

## Design of Vibratory Haptic Interface Model (VHIM) for Autistic Children's Social Interaction

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**Abstract:** The majority of educators consider problem solving as one of the most crucial learning outcomes. However, the instructional design models prescriptions for designing problem-solving instruction and engaging learners are still very limited. The design model process involved two instruments which were used to design model. The instruments used in this study to analyse children who have mild autism and children who have impairment in social interaction. This study depicts the workflows process design of the Vibratory Haptic Interface Model (VHIM) with the objective of gaining a comprehension on items of favourites among autistic children such as colours, games and shapes. The information gained assists in the creation of the Vibratory Haptic Interface Model (VHIM) design which incorporates favourite shapes, colours and 3D game. This study attempts to design the Vibratory Haptic Interface Model (VHIM) appropriate for specific disabilities in learning such as emotional and behavioural disorders which also comprise of autism and attention deficit hyperactivity disorder. With regard to the model for resolving well-structured problems, it is formulated in accordance to learning's information processing theories. The VHIM Model presented in this study is valuable for enhancing social interaction and practice throughout disciplines.

**Key words:** Vibratory, autism, design model, VHIM, 3D game

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### INTRODUCTION

Previous researches have addressed the advances in Computer-Assisted Technologies (CAT) which is multimedia computer technology that have designed sophisticated computer games particularly for children (Warnke *et al.*, 2010; Ploog *et al.*, 2013). Most children, including those with Autism Spectrum Disorders (ASD), show an affinity towards computers. This has led researchers to recognise the potential of computer technology as an effective and efficient tool in helping children with special needs to overcome their problems. The use of Computer-Assisted Technology (CAT) can assist in enhancing the social, communicative and language development in individuals with ASD in four main areas: language, emotion recognition, mental stability and social skills. Although, many studies have indicated the capability of CAT to enhance skills of individuals with ASD, most of their studies lack rigorous scientific assessment of efficacy relative to non-CAT approaches (Ploog *et al.*, 2013; Gonzalez-Rubio and Casacuberta, 2014). This study aims to design the suitable Vibratory Haptic Interface Model (VHIM) in order to develop the suitable system for the autistic children.

### PROBLEM STATEMENT

The haptic interface models which include vibration can be integrated in a virtual, 3D environment. These models provide assistance to those children with difficulties in dealing with social interaction issues. However, this technique is not yet fully applied in Malaysia. Literature pertaining to this technique is also found in great quantity while children with learning disabilities have caught the attention of specialists. These learning disabilities entail a vast spectrum of disability categories. With regard to the Autism Spectrum Disorder (ASD), it is a neurodevelopment condition where as reported by CDC (2009) and Dolah *et al.* (2011), one in 110 US children and one in 625 Malaysian children have this condition. Children with autism are of heterogeneous groups which include mental retardation, specific learning disabilities (DeQuinzio and Taylor, 2015) such as emotional and behavioural disorders which comprise of autism and Attention Deficit Hyperactivity Disorder (ADHD).

Through, techniques such as Motor Movement, 3D Virtual Learning Environment (3D VLE), Virtual Peers (VPs), 3D generic virtual environment platform, children are able to manage their daily activities better. In relation

to this, numerous researchers have conducted studies on the aforementioned techniques for instance (Moore *et al.*, 2005; Robins and Dautenhahn, 2004). Nonetheless, these aforementioned techniques are still lacking in terms of effectiveness. In particular, the haptic interface with vibration which can be integrated in a virtual 3D environment had not been added to these previous techniques. The creation of a technique that uses a haptic device with vibration which can be included in a virtual 3D environment for assisting children with autism would be valuable and in fact, many researchers such as Vetere and Mathew have mentioned this.

### PROCESS DESIGN OF THE PROPOSED VHIM MODEL

This study shows the instruments used in this study to analyse children who have mild autism and children who have impairment in social interaction. These tools are very helpful in providing understanding autistic

children behaviours. So, through the observation and questionnaire, we have understood the problems faced by those children such as impairment in social interaction and that their verbal and non-verbal communications are also impaired and limited interest in activities and play in their daily life. However, we have focused on only one of those problems which is impairment in social interaction among children with mild autism. This study also presents the design process of proposed model and the process model is discussed as follows:

**Design model process:** The design model process involved three instruments which were used to design and create the model. These instruments are: naturalistic observation, questionnaire and literature review. The instruments were used to ascertain the problem, objectives and scope to acquire System Requirements (SRS) in terms of specification in order to design the proposed model at the design phase as illustrated in Fig. 1.

