ORIGINAL ARTICLE

PROPOSED ROBOTIC-BASED MODEL FOR SLOW LEARNER'S LEARNING

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ABSTRACT

Learning is important for the development of children with special needs. Slow learners, which are included in the special-needs category suffer from extreme timidity thus making them unable to actively involved in learning sessions. It is important for them to actively involve in the learning activities as it affects their academic achievement. This study involves two phases of activities which are; Phase 1, identification specification through literature review and expert interview, and Phase 2, model development. From the specification identification phase, suitable elements and components are identified, gathered, analysed and organised to prepare a comprehensive model. Therefore, a robotic-based model for slow learners' learning is proposed. The model consists of the elements and the components that emphasize interactive student-centred learning. The model is derived from Care-Receiving Robot, Social Development Theory and Triple-D Model which consists of the teacher (More Knowledgable Other), the student, the robot (Care-Receiving Robot), learning by teaching to invoke student-centred learning, and evaluation (Triple-D Model).

Keywords: *Slow learner, student-centred learning, robotic-assistive learning tool*

INTRODUCTION

Children with special needs in Malaysia are categorized based on three categories: hearing impaired, visually impaired and learning disabilities (LD). Learning Disabilities consist of Specific Learning Disabilities (Dyslexia, Dysgraphia and Dyscalcula), Autism, Down Syndrom, Attention Deficit Hyperactivity Disorder (ADHD), Intellectual Disabilites and Slow Learner[1].

This research will focus on slow learners. Slow learners are the children that have an IQ score of 70 to 85[2,3] while typical children would have the IQ score of 90 and above. Like children with LD, slow learners seem to show inability to be independent, have extreme timidity, unable to make decisions and low self-confidence[4]. Therefore, to eliminate these problems, slow learners need to participate and engage more in learning activities[5]. These challenges make them unable to actively participate in class. Participation in class is very important for their development as it positively affects their academic achievements[6,7]. Through active participation in learning activities, the confidence level of slow learners might be enhanced thus making them independent and does not depend fully on their teachers. As mentioned by[8], there are factors contributing to student engagement which includes family factors, school factors[9] and peer factors. It can be concluded that student engagements influence students's positive academic achievements, emotional and behavioural developments. Therefore, the focus should be directed to the students' engagement in education.

Currently, the research on technology integration in slow learners' education is scarce[10,12]. There are several models and frameworks related to education developed for slow learners. Even so, the review of previous studies revealed that the models and frameworks[10,11,13] developed for slow learners do not emphasize on the student's direct participation component. Both of the reviewed frameworks developed[11,13] are not yet validated. Additionally, technological approaches for slow learners are available but these approaches use tablet technology courseware[14,16] which focuses more on device-centered component compared to student-centered component. These slow learners usually act as the user instead of the doer or the controller of the situation[17]. Hence, giving active roles to slow learners may create the possibilities of more engagement in learning.

This study proposes a robotic-based model for slow learners' learning. The model refers to the involvement of a robotic application in facilitating learning for slow learners. The model emphasises on the direct involvement of the slow learner in the learning sessions. Based on the review of existing models and framework for slow learners' learning, direct involvement component are not critically emphasized. Therefore, since there is a limited concentration on the component, further exploration is needed to ensure slow learners are engaged in learning sessions.Therefore, this study is conducted to answer the following research questions:

- What are the challenges that slow learner face in learning?

- What are the potential theories or concepts that can be adopted to solve the identified problems?
- How can the robotic-based model be developed?

LITERATURE REVIEW

A. SLOW LEARNERS

Slow learners as mentioned before are the children that have slower thinking rate than their typical peers which make it harder for teachers to help them[18]. That is supported by[19], which states that these slow learners are struggling to cope with conventional methods used in the regular classroom due to their below-average cognitive capabilities. Cauhan (2011) mentioned that these students have problems expressing their ideas, in term of finding and combining appropriate words. Thus, they do not usually participate actively in the classroom. Due to this problem, Novitasi et. al (2018) suggested that the increase in teaching and learning activities are able to enhance slow learners' learning achievements and learning outcomes. In order to deal with slow learners, *Paul*[21] listed several tips for effective teaching. The tips that are suitable for this research includes creating a fun atmosphere by using new teaching techniques, develop a helpful plan, and provide opportunities for them to show their capabilities.

