Providing Augmented Reality Based Education for Students with Attention Deficit Hyperactive Disorder via Cloud Computing: Its Advantages

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Abstract— **Providing education for students with attention deficit hyperactive disorder (ADHD) is a challenge. These students need a special approach compared to normal students. They are known to have limited attention span and easily distracted. One way information sharing where an instructor is the source of information is not suitable for them. A learning module that can simulate their interest and catch their attention is needed to ensure an effective learning session. Research shows that usage of augmented reality (AR) in education receives positive feedback from students and teachers. Students are excited on the interactive aspect of AR and the freedom for them to explore the subject of study within a safe environment. On the other hand positive responses are received from educators on the effectiveness of AR based module in supporting learning sessions. AR allows the virtual object and real world to coexist, allowing the object of study such as atomic structure to be brought to life, thus, breaking the boundary of space and time. This enhances the students understanding and memory. Cloud computing technology enables a location independent computing where the computing resources, software, and data are stored in the cloud. This provides more efficient information sharing among global internet users. Our project aims to provide AR based courseware for ADHD students so that a better education can be provided for them. We would also like to explore the possibility of providing this courseware via cloud computing, thus allowing it to be reach by wider target group and solving the issue of storage capacity. Hence this paper is looking into this issue.**

Keywords— **ADHD, augmented reality, cloud**

I. INTRODUCTION

Attention deficit hyperactive disorder (ADHD) causes a child to be inattentive, easily distracted and impulsive. Hence an education plan for these students need to simulate their interest and able to grab their attention. A learning module using Augmented reality (AR) is able to do so.

AR technology allows virtual objects appear to coexist with real world. It had been used in education through projects such as; Construct3D for math and geometry, educative games like 'Mystery at the Museum' and 'Environment Detectives' and MARIE. These works are highlighted in [20]. The usage of AR in education is able to capture students' attention and motivate them.

However AR is a computationally intensive technology [22] and the mobile devices used to provide AR application are normally equipped with limited processing power and storage capacity. Therefore this paper looks into the advantages and issues of providing AR based education through cloud computing. Before that AHDH is discussed on in section 2, followed by special needs education in Malaysia in section 3. The application of AR in education is briefly reviewed in section 4. This work is concluded in section 6.

II. ATTENTION DEFICIT HYPERACTIVE DISORDER

ADHD is a type of learning disability that causes the person to become less focused and easily distracted. KDISC [1] reported that 5 out of 100 newborns may have ADHD symptoms and might need educational intervention to support their learning as they grow. There are three common symptoms among students with ADHD[1]:

1) Inattentive type: the student cannot focus or stay focused on a task or activity. This disorder is more frequent with girls.
2) Hyperactive-impulsive type: the student is very active and often acts without thinking but does not show significant attention problems. This usually occurs among boys.
3) Combined type: the student is inattentive, impulsive, and too active. This is the most common ADHD disorder.

Research conducted by Saad and Lindsay [17], shows that common characteristics of students with ADHD are:

- Impulsive
- Frequent day dreaming
- Lack of interest
- Forgetful
- Moody and overly sensitive
- Lack of social skill and communication skill
- Aggressive and overly active

In order to overcome these ADHD characteristics, researchers must find out ways to improve the interaction between the content and the learner. Static form of information is found to be not effective with ADHD students [2]. On the other hand, strategies such as multimedia, interactivity, and animations were found to be helpful in providing the motivation for the students to stay focus and learn [3, 4, 5]. These students also response better to outdoor activities and more motivated when praised and rewards are involved [17].

III. SPECIAL NEEDS EDUCATION IN MALAYSIA

Based on Malaysian People with Disability Act 2008; formal education should be made available for people with disability. Education for these students is provided by the Malaysian government through the Ministry of Education (MOE) as well as Ministry of Women, Family and Community Development (MOWFCD). The division of responsibilities for providing educational services between the two ministries is according to the type of disabilities (see Table 1). The government aims is to provide the students opportunities to pursue their education to the highest level possible, secure employment and live independently. Guidance is provided by a number of policies such as the Education Act 1996, Education Act (Revised) 2002, Education Regulations (Special Education) 1997, United Nations' World Programme of Action Concerning Disabled Persons (1983), World's Declaration on Education for All (1990), Framework for Action on Special Needs Education (Salamanca Statement) 1994, and Biwako Millenium Framework for Action Towards an Inclusive Barrier-Free and Rights-Based Society for Persons with Disabilities in Asia and the Pacific (2002).

