Proceedings of the International Conference on Special Education
Vol.4 (2021) / e-ISSN 2948-4731 (463-472)
SEAMEO Regional Centre for Special Educational Needs

MULTISENSORY LEARNING USING PERSUASIVE TECHNOLOGY FOR EFFICIENT ADAPTIVE LEARNING OF CHILDREN WITH SPECIAL NEEDS SPEDATHOME PROGRAM

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ABSTRACT

More than two decades ago, a need to change the instructional direction was identified so children with special needs can be served better. According to the educational standards students with disabilities should be provided with opportunities to realize their potential. However, millions of children in poor or developing countries lack access to schools and support services. The COVID-19 pandemic has amplified this struggle. Over the last decade, technology has advanced to a great extent. Technology can be a powerful tool for assisting children with special needs and can serve as a great equalizer. Persuasive Technologies can help overcome challenges in learning and developing by revolutionizing the way education is delivered. Web 2.0 has the ability to change the way people communicate and interact. Thus, we propose a solution which combines Persuasive Technology and Web 2.0 to bring a sense of normalcy, growth, and development to their children with special needs.

Keywords: Persuasive technology, Persuasive learning, E-learning for children with special needs, Web 2.0,

1. Introduction

The term special needs cater to a wide array of diagnoses, some which may resolve swiftly, while some which may pose a challenge for life. For the rest of the paper, children with special

DOI : https://zenodo.org/record/6909928
Published by https://publication.seameosen.edu.my/index.php/icse/issue/view/4

needs are defined as children with average or above average intelligence manifesting with learning disability ADD/HD and high performing children on the spectrum. For children to reach their full potential these children with special needs require certain accommodations or modifications in the classroom. However, according to multiple reports [1,2,7] most of the children with disabilities do not get the opportunity to attend any educational institute. For the relative few who are able to attend, in spite of the efforts to make the education system inclusive their experience is often very difficult. Children with disabilities are considered as the world's most vulnerable, marginalized and stigmatized populations. The COVID-19 pandemic has caused disruption of life in every corner of the world but it's impact on children with pre-existing weaknesses is much worse. [3] The social distancing measures implemented by many countries have caused severe disruptions to daily routines with schools being suspended nationwide in 189 countries. [4] The only plausible solution is online learning which poses an additional challenge for children with special needs. Furthermore, parents of these children are forced to take up the role of a special needs teacher, occupational therapist, speech-language pathologist, behavioural therapist, and more along with fulfilling all the responsibilities they had otherwise. [5] Technology has evolved over time especially its use in education and learning. Assistive and adaptive technology, have been recognized as vital for use in instruction for students with special needs. [6] They improve the academic skills of students and promote independence of a student by reducing the constant need for direct teacher involvement. The development of Internet-based communication technology has the ability to alter the way learners communicate and interact. Blogs, social media and YouTube are some of the examples of Web 2.0 based technologies. Communication and interaction activities performed with Web 2.0 technology could provide an opportunity to be evolved into persuasion technology which can mould and improve current behaviour. [8] Thus, by combining the concepts of Web 2.0 and persuasive system a new model of inclusive learning can be devised that can better cater to children with special needs.

2. Literature Review

2.1. The KSMS Project [23]

The paper focuses on how a persuasive mobile learning application can serve as an alternative for schools. The target audience of the application is children in developing nations without access to schools or education. The project focuses on providing automation and gamification of learning and to combine HCI multimodal interaction design with persuasive design for the process. The distinctive feature of the application is that it is automated and unique. The application is not an add on to the regular classrooms but a standalone one that provides an integrated environment comprising of components like teachers, classrooms, resources, etc. They plan to do this by using persuasive technology to compensate for the non-availability of teachers. The framework for persuasive technology is divided into three main layers:

1. Learning Structure: The learning process is designed in such a way to be rewarding and consists of small achievable goals. These goals will help the end user to feel successful on accomplishing them which will finally lead to achieving the target goal.

2. Learning Medium & Infrastructure: The ARCS model of motivation is used to ensure that the user engaged with the application throughout and is motivated to progress with his studies. Virtual classrooms and learning groups are created with the help of data that is collected from devices. This formation of these groups can help in interactions between various peers and can even play the role of a teacher when one peer is helping the other one out.

