Measuring the Effectiveness of Exergames among Gen Z using Kinect Sensor and EEG

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Abstract: Nowadays, generation Z are not interested in applying the traditional method in sports or learning activity. General observation found that primary students nowadays are eagerly using technology during learning or sports activity. Exergames using Kinect is one of the solutions to encourage the interest of generation z. This research focusses on the Effectiveness of Exergames using Kinect Sensor among primary students. The research also uses EEG measurement to prove the attention level of students during this activity. The emphasis of this paper is the student's performance and their level of focus. The signals from the EEG set are acquired while the students are playing the games and the Kinect sensor will be able to sense their movements during the session. The Kinect sensor can sense the users' whole body movement and physical activity that makes it more flexible in terms of area of monitoring. Finding from previous research shows that Exergames using Kinect Sensor is more fun and relaxing to increase the attention level of primary students.

Keywords: Kinect sensor, EEG, Exergames

1. Introduction

In this modern era, technology has become a major part of our lives. Nowadays, technology can attract the attention of generation z in many games and activities (Hasdina, Azrina & Azrul, 2019). Generation z or Gen Z are the generations born between the years 1995 to 2012 (Finco & Maass, 2014). In 2020, they are now eight years old to 25 years old. This generation is more prone to the usage of technology in their daily life compared to other generations. The main objective of this research is to measure the attention level among students during their studies and other activities such as sports activities. This case study will be focused on primary students.

Exergames are games that involve physical movement or gross motor activity (Barry et al., 2014). Exergames refer to the simplified version of the term "Exercise Games". Exergames have evolved from a simple touch-based game console system in the 1980s to the current system which is integrated with a movement sensor that can track bodily movement (Finco & Maass, 2014). The impact of Exergames on the quality of life, rehabilitation and motivation has been proven by multiple studies such as (Fairuz et al., 2018; Jauhar et al, 2015).

Focusing problem among the primary school are nowadays more increase and concerned many parties especially parents and teachers. Common signs that can detect the child are having trouble focusing in their learning are low grades, a dislike of school and disruptive behavior in class. There are many factors why primary students cannot focus on their learning and the other activities such as lack of practice, lack of motivation, learning difficulties and not getting proper sleep or nutrition. The main objective of this research is to measure the attention level among students during their studies and other activities such as sports activities. This case study will be focused on primary students.

Kinect is a motion-sensing device from Microsoft. It consists of an accelerometer, a color camera, a microphone array, and an infrared camera and sensor. Natural User Interface (NUI) allows users to interact with a console or computer using body gestures and spoken commands with the help of the Kinect sensor. Kinect comes with a software pipeline that converts information coming from the infrared depth camera into the skeleton joints in the human body in real-time and therefore is capable to recognize and track a human body (Cristina & Late, 2015).

Figure 1 shows the Kinect sensor that has been used in this research. This Kinect sensor is able to meet all the requirements that are needed for this research such as body movement detection and more flexible physical attribute. Figure 2 shows the headset that is provided by NeuroSky Technologies called the Mindwave Mobile Headset that will detect the brainwave signals from the subjects (Gruzelier et al., 2014).

Figure 1. Kinect sensor by Microsoft Xbox

Figure 2. Mobile Headset

The activities of the brain cortex reflect the state of the brain. The best way to read the brain's activities is by using a non-invasive recording device that is positioned over the scalp named Electroencephalogram (EEG) (Nunez & Srinivasan, 2019). The information in the nervous system is conveyed via ionic current flows which in turn causes electrical activity (Cristina & Late, 2015). This paper focuses on measuring the level of attention using the NeuroSky Mindwave Mobile Headset.

The paper is ordered as follows: Section 2 presents the related works, followed by section 3 which explains the methodology of this paper. The explanation of EEG analysis is described in section 4. In section 5, an experimental study is presented and finally, section 6 concludes the paper.

2. Related Work

Having full attention is one of the key elements that ensure the students can achieve excellent performance in the classroom or sports activities (Yuhanim et al., 2018). In (Astaras et al., 2013), neurophysiological assessments based on individuals' brain signals are investigated using the EEG technique. In (Adam, Yusuf & Ahmet, 2015) real classroom setting, this technique is being used during learning to measure the attention level of students. In (Gruzelier et al., 2014) to make sure if the EEG will be able to increase the music performance, attention, and well-being in school children. In this study, EEG is used to capture the result of students' attention levels while playing Exergames.