B. CARE-RECEIVING ROBOT

The term Care Receiving Robot (CRR) is defined as the robot that is provided with care from people around the robot[22]. The word "care" in this concept carries several meanings that include, instruction, help, attention, and cooperation[23]. To invoke caretaking response, the robots show incompleteness or weakness such as answering the questions with a wrong answer or falling down. It promotes automatic learning by allowing the children to teach the robot the stuff that they know[24]. CRR is a type of interaction that is more rewarding and appropriate compared to a childcare-robot interaction where robots have the role of human caregivers[25,26]. Generally, it is a type of robot designed to reinforce children' learning by teaching[26].

Figure 1 shows the conceptual diagram of the application of the care-receiving robot in supporting children's education which consists of three main entities; the teacher or the parents, the children, and the robot. The teachers or parents first decide on the topic that the student will learn. The student is then asked by the teacher or the parents to teach the selected topic to the robot. The robot either pretends as if they are weak or make errors on purpose to invoke the children's caretaking response. The children then teach the robot and there's a possibility that they can learn that topic by teaching the robot[23,24].

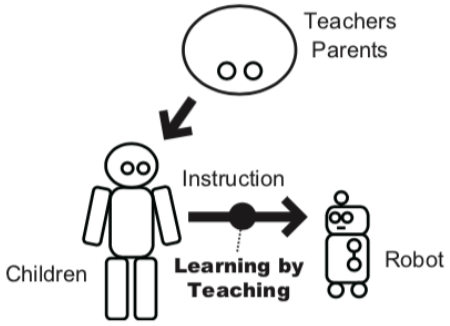

Figure 1. Conceptual diagram of the care-receiving robot in supporting children's education adapted from *Tanaka et. Al*[22]

These aforementioned researches mostly mentioned the learning behavior, children's performance, learning interest and attention, but not in the context of direct involvement of the children. Even there are researches conducted a study to verify the feasibility of using CRR in education, there is still limited research in this area[27]. Thus, in this research, the effectiveness of the CRR robot in term invoking direct involvement of the slow learners will be investigated further. The teacher, the slow learner and the robot are the main elements of the proposed model. The slow learner wil act as a teacher and teaches the robot on a selected topic.

C. SOCIAL DEVELOPMENT THEORY

Jean Piaget and Lev Vygotsky developed theories that cater children' cognitive development and learning. Vygotsky believes that knowledge is developed through the process of social interaction and dialogue[28]. On the other hand, the Theory of Cognitive Development by Piaget explains that children learn from the environment through observations[29]. However, *Charlop et. al*[30] states that social interaction is a powerful tool for children' learning and development. With successful social interaction with others, it provides more motivation and context to learn more[31]. It is also supported by [32], which states that socializing including caring for others are able to yield positive learning development. Therefore, it can be concluded that, Vygotsky's theory which states that social interaction influences cognitive development is more suitable to be employed in this research rather than Piaget's Theory of Cognitive Development.

The three major themes of the Vygotsky's Social Development Theory; social interaction, the zone of proximal development and the more knowledgeable other (MKO) are further discussed:

i. Social Interaction

Vygotsky believed that social interaction plays a vital role in the cognitive development process. While Jean Piaget believes that developments

come before learning, Vygotsky considers that learning comes before development[33].

ii. The Zone of Proximal Development (ZPD)
The Zone of Proximal Development (ZPD) is the exploration area for which the learning process occurred. The students are prepared cognitively, but they require help or guidance from adult and/or with collaboration with their peers. Basically, the learners learn and internalize new concepts, psychological tools and skills while collaborating with a more skilled person[34].

iii. The More Knowledgeable Other (MKO)
The More Knowledgeable Other (MKO) concern to anyone that is more skilled and has a better understanding than the learner on a particular process, concept, or task[33]. The learner learns promptly and actively with the presence of MKO compared to when the learner learns independently. Thus, it shows that there is a big difference in the learners' development[35].