The education plan for the special needs students are provided based on their disabilities which are categorized into three groups [18];
- students with hearing disability,
- visual disability, and
- students with learning difficulties.

Among the students categorized with learning difficulties are those with Autism, Syndrome Down, ADHD and Dyslexia. The schooling period for special needs students in Malaysia is 13 years, which is 2 years more compared to mainstream system (see Table 2).

Under MOE there are two categories of special education programmes, i) Special Schools for students with visual, auditory and learning disabilities (secondary level), and ii) Special Education Integration Programme for students with visual, auditory and learning disabilities – employs both isolated and partially inclusive teaching and learning approaches (primary, secondary and vocational levels). In the secondary level the students are able to either follow the national curriculum or opt for vocational courses. The Special Schools are administered by the Ministry's Special Education Division. The Special Education Integration Programmes at primary and secondary schools levels are administered by the State Education Department. For the Special Education Integration Programme in technical and vocational schools are administered by the Ministry's Special Education Division, responsible for matters pertaining to policy and content.

Education for special needs children is also provided through community centres. These centres focus on providing education to students with more severe disabilities. The students are trained with living and basic vocational skills so that they could live independently and secure employment. These community centres are run by social welfare department.

Many efforts are taken by the government to enhance the education quality for the special education students including allocation of generous amount of money to enhance the usage of ICT.

TABLE 1. PROVISION OF EDUCATIONAL SERVICES BY MINISTRY AND TYPE OF DISABILITIES

Ministry	Type of Disabilities
MOWFCD	Severe physical disability
	Severe and mild retardation
	Multiple disabilities
	Disabilities that does not allow the children to study in schools provided by MOE
MOE	Down Syndrome
	Mild Autism
	Attention Deficit Hyperactivity Disorder (ADHD)
	Minimal Mental Retardation
	Specific Learning Disability (ie: Dyslexia)
	Special Visual Disability
	Special Auditory Disability
	Special Remedial Students

TABLE 2. SCHOOLING PERIOD FOR SPECIAL NEEDS STUDENTS IN MALAYSIA [18]

Year	Education Level
Form 5	Higher Secondary Level
Form 4	
Form 3	Lower Secondary Level
Form 2	
Form 1	
2nd Extra	
Standard 6	Primary School
Standard 5	
Standard 4	
Standard 3	
Standard 2	
Standard 1	
1st Extra	

According to [26] the MOE identified ICT strategic roles as i) the usage of ICT as middleware to minimize the gap between student and school, ii) as teaching and learning tool, and iii) increasing the productivity, and efficiency of education management system. Within the MOE there is a department - Educational Technology Division (ETP), whose focus is to develop and promote the use of educational technology amongst teachers and students in order to increase the effectiveness of the teaching and learning process. ETP plan, prepare and produce multimedia teaching and learning materials according to the national curriculum and the technology medium used include print media, radio, televisyen, CD-ROM and computer networks. ETP aims to produce around 500 multimedia coursewares a year. However, the coursewares produced are largely for normal students, only a small percentage of the titles were for special education programmes and the ones that were for special education the design approach used was no different from the ones for normal students. It appears that a gap exists in the Malaysian special education strategy i.e.: the lack of specifically designed multimedia coursewares to be used in the education of the special needs students. Furthermore, different types of disabilities will require different design strategies in order for effective delivery of the learning objectives. Coursewares designed without specific consideration of the needs of the users in the special education programmes are denying the students' access, to the opportunity to a better educational system. There is a need for more socially inclusive coursewares. This research objective is to develop a multimedia courseware for students with ADHD in MOE's Special Education Integration Programme (primary school level). It is a project funded by the Malaysian Ministry of Science, Technology and Innovation.

IV. AUGMENTED REALITY IN EDUCATION

AR is a variation of virtual reality (VR) [6]. However unlike VR where users are brought into a virtual/synthetic environment, AR merges virtual objects with the real world. Hence AR is supporting the real world rather than replacing it with synthetic environment [7].

AR can be used in learning to enhance students' motivation and attention, in addition to that the students' interaction with AR objects improves their understanding and memory [8]. By creating the magical feeling of a 3D object appearing on top of the physical world, AR gains and keeps the attention of students that is difficult in other form of education [27]. Other than these benefits, AR is able to overcome the problem of broken experiment equipment, and the students can conduct experiments in a safer environment. AR also breaks the space and time boundary and allows the object of study to be brought up to life [9].

Experiments conducted on AR learning modules such as in [8] show that AR received positive response from instructors and students. In Virtual Merdeka AR application it is found that AR elements can add heighten the excitement of the gaming experience and make it more engaging [10].