Exergaming tools have their characteristics and functions. Most popular and commonly used by people now are Nintendo Wii, Playstation Move, and Microsoft Kinect. In this part, the author will explain and discuss the Kinect tools with other different tools to prove that Kinect tools are the best to capture data automatically.

2.1 Playstation Move

Playstation Move is a motion-sensing games controller developed for the gaming console Playstation 3. The device uses six-axis sensors that have a detection camera built-in XYZ-axes (Gholamitooranposhti et al., 2012). When the user moves the Motion Controller, the user movement will be detected by using Move Eye. Motion Controller will give feedback and vibration to the Move Eye sphere which in turn, will change color. In this device, both visual and acoustic data of the user are captured by using its three-dimensional gyro sensors, three- dimensional acceleration, and a geomagnetic sensor. Moreover, the device can receive and analyze three- dimensional information of acceleration, position and rotational angular of the controller because equipped with high resolution for visual data capture. This device also has better hand recognition as the construction is three- dimensional, additional high robustness and high spatial resolution although the other functions are similar to the Wii.

2.2 Nintendo Wii

A handheld device that uses the Playstation Eye camera to track its position via the remote controller is known as Nintendo Wii. With the addition of the Wii Motion Plus Console, the user can be tracked by the motion detection through the six-axis sensors. This makes it capable of detecting three-dimensional data using its three-dimensional gyro features to obtain information of acceleration and rotational angular of the controller by using the axis of detection on the x-axis and y-axis through the infrared sensor. When the user communicates with the sensor using the device's buttons, the device will receive audio and vibration feedback. The device has a secondary controller and has wireless functions that must be tethered to the Wii remote. The user's hand gesture and movements are specifically focused on the device other than the pathway of the controller's movement. Outstanding games have been developed for Wii however some of the games are quite lackluster (Hafeez, A. et al., 2014).

2.3 Microsoft Kinect

A controller free sensor that can track the user's body movement is known as Xbox Kinect Sensor. The capabilities are similar to the Playstation Move as this sensor also has a camera. It can sense the users' whole body movement and physical activity and more data can be captured which makes it more flexible in terms of area of monitoring. Kinect tools are divided into the Software Development Kit (SDK), Windows Hardware, and Kinect Tools and Resources which explains by Windows Developer Center. SDK 2.0 allows users to create applications and experiences that support gesture and voice recognition through the usage of programming languages such as C++, C#, Visual Basic, or any other Windows Store projection which are the current version of SDK. SDK provides some samples with access to the full source code, Kinect Studio, and resources to aid beginning programmers and developers in application development. (Zhang, Z. 2014).

3. Methodology

Figure 3 shows the Graphical Methodology used in this experimental study. Step by step has been framed to make sure the activities to collect data are done smoothly. The sample will first be taken and the attention level of that sample will be tested using the headset. Kinect sensor can sense the attention level based on the movement of the sample. EEG will then be recorded according to the wave that has been generated by the sample. The next step is the EEG Signal Data Acquisition. In this step, the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure or sound. Then the data will be analyzed to obtain more information. The final step is to obtain the results of the previously analyzed data. A conclusion will then be made by using the result that has been generated.