D. TRIPLE-D MODEL

There are limited numbers of publications on planning and teaching special education students. The Triple-D Model is a framework that is designed for special needs students that embrace students with most types of disabilities such as learning disabilities, deaf, dumb and autism[11]. The model involves three components; Diagnostics, Didactics, and Dialogics[36]. The model is presented in Figure 2:

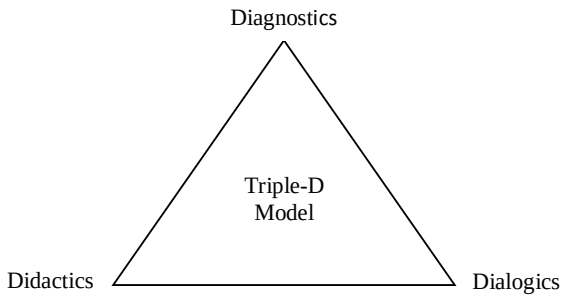

Figure 2: Triple-D model adapted from *Chia*[38]

According to *Chia et. al* (2014) diagnostics concerns with the assessesment of the level of the students that are suspected to have behavioural and/or learning problems. The term Dialogics refers to the communication process between the teacher and the student that engaged them in a suitable activity[38]. Apart from that, [37] added that consultations with other teachers and parents are needed to ensure that the implementation of learning sessions are successful. [38] state that didactics means implementing the lessons planned[37]. Therefore, special education teachers and educators can have a clearer view based on the Triple-D model which is important to understand their students better.

Based on the concepts and theories discussed above, a robotic-based model will be proposed and developed. These concepts and theories will be consolidated in the proposed model to ensure the effectiveness of the model in enhancing the slow learners' learning experience.

METHODOLOGY

As illustrated in Figure 3, this study involves two phases of activities which are identification specification and model development. The activities involved in the first phase are the literature review and expert interview. Data in regard to suitable elements and components of the model were identified, gathered, analysed and organized to prepare for Phase 2. These data are further discussed in the next section. The second phase of the study is the model development phase where the conceptual design of the model is determined based on the data organized in Phase 1.

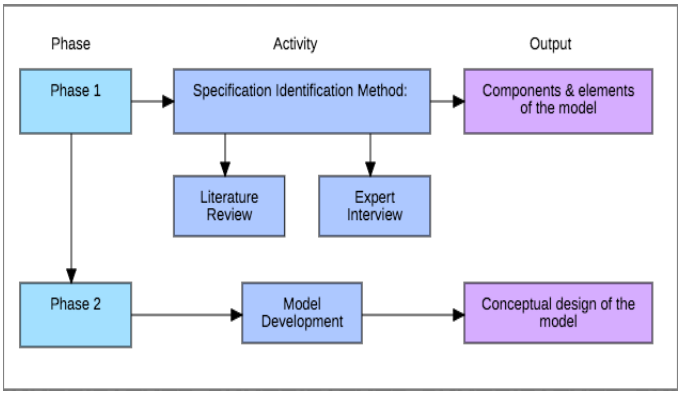

Figure 3: Summary of Activities

1. Literature Review
Numerous studies have been studied and reviewed to get an understanding of slow learners and their learning sessions. A set of semi-structured interview questions were designed based on the initially gathered information.

2. Interview
A set of semi-structured interview questions is developed to gather information from two educators (Educator 1 & Educator 2) from a selected primary school in the district of Perak Tengah, Perak. The details of the educators and the lists the question prepared for the interview session are listed below:

Educator 1:
33 years old with 9 years of experience as Special Education Teacher

Educator 2:
37 years old with 10 years of experience as Special Education Student Management Assistant

Table 1. Interview Questions

	Items
Q1	What are the learning challenges faced by the slow learners?
Q2	Do slow learners actively participate in class activities or learning sessions? Please elaborate.
Q3	How do slow learners behave in class?
Q4	What is the method that you usually employ to teach the slow learners?
Q5	What is the disadvantage(s) of your current teaching methods?
Q6	How can we improve their learning experiences in term of engagement and participation?

