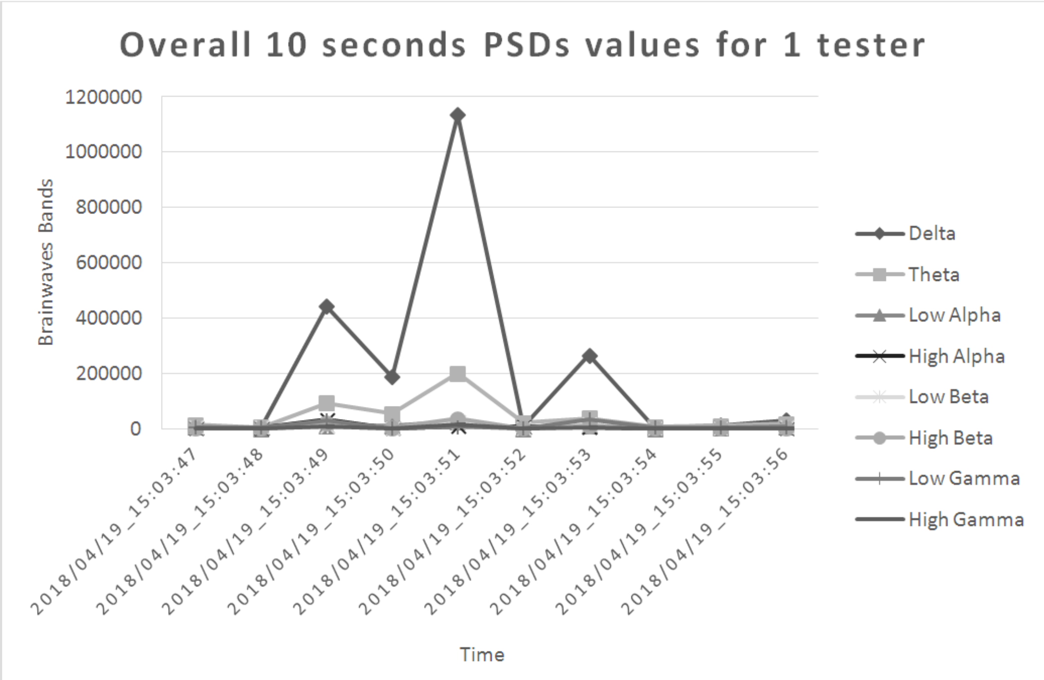


FIGURE 5. PSDs for User 1

Theta, Low Alpha, High Alpha, Low Beta, High Beta, Low Gamma, and High Gamma, Standard Deviation (SD) [26] are all calculated. The equation is shown in Equation (9) below.

$$SD_j(w) = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_{i,j,w} - \mu_{i,j,w})^2}, \tag{9}$$

where μ is the average of x. x is the $PSD_f(w)_i$ value for each j test participant, and N is total students in Tra-Testing and M-Testing as test participants. After system calculated all standard deviation for each waveband (w) and each user's j, the system will calculate the average of standard deviation for the test Tra-Testing and M-Testing. Calculation of standard deviation by averaging cumulative SD is as shown in Equation (10).

$$\overline{SD_g}(w) = \frac{1}{N}\sum_{n=1}^{N} SD_n(w), \tag{10}$$

where g is Tra-Testing and M-Testing index, and N is total users in testing. In this paper, we only have two tests, in which M-Testing is MOOCs teaching method test and Tra-Testing is the traditional teaching methods test. We use T-Test to test the two groups shown in Equation (11).

$$P_{value(w)} = T - Test\left(\overline{SD_1(w)}, \overline{SD_2(w)}\right). \tag{11}$$

Our first test (MOOCs) and the second test (Traditional Teaching Methods) have the same students.

3.3. **Measurement process.** This study uses traditional general teaching and MOOCs-based teaching methods. Each method was used to teach a 10-minute course, and the two sets of brainwave data were compared with each other. The number of people surveyed in each group was fifteen. The video of MOOCs-based teaching is GEPT (General English