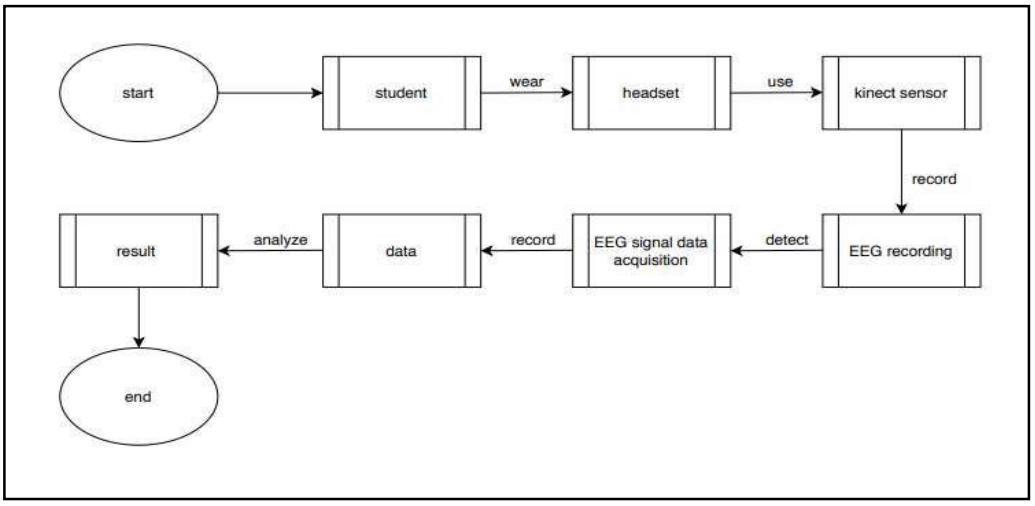

Figure 3. Graphical Methodology

4. Experimental Setup

This test was held in primary schools in Selangor which involves SK Desa Putra, SK Bangi and SK Bandar Tun Razak (1). About 80 students were tested to measure the Effectiveness of Exergames using Kinect Sensor with EEG. The students played a car racing game. For each session, two students played the game together. They wore the headset that measures the wave of attention level. This headset measures the EEG wave and the data will be captured by using the software called EEG Analyzer. Figure 4 shows the result of the student's attention level that was captured by the EEG Analyzer.

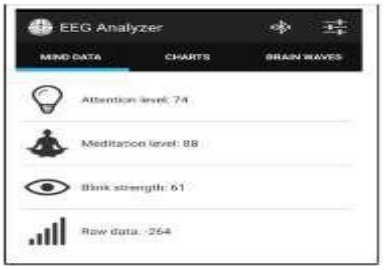

Figure 4. Data that is captured by EEG Analyzer

Figure 5. Respondent using the Kinect sensor

Figure 5 shows the respondent playing the games using the Kinect sensor. The students will stand up and play car racing games. The kinetic sensor can sense the movement of the students while the students are playing these games and the headset will count the attention level of the student. The time taken to capture the data will take about five minutes.

Table 1 shows the measurement category of attention level. This table has five categories. First is great attention which is the attention level at 80-100. Next, is the good attention which shows the attention level at 60-79. Category neutral is also one of the measurement categories which shows the attention level at 40-59. Less attention and Poor attention are also included as measurement category which the attention level at 20-39 and 1-19.

Table 1. Measurement category of attention level

Attention Levels	Category
80-100	Great Attention
60-79	Good Attention
40-59	Neutral
20-39	Less Attention
1-19	Poor Attention

5. Results and Discussion

This section discusses the result of the attention level achieved by the respondents playing games using the Kinect sensor. Table 2 shows the data collection of the respondents using the Kinect sensor divided according to the schools. This table shows the attention levels, category of attention level and the number of respondents from the three schools.

Table 2. Respondents using the Kinect sensor by schools

Attention Levels	Category	Percentage of respondents		
		SK Desa Putra	SK Bangi	SK Bandar Tun Zadak(1)
80-100	Great Attention	0	0	0
60-79	Good Attention	39%	36%	37%
40-59	Neutral	57%	40%	33%
20-39	Less Attention	4%	24%	26%
1-19	Poor Attention	0%	0	4%

Figure 6 displays the graph that all respondents achieved by using the Kinect sensor in schools. The schools that are involved in this paper are SK Desa Putra, SK Bangi and SK Bandar Tun Razak (1). Based on the activity, the attention level that is achieved for the majority of students from three schools are in category neutral. This category falls in attention level at 40-59. This is proven by the values of 57% from SK Desa Putra, 40% from SK Bangi, 33% from SK Bandar Tun Razak (1), which is the highest percentage involving 35 students. The second highest attention level is Good Attention in level 60-79. The percentage of students at this level is 39% from SK Desa Putra, 36% from SK Bangi, 37% from SK Bandar Tun Razak (1) which involves 30 students from the three schools. For the category of Less Attention in level 20-39, the percentages of students are 4% from SK Desa Putra, 24% from SK Bangi, 26% from SK Bandar Tun Razak (1) that implicates about 14 students. For the last category, the attention level of Poor Attention is in between level 1-19. Only one student from SK Bandar Tun Razak (1) is involved in this level. This is because the activity was held in the open area. So the respondents are in a crowded situation and are disturbed by their friends. Due to this, the attention level became poor. The Great Attention Level is not achieved at any school. The surrounding factor of this result shows that the respondents are unable to fully focus during this activity. From the observation, the space at the SK Desa Putra is limited compared to other schools such as the open area at SK Bandar Tun Razak (1). This is one of the reasoning as to why the Great Attention level cannot be achieved.