RESULTS

A. INTERVIEW

Both educators defined slow learners as the students that have slightly lower thinking abilities as compared to their same-aged peers. For example, for slow learners with the age of 12 years old, their thinking abilities are actually at the age of 5 – 6 years old children. They mentioned that "Slow learners actually requires more attention than other children" which are supported by the research of [39]. The children are identified through a test called Literacy and Numeracy Screening (Linus). They first enrolled in conventional school before being identified by their teachers if they have any special needs in learning. They then required to take the test before being referred to the medical doctor. Depending on the results, they can be enrolled in the schools with special education programs. These children are also being classified not based on their age but depending on their cognitive level. Their levels are determined by their LINUS test results.

In terms of learning, the educators mentioned that these children have poor memory capabilities, limited attention span and low self-confidence which are also mentioned by the study [29,30]. Both educators agree that these children require step-by-step guidance. [21] supported that statement which added that these children require accurate instructions. Due to their low self- confidence, they tend to avoid participating in class activities. They also tend to depend on teachers and unable to decide by themselves without guidance". Thus, according to the educators, they need to be creative in term of teaching these learners. They need to come out with their own teaching methods in order to grasp these learners' attention. Most common methods used are flash cards, hands-on assignments, music, videos and real-life objects and situations. The teachers also need to make sure that the learning environment is conducive and fun. Supported by the literature [40], the educators state that the current methods are sufficient but are unable to keep the children motivated in participating in the learning process. The current teaching methods bore the children out and they require something new. Both educators highlighted that these children participate more when it comes to the hands-on assignment and usually remembers the learning content if they are interested in the subject matter.

B. ROBOTIC-BASED MODEL FOR SLOW LEARNER'S LEARNING

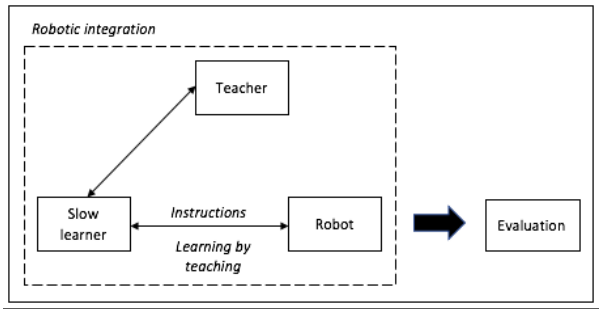

Figure 4. The robotic-based model for slow learners' learning

Suitable elements and components of the model to support slow learners' learning are derived from the specification identification process. Based on the derived components, a robotic-based model for slow learners' learning are proposed as illustrated in Figure 4. From the aforementioned models, each domain elements are incorporated into a model. The foundation of the model is based on the concept of Care-Receiving Robot. The teacher (as in the MKO), Slow learner (student) and the robot (CRR) are the main elements of the model. These elements are crucial to support the slow learners' learning needs to ensure the effective application of robotics in their learning. The MKO from Social Development Theory is adapted to the model to facilitates the learning process by supporting the slow learners directly. The slow learner will be given active roles as the "teacher". Therefore, they are involved directly in the learning process thus invoking active learning. The robot element will appear as weak or incomplete in order to promote the care-taking response from the student. The development of the robotics module will focus on invoking the slow learners' care-taking response. The teacher is also responsible for evaluating the compatibleness of the robotic application, learning activities with the ability of slow learners. The Evaluation (Diagnostics from the Triple-D model) is adapted to the model as the evaluation of the slow learners' profile, motivation, response and participation enhancement will be employed at the end of the proposed model.

DISCUSSIONS

This section provides the discussion of results obtained.

A. INTERVIEW WITH THE PRACTITIONERS

The results found that slow learners have lower thinking skills as compared to their normal peers. Their common characteristics include inability to express ideas, extreme timidity and low self confidence. Educator 2 mentioned that "From my observation, these slow learners are usually diffident and quiet. Due to their low self-confidence, they tend to avoid participating in class activities. They also tend to depend on teachers and unable to decide by themselves without guidance". This result related to a study by Paul (2016), who reported that slow learners require accurate instructions or guidance.