3. Learning Content and scenarios: The persuasive technology is integrated with the content in such a way that the learner gets the content. For example, the data from the GPS is decoded in a way that it provides informative content to the user like suggesting words like umbrella on a rainy day. Moreover, when a user is done with a task, he will be contacted to peers having difficulty in the same task via Bluetooth to create a teacher-like atmosphere.

Strengths:

i. Results of the experiment conducted show that an application such as theirs that makes use of persuasive technology can be used as an alternative for traditional education
ii. Automation in learning

Limitations:

i. The possible challenges to the application are the absence of internet in the areas where the target population live and also to create content that meets the standards of the Central Board for Secondary education in its international version. [23]

2.2 Persuasive Technology for Enhanced Learning Behaviour in Higher Education [25]

The paper focuses on how persuasive technology and Web 2.0 can be used in amalgamation for enhanced learning behaviour. To verify the accuracy of the hypothesis in the previous sentence, a survey was conducted with 30 participants. Data was collected using questionnaires that matched the context of the user and the persuasion aspects. The questionnaire had a 5-point independent scale. The data was collected in two parts. First before the intervention and then after the intervention. Smart PLS 3 was used for data processing and to test and analyse the relevance of the variables.

The participants were grouped based on how often they used the internet in the past and if they have used learning media from the internet before. After which the users were persuaded in accordance with the Gellers model of behavioural change which included three types of interventions namely instructional, motivational, and supportive interventions and four stages of change. Behavioural changes observed with e-learning (Web 2.0) and persuasive technology change in the positive direction in most cases. Web 2.0 creates opportunities for users to connect and collaborate as a community. The concepts computer-human and computer-persuasion are combined when Web 2.0 is combined with persuasive technology. The results of the hypothesis show that there is significant positive difference in the level of understanding before using e-learning based persuasive technology and after it. [25]

Strengths:

i. Positive behaioural changes are observed when persuasive technology with web 2.0 is used for e-learning
ii. The Gellers Model is effective for positive change

Limitations:

i. The universal use of Web 2.0 technology brings a very diverse set of features; hence, the persuade may not realize it.

2.3 Awareness of Sexual Abuse Situation (ASAS) [26]

The paper focuses on an application called Awareness of Sexual Abuse Situation (ASAS) that uses persuasive technology to increase children's awareness during situations that may impact their safety. The application was built for children between the ages of 7 and 9. The design principles that were used to increase children awareness towards child sexual abuse (CSA) are similarity, simulation, attractiveness and suggestion. The application has an attractive interface to be visually appealing to the kids and has a mascot to guide the children along the way. It uses the language that is known by the child and a child's voice to meet the similarity principle so that the child feels familiar and comfortable with the application. The application also provides various suggestions that the children should be aware of if they are ever stuck in a dangerous situation. Finally, simulation is used so that the children can rehearse the behaviour without actually having to face the situation. 28 primary school students below the age of 13 were used as the target population of the experiment. The experiment confirms that ASAS has the potential to be an educational tool. Most of the participants agree that the application was useful in increasing their awareness about CSA. The paper concludes with that fact that selecting the right persuasive principles is critical in creating a persuasive learning application. [26]

Strengths:

i. ASAS can be used as an educational tool, for educating children (about CSA).
ii. The interface of the application is interesting and user friendly. This helps understand content in an easier way and enhances motivation

Limitations:

i. The study was performed on a small group. Increasing the sample size would provide more accurate results.

2.3.1 SpEd At Home Program

SpEd At Home's main goal is to create a learning system initially as a web-based solution, later as a mobile application that will be adapted for individual self-learning of numeracy and literacy skills of children based on their functional proficiency. The project targets children with special needs who have difficulty to access remedial and occupational therapy services. The main objectives of SPED at home are as under:

1. To provide a screening and assessment tool for children between ages of 6 to 13 years, to identify their numeracy and literacy functional proficiency, to build a occupational assessment therapy tool to identify the cognitive and physical deficits resulting in academic and behavioural performance area of children.