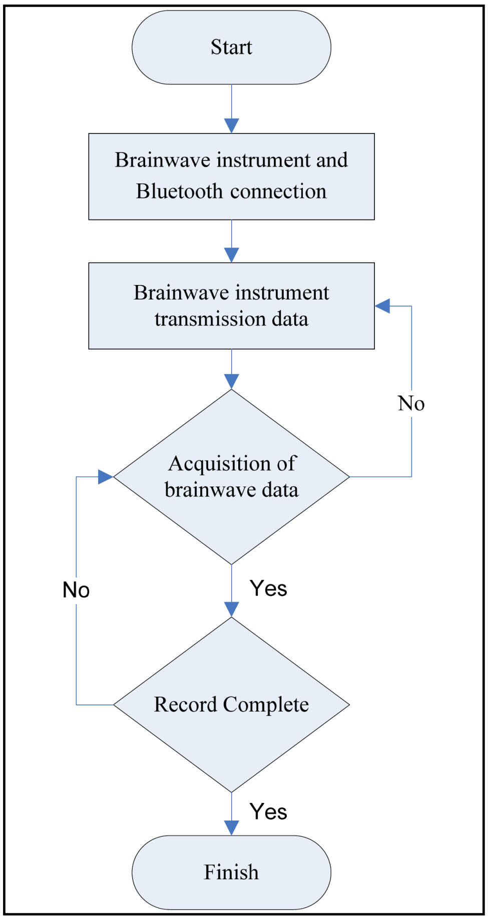


Figure 6. Measurement flow for both groups

Proficiency Test) superior course teaching video from language cram school. The traditional teaching location was a general classroom, and a native English tutoring teacher taught them. The MOOCs-based teaching method requires fifteen participants to sit in a comfortable space. In this space, the participants can choose their comfortable place. In the two teaching methods, participants were given the brainwave measuring instrument, and their measured brainwave data recorded which represents objective data for the two learning methods. The Mindwave Mobile brainwave instrument was used to measure changes in brainwaves. The brainwave instrument can measure each participant's state of consciousness, such as concentration or relaxation. Brainwave measurement is the most subjective factor involved in the intervention. It can also be the truest reflection the current state of each person's changes. Figure 6 gives the flowchart for the measurements.

4. **Results and Discussion.** We use the EEG signal to integrate the digital audio and video teaching feedback system to extract brainwave data. The experiment length is ten minutes. The video is a GEPT superior course teaching video. The test unit is the basic level of GEPT. The system recorded the brainwave data during the study. We get the attention and meditation level using the software which is implemented proprietary algorithms as the state in [27]. Table 3 shows the data for the statistics conversion and the output of the standard deviation of different brainwaves.

By analyzing the changes in the brainwave data of the fifteen participants, it was found that the changes in Attention, Meditation and Low Alpha and Low Beta were significant using the new teaching method, which indicated that the MOOCs-based teaching method

TABLE 3. Participant standard deviation index

ID	Att.	Med.	Delta	Theta	Low Alpha	High Alpha	Low Beta	High Beta	Low Gamma	High Gamma
1-1	17.146	16.854	391220.472	74895.127	24911.197	23623.674	25618.847	13928.887	5310.877	3762.936
1-2	17.046	17.090	364207.968	115401.864	27812.501	17200.838	17149.381	9814.291	4893.326	1787.563
1-3	15.706	16.042	404551.224	85388.019	24605.546	16672.029	19231.395	8063.105	4528.640	2280.572
1-4	15.302	16.995	331469.828	63194.928	25868.717	11689.184	22761.253	5791.418	4389.527	3037.082
1-5	16.048	16.469	431534.334	98210.325	28030.193	16148.195	19986.030	7900.341	4722.275	2416.130
1-6	16.350	14.306	430451.586	90804.148	27091.735	18905.647	21429.284	13291.220	14864.810	6027.397
1-7	14.486	13.887	609780.420	188265.167	37384.008	35169.355	37656.481	24910.868	11829.316	6017.767
1-8	17.436	15.086	432845.751	76445.253	29860.953	19035.742	19814.141	10150.037	6613.317	5349.686
1-9	14.271	19.198	388120.951	79505.107	29284.172	21692.354	18664.328	12876.089	7240.649	5080.163
1-10	19.147	18.712	427645.973	73895.712	26998.577	35984.352	25942.496	52566.020	42999.945	49768.558
1-11	13.597	15.429	329399.013	65389.493	29230.591	15823.438	17132.530	10124.398	4955.230	1835.556
1-12	16.673	14.880	439625.207	77687.321	27273.467	19371.862	17410.718	10067.404	6882.831	5480.939
1-13	19.018	19.638	556490.706	126732.643	27714.068	21712.680	22961.013	17507.769	15348.314	10653.538
1-14	15.532	16.209	358251.770	109572.640	23540.754	17131.573	14076.770	10209.726	5079.790	1745.963
1-15	17.049	14.587	421889.906	78115.213	20971.920	19038.485	22061.756	10194.952	6436.312	5297.587
2-1	11.080	18.161	596297.047	102729.094	21336.770	38293.733	21997.475	38301.481	33033.749	26221.399
2-2	15.913	15.758	441253.362	107810.782	21150.357	21906.762	12341.915	13086.819	13700.008	6034.786
2-3	15.603	14.936	433150.301	104565.552	23006.862	16192.682	13005.360	14402.038	11010.194	5168.169
2-4	11.080	18.161	596297.047	102729.094	23336.770	38293.733	21997.475	38301.481	33033.749	26221.399
2-5	15.913	15.758	441253.362	107810.782	21150.357	21906.762	17341.915	13086.819	13700.008	6034.786
2-6	15.603	14.936	433150.301	104565.552	23006.862	16192.682	13005.360	14402.038	11010.194	5168.169
2-7	11.080	18.161	596297.047	102729.094	33336.770	38293.733	21997.475	38301.481	33033.749	26221.399
2-8	15.913	15.758	441253.362	107810.782	21150.357	21906.762	17341.915	13086.819	13700.008	6034.786
2-9	14.603	14.936	433150.301	104565.552	23006.862	16192.682	13005.360	14402.038	11010.194	5168.169
2-10	19.209	15.975	431707.649	76012.727	18135.203	25656.361	23836.609	22604.497	6185.712	4352.147
2-11	11.913	15.758	441253.362	107810.782	21150.357	21906.762	17341.915	13086.819	13700.008	6034.786
2-12	15.603	14.936	433150.301	104565.552	23006.862	16192.682	13005.360	14402.038	11010.194	5168.169
2-13	16.617	19.969	489387.475	105721.600	26006.007	15719.954	12025.744	12941.777	14814.093	9973.939
2-14	11.806	16.462	437003.905	78600.570	20890.794	28305.274	12990.870	17093.386	8049.236	6886.545
2-15	14.283	15.617	415377.161	73806.472	18096.629	28691.297	10902.604	17485.361	6166.599	3900.657

