Profiling Students for Effective Learning based on Neuro-Physiological Interface of Affect

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Abstract: Many developing countries are looking at means and ways to implement inclusive education, although, most do not seem to understand on the way to handle different learning abilities of individuals. Normal children with average learning capabilities may be generalized to a common learning experience but individuals with Learning Disabilities (LD) cannot cope with the learning capabilities of the normal children. It is thus, important to introduce personalized learning for individual such that students with different LD can effectively learn at their own pace, although, in an inclusive environment. Thus, this study takes the opportunity to understand the brain functionality and to allow student to be profiled for differentiated learning experience. The availability of Electroencephalogram (EEG) devices and its ability to measure and capture brain waves for analysis makes it easier for researchers to use them in understanding the functionality and state of the brain. The mobility and low-cost EEG devices, recently, makes it attractive for researchers and teachers in the long run to provide profiling of every students. In general, this can help students to self-pace their learning experience. Moreover, various engineering tools and method were also introduced to improve the performance of the detection system for early childhood developmental disorder. In this research, 10 students with Autism Spectrum Disorder (ASD) and normal children were measured for brain wave pattern differences through, the use of EEG in detecting ASD. An extended application of the EEG processing using the neuro-physiological interface of affect were also, used to understand behavior through personality traits providing new avenue and possibilities of profiling students effectively.

Key words: Inclusive education, profiling, Electroencephalogram (EEG), Autism Spectrum Disorder (ASD), Neuro-Physiological Interface of Affect (NPIOA), personality traits

INTRODUCTION

In the UNESCO 2030 agenda inclusive education should be able to provide opportunity for all children to be given same or similar training irrespective of culture or background. Children with differing learning abilities need to also be provided with enough opportunities for them to be able to cope with the need and challenges of the differing learning outcomes. Nevertheless, studies have shown that inclusive education does help students with disabilities to mingle with the rest of the normal students thus, improving their language skills. Figure 1 shows from the National Center for Education Statistics, (NCES, USA last updated April 2018) that under the Individual with Disabilities Education Act (IDEA) students with learning disabilities were about 34% while students with social interaction problem were about 15% (autism and intellectual disability). Thus, it is important that inclusive education also provides general enough education for everybody and yet specific enough, so that, students with disabilities can also cope with their specific training needs. Inclusive education should be able to provide better opportunities for children to be able to learn at their own pace and yet provide the inclusive environment. Such exposure in the inclusive classroom can help them be ready to simulate their future community life as children and adults. In addition, inclusive education provides equal educational opportunities for all which has been a major focus and challenge for many education systems worldwide (Navarro *et al.*, 2016).

Since, inclusion expresses commitment to educate a child, to the maximum extent appropriate, in the school

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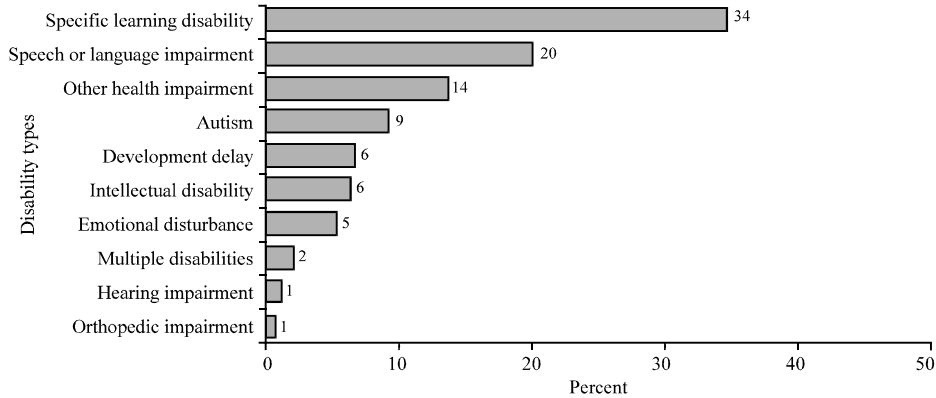abdulwahab@iium.edu.my