2. To design curated educational plans for children based on game architecture (to support the delivery of learning contents) to be delivered either as coach-led, parent-led or self-led track to support learning outcomes

3. To integrate persuasive design and HCI multimodal interaction design in the learning process. The main goal here is to ensure a more adaptive system that allows users perceive ease of task helping him/her control the pace of learning thus being continuously motivated to learn and have improved learning outcomes

Through this paper, we will answer the following research questions:

1. Role of persuasive technology for student motivation and perseverance.

2. Level of contextual persuasion needed in order to ensure learner centred strategy and efficient self-determined education

The proposed model uses Web 2.0 coupled with persuasive technology to help children with special needs.

2.3.2 Background

2.3.2.1 Motivation

Motivation has no single definition. It is something that helps begin goal oriented behaviour, and stay on the right track. Biological, cognitive, social and emotional forces are responsible for activating behaviour that leads to motivation. Motivation is the driving force behind every action that one takes. It is the reason why someone does something or takes any action. Every action is always fuelled by motivation.[9] Marshall H coined the term “motivation to learn” whereas the benefits the learner gets out of learning academic work irrespective of whether there is interesting. [10] Brophy, J. Has a different take to “motivation to learn.” He defines it as competence gained by an individual over the years but influenced most likely by direct instruction by mostly parents and teachers. Motivation can be divided into two categories:

1. Extrinsic motivation: Are often factors outside of an individual’s circle of control like rewards, trophies, fear of punishment, recognition, etc. [11] An extrinsically motivated student will perform well in class for praise by teachers, trophies, good grade, fear of punishment by parents, etc [12]. They might also do well due to pressure, for incentives, and other reasons. [13]

2. Intrinsic Motivation: Another word for intrinsic motivation is self-motivation.[14] It often includes one’s personal values [15]. An example would be to solve a complex Sudoko puzzle for self-high or personal gratification that the individual was able to solve the problem. [16] Thus, an individual who is intrinsically motivated takes up an activity for his/her own sake as the its provides enjoyment, learning and accomplishment to the individual. [17]

2.3.2.2 Persuasive Technology and Motivation

In order for people to change their beliefs or behaviours on their own, they need to be motivated. Persuasive technology helps them build this motivation without deception.
As tools, persuasive technology increases one’s ability to carry out a task by making it easier or restructuring it.

Many researches have been conducted on how student motivation can be managed and monitored. The one by Keller, J.M. is the most popular one. It is called the ARCS model and has four dimensions or parameters of motivation and is used to improve the motivational appeal of the course content. It stands for Attention (A), Relevance (R), Confidence (C) and Satisfaction (S). [18] It uses motivational messages to enhance the interaction between the teachers and students which helps to enhance the motivation of the students. [19] Ciampa, K [12] argues that the dimensions that cover both intrinsic and extrinsic motivation are curiosity both cognitive as well as sensitive, cooperation, challenge, control, recognition and

competition. Bobis, J., et al. [20] propose a mathematical motivational model to enhance student motivation. Their research covers topics like teaching strategies that would help motivate students to learn mathematics more effectively and efficiently. They also proposed an upgraded version of Martin, A.'s motivation wheel framework by breaking down the wheel into 3 divisions namely: maladaptive, adaptive and impeding.[21]. Fogg [22] provided a different perspective to motivation where he introduced motivators that lead to behaviour change in the Fogg Behaviour Model (FBM). They are:

i. Pleasure vs pain
ii. Social acceptance vs rejection
iii. Hope vs fear.

3. Proposed Persuasive Technology Model for Motivation

Like we discussed earlier, in order for a child to be adequately motivation, a combination of intrinsic and extrinsic motivation should be given to the child. Our application provides both of them to the child which is discussed below.

Intrinsic motivation: Our application through its assessment identifies the functional proficiency of the child for numeracy and literacy. Based on the same, an individual educational plan (IEP) is curated for the child which helps the child pick up from the point where he derailed and gets him back on the right track. This will help the students to get motivated to learn and go forward.