Student with learning disabilities especially autism uses assistive technology the most, but slow learners use them the least. This is because there is limited applications developed for slow learner compared to other disabilities. Educator 1 mentioned that "We need to be creative and come out with their own initiatives and teaching tools. The tools that we use include flash cards, hands-on assignments, music, videos and real-life objects and situations." These methods used currently are also not specifically designed for slow learners. In regard to that, Rajendra & Sudana (2018) found that current methods are sufficient but bore the students out.

Both educators highlighted that these children participate more when it comes to the hands-on assignment and usually remembers the learning content if they are interested in the subject matter. In this regard, when considering developing a model specifically for slow learner, it is important to consider giving active roles to the slow learners. This is because according to the educators, giving them roles might create possibilities oft hem engaging more in the learning activities.

B. ROBOTIC-BASED MODEL FOR SLOW LEARNER'S LEARNING

CRR literature indicates that CRR latest applications mostly focused on learning by teaching, the robot as student, teachable robot[27,41], empathy[42] and language learning[26,43]. Collectively, these works indicate that CRR have potentials in supporting learning for children but the supports for children with learning disabilities are unclear. Since there is limited research for slow learners' learning[10,12], this study is motivated to focus on slow learners. As mentioned before, the main entities of CRR are; the teacher or the parents, the children and the robot. Therefore, the children entity from CRR is specified as the slow learner in the proposed model.

MKO component from Vygotsky's Social Development Theory is adapted into the proposed model. Despite the interest in Vygotsky's theory[29, 34, 35, 44], most research generally focuses on the other component, ZPD. Therefore, there is still a lack of explanation on the concept of MKO. The process of acquiring knowledge is mediated by the MKO[45] and since MKO refers to someone with better understanding than the learner, it is suitable to be represented as the teacher compared to the robot. Comparing CRR' teacher component with MKO, the teacher only facilitate and make the learning process easier while the MKO act as the mediator of the learning process. Hence, by adapting MKO into the model, the teacher is expected not just to facilitate but mediate the learning process.

The literature[36, 37, 46, 47] define Triple-D Model's Diagnostics as the evaluating and profiling the learner that were suspected to have learning and/or behavioural problems based on psychological and educational assessments. Current applications of the model include the examination of Hyperlexia[48], case management system[47] and integration of tablet technology for slow learners[11]. Therefore, the application of the Triple-D model is still unclear. Even though the model is developed to aid special needs therapists and educational therapist, the model only emphasize the assessment and management of the students' learning and/or behavioral problems but not on the identification of suitable learning aids. However, which adopted the Diagnostic component[11], mentioned that the assessment for the children may include the applications to be used and its' compatibility with the slow learners' capabilities. In the proposed model, the Diagnostics component are represented by Evaluation. Comparing the proposed model with the Triple-D Model and[11], the Evaluation component is for the teacher to not only profile and assess the learners, assess the compatibility of the application with the slow learners' capabilities, it also evaluates the slow learners' motivation, response and enhancement of direct participation

To conclude, the model need more refinements to further strengthen the concepts and elements oft he proposed model before going through the validation process.

CONCLUSION

The aforementioned studies revealed the suitability of robotic technology in teaching and learning especially for children with LD. Therefore, this study has proposed a robotic-based model for slow learners' learning. It considers the inclusion of the active learning concept emphasizing on students' involvement which is crucial in promoting students' learning experience. Robotic applications as mentioned before could contribute towards slow learners' learning. The three root elements; the teacher (MKO), the student and the robot (CRR) are pivotal

in assisting slow learner needs in emotional learning. The applicability of the elements has been supported as mentioned previously. The teacher element act as the facilitator and the expert is present with the student during the session which enables them to evaluate the compatibleness of the robotic application, learning activities with the ability of the slow learners. The robotic element is crucial to invoke the students' care-taking response by giving them an active role as a teacher. Therefore, the students are able to learn through teaching. It is expected that this proposed model provides a guideline for slow learners' learning content development. The model will go through refinements with the stakeholders before it is validated and confirmed by the experts. Further refinements are needed before the model is ready to be adapted into robotic modules.

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COMPETING INTERESTS
There is no conflict of interest.

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