Fig. 1: Percentage distribution of students ages 3-21 served under the Individuals with Disabilities Education Act (IDEA), part B by disability type: school year 2015-16 (US Department of Education) (USDA., 2017)
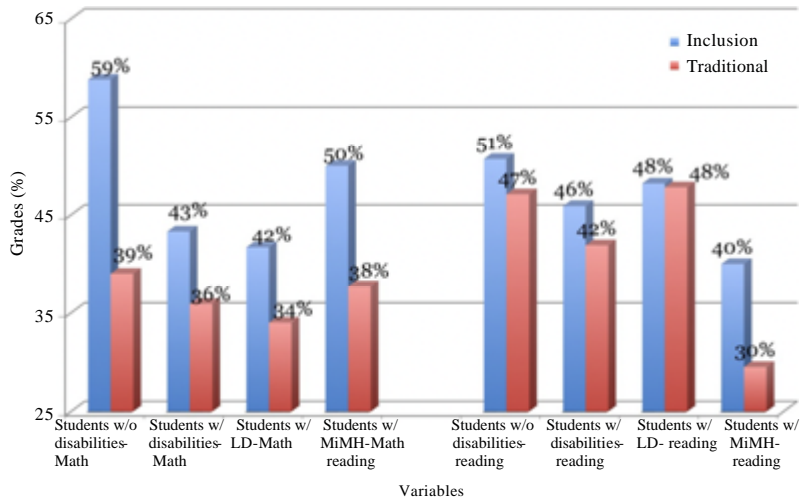

Fig. 2: Percentage of student's grade 'improvement' over a year (Waldron and Cole, 2000)

and classroom he or she would otherwise attend. It involves bringing the support services to the child rather than moving the child to the services (Causton-Theoharis and Theoharis, 2009). Unfortunately, the idea of a "one size fits all" classroom has often caused the downfall of the inclusion movement. Specialized services and placements for students with specific training needs should be able to provide their "free appropriate public education." There are many teaching strategies that are proven to be effective in education, through, academic and social aspects such as cooperative learning, constructivist activities and problem solving, which can be implemented (Holahan and Costenbader, 2000). As can be seen from Fig. 2 the study done by Indiana Institute of Disability and Community shows and improvement of students with learning disabilities in the inclusive setting environment (Waldron and Cole, 2000).

The same classroom settings and curriculum cannot be used and claim to be supporting inclusion. Administrators and teachers need to be well trained in the inclusive education settings with specialized training needs and expertise in handling different types of learning disabilities. Thus, it is important that students with different Learning Disability (LD) need to be profiled, so that, specialized and individualized training needs can be programmed. Especially, students with comorbidities would require multi-level training needs as generalized training will not work at all for them in fact it will have adverse effect. It is important to create personalized or suitable lessons for students with different learning disabilities such that they can manage to learn at their own pace or learning momentum even in an inclusive environment. Therefore, this study aims to understand the brain functionality and to profile the children in order to differentiate their learning experience.

Literature review: Children with learning disabilities are often overlooked in their learning process which resulted as slow performers and affected their self-esteem with their disabilities compared to other with typically developing children. Throughout the challenges and issues with the inclusion, the Centre for Applied Special Technology (CAST) has introduced a widely used framework for teaching which is the Universal Design for Learning (UDL). The framework aims to help teachers in improving and optimizing their lessons with the specific guidelines of educational design for all learners based on scientific insights of the learner types (Gordon *et al.*, 2014).

Even though the UDL framework is often included and also goes well beyond accommodations for students with disabilities, some might have different ideas or thought in the controversy that the inclusion education could have. One of the study stated that the way forward for the inclusive education could be improved by involving the placement of the learners which focus and include those disabilities learners with suitable instruction and most likely skills and environment in the general education can be more effective rather than putting them into the heterogeneous number of typically developing learners (Kauffman *et al.*, 2016). In order to have a better inclusive education, the improvement could be made to see the real progress and needs to remember the struggle of the old days in achieving an appropriate education of the children with disabilities (Martin, 2013).