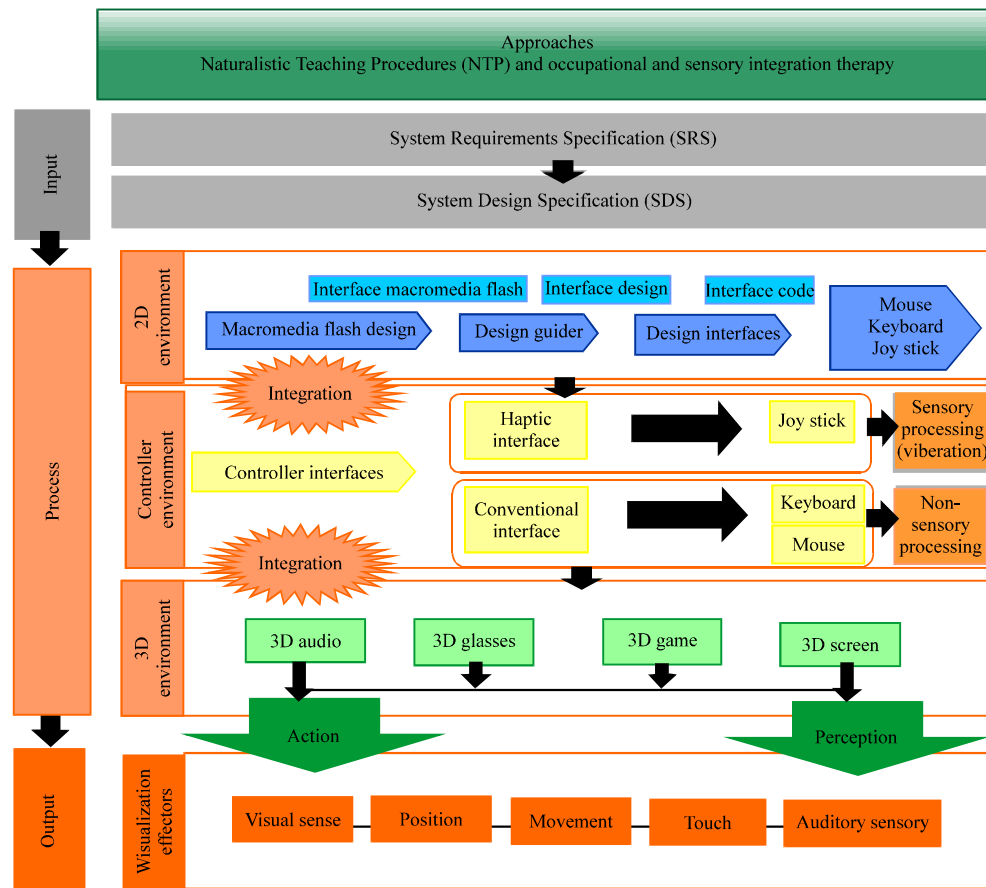


Fig. 1: The proposed VHIM Model

Thus, naturalistic observation and questionnaires are important to understand the exact problems faced by autistic children, specifically, those with impairment in social interaction and verbal and non-verbal communication and limited interest in activities and play. This research focuses on impairment in social interaction amongst mildly autistic children. Additionally, this phase also determined the samples' behaviour and attitude towards using available objects in their environment. With regard to the data, they were collected through naturalistic observation in which the researcher observes authentic behaviours in a naturally occurring setting and also through questionnaires. Based on the data obtained from these two instruments, an assistive mechanism through, the VHI Model was designed in order to improve social interaction amongst autistic children. The instruments used to design the model are discussed as follows:

**Instrument (naturalistic observation):** Social and communication difficulties can have an impact on how autistic children deal with their social situations. They may find social situations very demanding or stressful because they have to work hard to communicate with other people. However, not all children with an Autism Spectrum Disorder (ASD) will understand that other people hold views or perspectives that are different from theirs. This may also make social situations difficult. Children with ASD may not understand social rules which entail the unwritten rules that govern social situations such as how close they can stand to other people or how to take a turn in a conversation. This is especially true if children find themselves in a new and unfamiliar situation. Therefore, social situations can be daunting and unpredictable. In fact, some children may engage in a particular behaviour to avoid social contact.