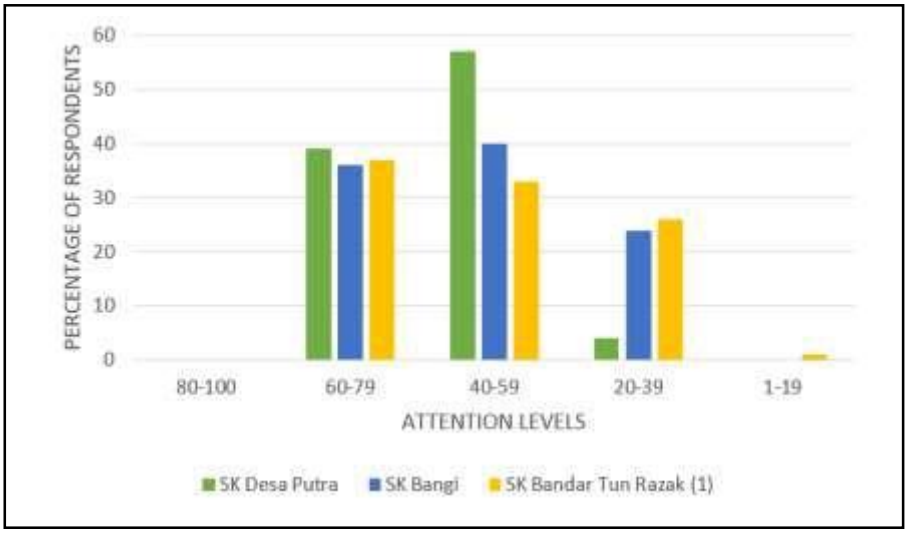

Figure 6. Graph respondents using the Kinect sensor by school

Table 3 shows the data collection respondents using the Kinect sensor from three schools. This table will show the attention levels, category of attention level and the number of respondents.

Table 3. Total Respondents using the Kinect sensor

Attention Levels	Category	Number of respondents
80-100	Great Attention	0
60-79	Good Attention	30
40-59	Neutral	35
20-39	Less Attention	14
1-19	Poor Attention	1

Figure 7 displays the graph that all respondents achieved by using the Kinect sensor. Based on the activity, the attention level that is achieved for the majority of students are in the neutral category. This category falls in attention level at 40-59. This is proven by 37.5%, which is the highest percentage that involves 30 students. The second highest attention level is Good Attention which is level 60-79. The percentage of students that are at this level is 43.75% which involves 35 students. For the category of Less Attention which is level 20-39, the percentage of student are 17.5% that implicates about 14 students. For the last category, the attention level in Poor Attention that in level 1-19. The percentage of students in that category is 1.25%. The Great Attention Level is not achieved at any school. From the previous discussion, the main reason that the students are unable to fully focus during the activity was the environmental factor.

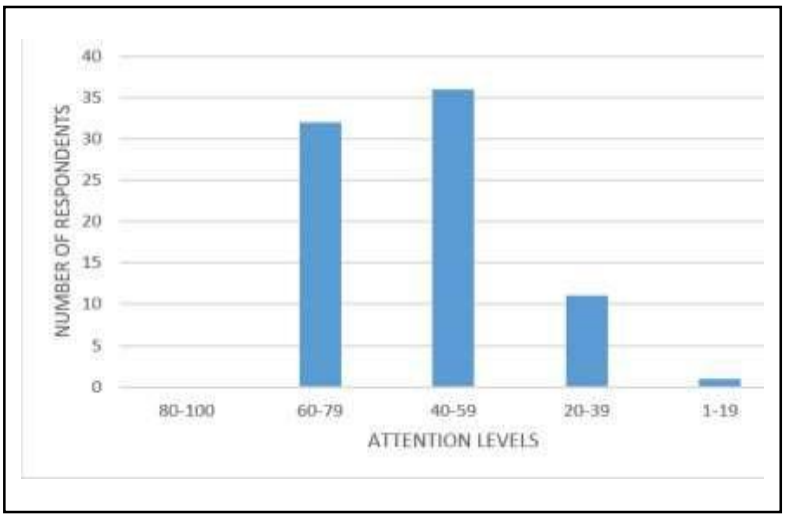

Figure 7. Graph respondents using the Kinect sensor

6. Conclusion

The purpose of this paper is to measure the effectiveness of Exergames using the Kinect sensor among Gen Z. In this study, the emphasis was given on the primary students in three schools. The EEG headset will capture the focusing attention level while the students are playing a racing game. Findings for this study has proven that the attention level of students using technology will increase. In a nutshell, Gen Z tends to use technology in daily activities. By relying on this research, an idea can be given to the educators to add technology equipment when teaching and learning activities. For example, an interactive software such as augmented reality or virtual reality can be use. For future research, the authors are aiming to measure the emotion level of Gen Z using Exergames with the Kinect sensor.

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