Kurtts and Gavigan (2017) highlighted that the bibliotherapy approach is a useful strategy which is the process that provided literature in therapeutic ways to have a better understanding of children and young adult associated with the disabilities issues. The literature has been addressed the needs of disabilities children at the same time could help those typically developing children to understand the lives of special needs children other than that quantitative Electroencephalogram Neurofeedback (qEEG NF) was conducted by Cavanagh and Frank (2014) in which they correlated the brain signals with the EEG functional deficits of individual quantitative evaluation to enhance the brain functions rather than traditional and observable identification.

Thus, this study investigates Autism Spectrum Disorder (ASD) as one of the learning disabilities and how detecting ASD can be used to profile students with LD. In addition, Electroencephalogram (EEG) based Neuro-Physiological interface of Affect (NPiA) was also, used to in understanding behavior through, personality traits in order to profile LD children.

MATERIALS AND METHODS

EEG studies have shown that linear regressions of high functioning children with ASD showed a decrement in the theta/beta ratio of interest, while the relative power of gamma showed an increment during the neurofeedback (NFB) training sessions. Moreover, EEG activity also can be measured by the relative power or absolute power of EEG in differentiate the abnormalities which refer to their frequency bands. This view is supported by Jun *et al.* who suggest the U-shaped profile of abnormal functional connectivity pattern between ASD and healthy person with excessive power in frequency bands.

EEG-based serious games are relatively new to the research community and they have proven their ability to make a significant differences in rehabilitation. An EEG-based serious game that targets ADHD symptomatic individuals to augment their focus (Alchalcabi *et al.*, 2017). A study by Van Doren *et al.* concludes that theta/beta training in ADHD children with the short-term of neurofeedback (NF) could be valuable and economical to study the NF-associated plasticity mechanisms in the clinical disorders.

Developmental dyslexia are often undetected as they seem to be normal in others except for their disability which causes trouble in reading and writing despite average intelligence. Most of the research highlighted that children with neurodevelopmental dyslexia may cause by sensory dysfunction. Study suggested that the identifying of the developmental dyslexia basis should begin from infancy with their sensory processes in order to have the high impact of remediation (Goswami, 2015). A recent study by Perera *et al.* (2018) have examined the advantages and disadvantages of features and classifiers of Electroencephalography (EEG) based frameworks and integrated the reading-related and writing-related tasks in the experimental protocol of data collection might assist the framework to be better for the developmental dyslexia.