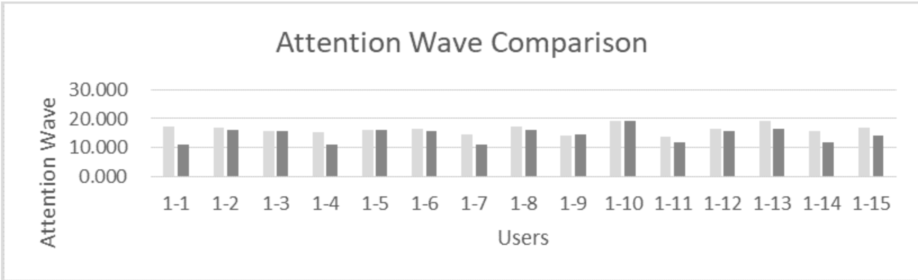
1-M-Testing; 2-Tra-Testing

TABLE 4. Analysis of the teaching method of traditional teaching and MOOCs

Item	Att.	Med.	Delta	Theta	Low Alpha	High Alpha	Low Beta	High Beta	Low Gamma	High Gamma
MOOCs	16.32	16.35	421165.67	93566.86	27371.89	20613.29	21459.76	14493.10	9739.68	7369.43
Traditional	14.41	18.57	470665.47	99455.60	22517.85	24376.79	16142.49	19665.66	15543.85	9905.95
T-INV value	2.51	2.08	1.90	0.67	3.67	1.36	2.90	1.32	1.64	0.67
p-value	**0.02**	**0.04**	0.07	0.51	**0.00**	0.19	**0.01**	0.20	0.11	0.51

*p < 0.05, **p < 0.01, ***p < 0.001

succeeded in attracting the attention of the learners. With the advancement of the course, the attention of the participants in the experiment gradually increased to a high level. The learners' attention showed an upward trend, and the index of Low Alpha and Low Beta increased gradually, which also indicated that the learning process, fitness, and relaxation have achieved a better learning state. At the same time, the participants also had more time to carry out independent learning. The result reflects the understanding that the best learning environment depends on the learning space, technology, and teaching methods of effective integration. In this study, we calculated Standard Deviation (SD) from each raw data. After calculating all the SD, we calculate the p-value from two-tailed test t-value. Our null hypothesis (H0) is that the MOOCs-based teaching method is not different from the traditional teaching method. We obtain a p-value less than 0.05, meaning that the null hypothesis is rejected. We can find that the MOOCs-based teaching method is different from the traditional teaching method. The p-value for the attention brainwave is less than 0.05, meaning that there are differences in Attention between MOOCs-based teaching methods and traditional teaching method. In Table 4, Attention, Meditation, Low Alpha, and Low Beta brainwaves for MOOCs-based teaching method are higher than those for the traditional teaching method. This means the MOOCs-based teaching method is better at attracting student attention. When using the MOOCs-based teaching method, students enjoy study more, based on the data from the meditation signal in Figure 7.