Extrinsic motivation: The application is gamified such that a child receives points on completing tasks such as submitting worksheets, completing quizzes and revision. These points can then be used to grow one's own dragon and defeat other's dragons which will give the children the reward they need to stay motivated.
After discussing motivation in general and how the students can be motivated through the SPED at Home application, we discuss the persuasive technologies and how they are useful for education and specifically to our application in the next section.

4. Using Web 2.0 to Engage Learners

Web 2.0 tools are applications that are based on social networking, dynamic interaction or user interfacing between information and its associated people. They are digital programs. They are interactive, easy to use, interactive platforms which can be used by students to learn, create, collaborate and share. Web 2.0 tools make learning more engaging, interactive and help facilitate students to learn course material more easily. This is because the users decide how they want to interact with create and use information
Benefits of Web 2.0 tools are:

i. Ease of use
ii. User Friendly
iii. Intuitive
iv. Increases self-efficacy of students [27]

Web 2.0 is used in education mainly because it helps with both collaborative and self-directed learning [28]

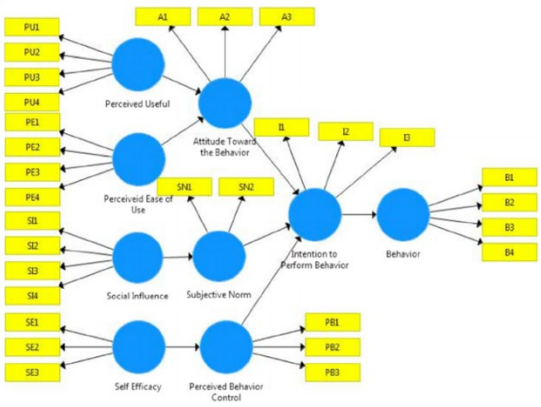
The proposed program will adapt to the proficiency level of the child, helping the user perceive ease of use of tasks and making it user friendly to keep the user motivated and thus engage with the task. By integrating web 2.0 with our program, we were able to get all of the benefits that web 2.0 provides to create a complete holistic program.

5. Proposed Model

Persuasive technology has been known to modify human behaviour in various situations. We believe this approach will be highly beneficial in the area of education and learning. The Geller's model of behavioural change states that there are three types of interventions and four stages of change. Each stage of change can work well if an intervention is carried out. There are three types of intervention in the Geller model, namely instructional, motivational, and supportive interventions.

Therefore, we propose to integrate persuasive technologies in a framework of with the above mentioned interventions. The proposed hypotheses model of Geller is used to build positive behavioural change among users. It explains the factors responsible for a habit formation and completion and continuation of a task. It is based on four tenets – Perceived usefulness of task, perceived ease of use, social influence and self-reliance. All the four tenets ensure effective behavioural change and task maintenance and sustenance. This used effectively in our model of persuasive technology with web 2.0 does make it engaging, user friendly for the children with special needs who are often reluctant to take on educational tasks. It is pictographically represented with the help of figure 1.

Figure 1. The Hypothesis Model [24]



Given below is a description of the framework and how each intervention is achieved:

1. Instructional Intervention
   We aim to provide a Multisensory instructional model which encompasses combination a of physical and cognitive along with numeracy and literacy performance areas based on functional proficiency of the child. Multisensory education is conceived as an instructional method using visual, auditory, kinaesthetic, and tactile ways to educate students.

2. Motivational Intervention
   The program provides session scores, assignment scores and overall proficiency scores, gamified for the child based on token economy and rewards to ensure adequate motivation.

3. Supportive Intervention
   All the users are screened with the help of quizzes and tests pertaining to the topics - language and math to determine their functional proficiency. Based on this score, a personalized IEP (Individualized Education Program) is developed for the child. Adequate scaffolding is ensured by initially handholding the child through a coach led support transitioning to a parent led support eventually enabling the child to function independently.

6. Conclusion and Future Work

An understanding evolved out of the presented literature review. It reveals the efficacy of persuasive technologies with web 2.0 as an effective model across various target populations towards improving engagement and learning outcomes. The SpEd at home model therefore can be viewed as an experimental program to be based on both persuasive technology and web 2.0 to allow access to education and ensure better learning outcomes for children with special needs. Future work would include to create and curate a pilot study to study this proposed multisensory learning program using persuasive technology for efficient adaptive learning of children with special needs.

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