RESULTS AND DISCUSSION

Figure 3 shows the experimental setup in detecting the various learning disabilities but in this study only ASD results will be discussed. Data collected from the brain wave of 15 subjects were collected and analyze off-line to see, if the subject has potential of being ASD. Two type of experiments were carried out in order to understand and analyze the subjects based on the Neuro-Physiological interface of Affect (NPiA). The
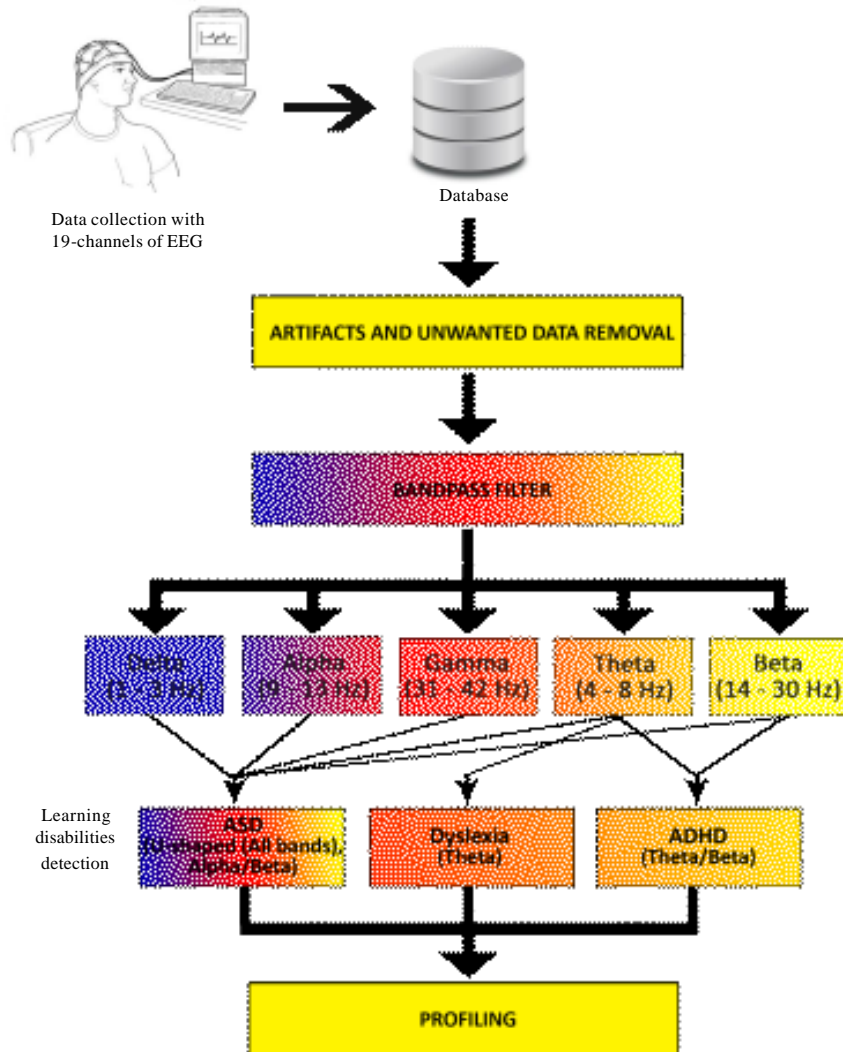
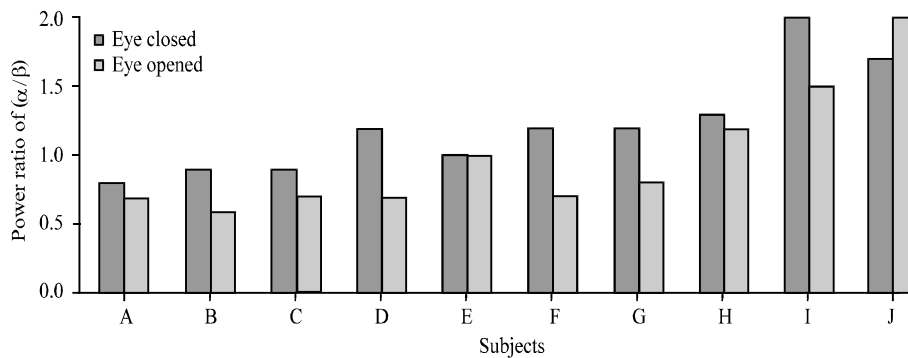Fig. 3: Methods of study: data collection, data analysis and profiling

Fig. 4: Power ratio of alpha over beta for ASD detection

power of alpha and beta wave was calculated from the EEG of the frontal areas and plotted as shown by Fig. 4.

Data collection and analysis: Data collection was carried out involving 10 children age 9-13 years old from Yayasan Kita dan Buah Hati (YKBH) in Jakarta, Indonesia.

The EEG device, BrainMarker which has 19-channels was used in order to measure the EEG resting state, eyes closed and eyes opened. Elliptic filter was used to eliminate low frequency of ocular artifact with the 250 Hz sampling frequency (Razi *et al.*, 2017). The EEG frequency bands used for this study are Delta is 1-3 Hz, Theta is 4-8 Hz, Alpha is 9-13 Hz, Beta is 14-30 Hz and Gamma is 31-42 Hz (Wang *et al.*, 2013; Lomas *et al.*, 2015).

CONCLUSION

In this research, potential of using the NPiA to detect students with ASD and in fact experiments were also, carried out to detect children with dyslexic and ADHD as part of our understanding and analyzing learning disabilities for profiling. In addition, five factors behavior were correlated to EEG based NPiA modelling to derive the five behavior or traits using the EEG signal analysis.

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