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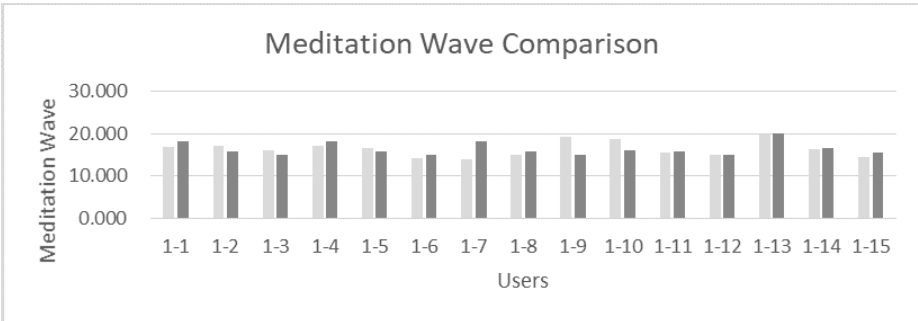
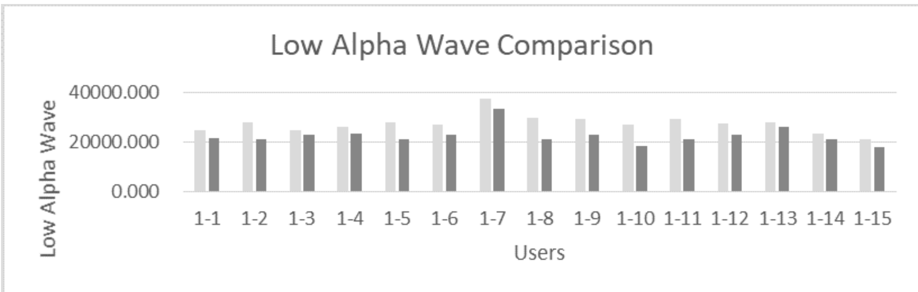
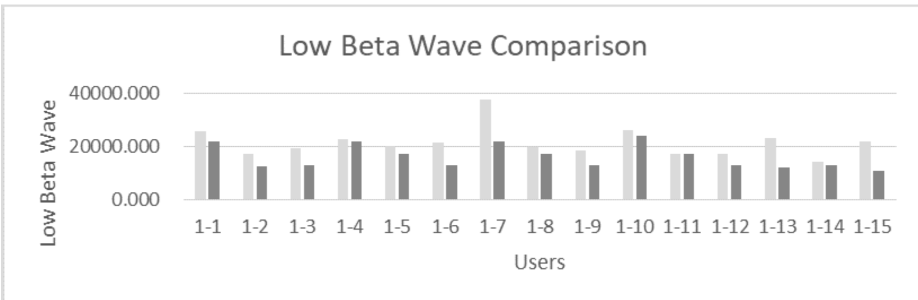


(b)



(c)



(d)

FIGURE 7. The comparison of different brainwaves: (a) Attention wave comparison; (b) Meditation wave comparison; (c) Low Alpha wave comparison; (d) Low Beta wave comparison

There are no any studies about combining brainwaves and MOOCs ever before; the method is a new one and perspective. We will continue to expand our research; we expect to find more significant research breakthrough.

5. **Conclusions and Future Work.** In the past, participants primarily used questionnaires to measure the situation using subjective responses. Therefore, in this study, we verify the subjective assessment results via comparison with the data from brainwaves. MOOCs based teaching have higher attention level than traditional teaching. MOOCs teaching makes the participants more relax during the learning phase. In the past, the quality of the traditional class will be affected by the different living situations of the participants, as well as the influence of time and space constraints on teaching. The mood and concentration of the participants themselves will be affected since the class ignores whether the brain is in the proper learning state. This study combines brainwave detection and MOOCs-based teaching to provide participants with the ability to understand their learning situation in real time to improve it. The experimental results suggest that MOOCs-based teaching is useful for student attention and focus on learning situation. However, the study is only based on their attention level and is not related to student gaining knowledge from learning. If the changes of EEG (alpha or beta) rhythms can reliably indicate the performance of learning, current findings support the research results.

In the future work, the factors such as scores obtained from tests will be included in the analysis. More parameters such as inside hardware environment, the temperature of the teaching room, and external parameters such as noise would be considered as factors to determine teaching methods to gain attention and meditation of the students. In the future, the condition of the student's mental states also needs to be taken into consideration, as we know that in the research environment users did not show their psychological state naturally. We also want to expand goal of the research to predict not only attention and meditation but also to predict creativity and reactivity of the students from their brainwaves state.

Acknowledgment. This research is supported by Ministry of Science and Technology, Taiwan, with project number: MOST-106-2221-E-324-025 and MOST-106-2218-E-324-002.

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