A naturalistic inquiry of observation through observational checklist: it is felt that there will be less control by the teachers. This is because control distorts the inquiry process while the social context of human communication influences what (and how) things and relationships take place or occur. A naturalistic type of research focuses on studying autistic children in situations where they usually interact, behaving as they naturally do when engaged in their everyday activities without teachers interfering or controlling what they say or do.

A structured observation method employs note taking and observing using the observational checklist throughout the process of this phase. Being a non-participant by-stander, the researcher watched and

listened only without attempting any interactions with the subjects. The research examined 20 autistic children from the National Autism Society of Malaysia Centre (NASOM) who faced impairments in social interactions. The method employed the purposive sampling which is a form of non-probability sampling. Observations took place at two different locations. The first location was in the classroom and the second location was in the court of the NASOM Center in Kuala Lumpur, Malaysia. The main goal was to observe the behaviours of autistic children such as to see if they were interacting with others like the way most people do (they may not be interested in other people at all).

People or children with ASD may not make eye contact and may want to be left alone. They may also have trouble understanding the feelings of others or talking about their own feelings. Children with ASD may not like to be held; they may have difficulty making contact with others or may make contact only when they want to. Some people or children with ASD may not even notice when others are trying to talk to them. Others may be very interested in people but do not know how to talk, play or relate to them. In addition, the researchers also observed the favourite objects or likes and dislikes of autistic children (such as games, colours, shapes and toys). Further, through the observational checklist the researcher obtained enough information about the fundamental difficulties that autistic children have with communication and social interaction that are often the root cause of their difficult behaviours. The second goal of the observation was to minimise the researcher's bias in interpreting the data and retrieving more information about sample behaviours with objects available in their surrounding environment.

Findings will indicate how the children interacted and how they developed and improved the problem of social reaction among autistic children. That was achieved by way of understanding aspects such as: direct environment (sound, light, temperature and design), private excitement (motivation, persistence, responsibility and the need for flexibility), physiological needs (entity, competitor, peers and adults) and physical needs (sensual power, comprehension, time and mobility).

**Instrument (questionnaire):** The questionnaire known as the Q-CHAT adapted from the study by Allison was used to collect data from the teachers of autistic children. The questionnaire involved two main components: social interaction and social communication. Specifically, we adopted eight out of twenty five questions or items in the questionnaire. These are

questions numbered one to eight. However, three questions were added to the eight selected questions in the current study. These are questions 9, 10 and 11. The main goal of the questionnaire was to determine if autistic children feel comfortable when using the haptic and non-verbal interfaces such as joysticks, to ascertain their favourite colours and to determine if they prefer to play alone or with others.

The first four questions or items were: Does the autistic child look at you when you call his or her name? To what extent does the autistic child make eye contact with you? Can you easily understand the speech of autistic children? Does the child make gestures to indicate that he/she wants something (such as a toy that is out of reach)? The purpose of these four questions was to understand the behaviours of the children with the objects available in their surrounding environment. The questionnaire was designed for teachers of the autistic children to answer and the data were analysed and presented based on frequency. For example, in questions one through four, the response of “sometimes” was the most frequent answer with approximately 42, 50, 50 and 58%, respectively. In question or item four specifically, seven of twelve teachers answered “sometimes” when they were asked if an autistic child makes gestures to indicate that he wants something (such as a toy that is out of reach). A histogram depicting the frequencies of answers to questions 1-4 is shown in Fig. 2.

Questions five and six: Does the autistic child point to an object that interests him or her and wants to share his or her interest with you (for example, pointing at something interesting)? How long can the autistic child’s interest be maintained by a spinning object (such as washing machine, electric fan and toy car wheels)?