The usage of AR in the education for students with ADHD could help to capture their attention and encourage more active participation from the students. Yusof and Ab. Aziz [25] in their work suggest that usage of multimedia such as animation is able to enhance learning experience in term of:
- Cosmetic function: to attract learner
- Attention gaining function: grabbing student's attention
- Motivation function: effective feedback mechanism
- Presentation function: helping student to understand by visualization of the information
- Clarification function: clarify the concept through visual means

V. PROVIDING EDUCATION VIA CLOUD COMPUTING

European Community for Software and Software Services describes cloud computing as the delivery of computational resources from a location other than your current one [11]. Cloud computing as defined by Wikipedia is "*location independent computing where shared servers provide resources, software and data to computers and other devices on demand*" [12]. The key of cloud computing is; data and application programs are installed in the cloud servers instead of the users terminal (Fig. 1). These users are able to access the data and used the application through their terminal devices such as PCs, laptops, PDAs, smart phones etc. that are connected to the network. Cloud computing is the future of the internet. Among the advantages of cloud computing are [28]:
- Freedom: users are capable to access the contents regardless of location and service can be provided faster.
- Scalability: computing resources can be provided based on demand
- Low cost: cost of building data centre, power and cooling is minimized.
- Innovation: could computing encourage innovativeness
- Speed: computing services can be provided much faster
- Security: better security with lesser cost is available as the service is provided in a larger scale.
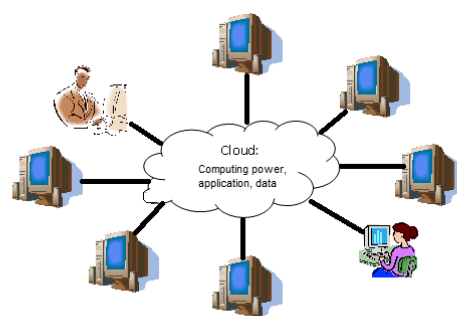

Figure 1. Cloud Computing Concept

Educational sector can also benefit from the advancement of cloud computing. Education cloud computing is the new

method of providing distance education where it provides convenient data sharing and easily access information [16]. In addition, cloud computing also offers extremely large storage ability and resolves the machine compatibility issue for educational software installation [13]. For some educational module particular software is needed, with cloud computing applications are install in state of the art servers, therefore incompatibility and outdated machine is not an issue. Cloud computing helps the educational institutions to cut cost as they do not have to build infrastructures and the resources can be purchased on demand [14]. It also provides freedom to students to determine on their own what, where and when to learn.

Example of educational cloud computing is the EduCloud project in China [15]. The project is constructed in two phase; construction of cloud platform and infrastructure and conversion of traditional teaching module to cloud compatible module.

AR Learning Module & Cloud Computing

AR field can also benefit from cloud computing. Therefore research had been conducted in convergence of AR and cloud computing [19].

AR based courseware application may be too big and take up too much of a mobile device's capacity. On the other hand, the cloud has vast storage capacity, hence providing the courseware through the cloud helps to solve this problem. AR also involves intensive processing [19, 22] which is a challenge to mobile devices, however, this is not a problem to the cloud as it has state of the art computing and processing ability. By providing the module through cloud computing the MOE does not have to equip each school with advanced computing facilities in order to enable the AR learning module to be adopted. This reduces the implementation cost.

Typically AR technology is enabled using mobile devices. These mobile devices have limited battery life, moving the computation to the cloud extend the battery lifetime [20]. Providing AR learning module on the cloud will also allow for more efficient content sharing among educators and application developers. Therefore in addition to developing the AR learning module for students with ADHD, our project suggests for the module to be made available via the cloud.

However there are certain aspects that need to be taken into consideration such as ensuring the data format of the content can be operated in multiple platforms involve [22, 23]. Other than that, AR technology normally used mobile devices, hence the quality of wireless communication need to be improved to ensure smooth delivery of content [21, 22, 23]. In addition, a proper security model to ensure privacy and integrity of content is also needed [23].

VI. CONCLUSIONS

Advancement in technology has benefitted the education system. It gives a more interesting learning experience to the students. Education for students with ADHD can also be improved with the advancement in multimedia technology. In this paper, the possibility of providing AR based education for these students via cloud computing is explored. It is believed that cloud computing is able to provide AR based education with lesser cost, more centralized, better resources and content utilization. However issues such as network's quality of service, data format and security need to be carefully addressed to ensure smooth content delivery.

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