The purpose of questions five and six was to understand the children’s feelings and how expressive they were by pointing at something interesting. The response of “a few times a week” was the most frequent answer with frequencies of approximately 50 and 59%, respectively. Seven out of twelve teachers provided the answer “a few times a week” for question Q6. Figure 3 is

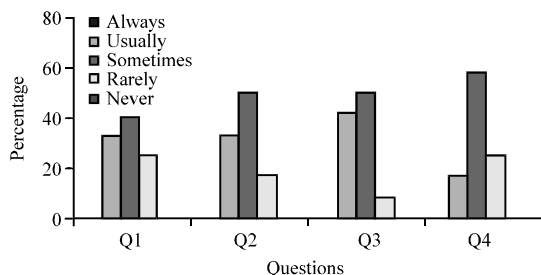


Fig. 2: Frequencies of answers to questions or items 1-4

a histogram of the teachers’ feedback for these two questions. This histogram also indicates that the children have difficulties in expressing their own feelings.

Questions seven 7 and 8 were: How fast is the autistic child’s response when asked to do something? To what extent does the autistic child keep himself or herself motivated with objects (such as with games)?

The purpose of questions 7 and 8 was to understand the pace of response by the autistic child when dealing with real objects available in their surrounding environment and to know the importance of games in motivating them. The response of “half an hour” was the most frequent answer at 67 and 59%, respectively. Figure 4 shows a histogram of the teachers’ feedback on these two questions.

Question or item nine: “Do you think that an autistic child feels comfortable when holding a haptic interface (joystick).” The purpose of this question was to determine how the child feels when using the joystick and how convenient it was for him/her to use it.

Approximately, 75% of the respondent teachers which is nine out of twelve teachers, answered “yes.” A

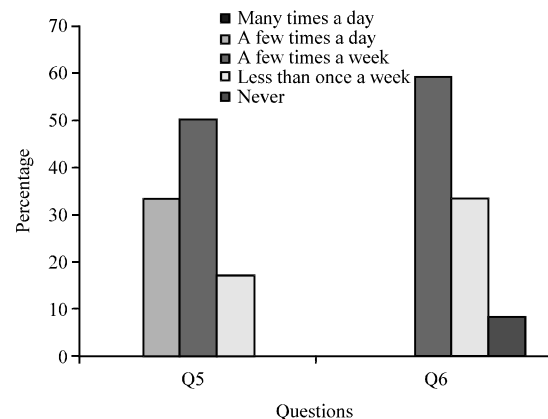


Fig. 3: Frequencies of answers to questions or items 5 and 6

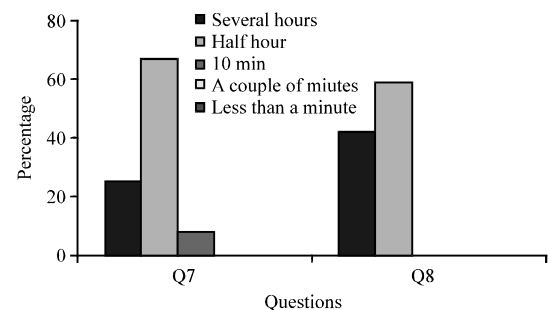


Fig. 4: Frequencies for answers to questions or items 7 and 8

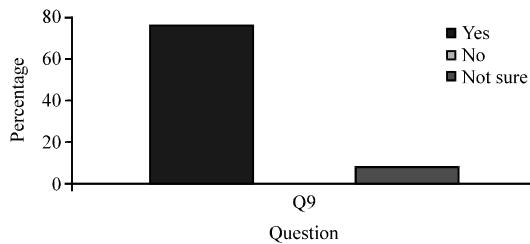


Fig. 5: Frequencies for answers to question or item 9

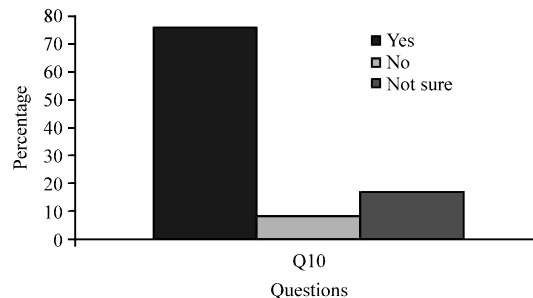


Fig. 6: Frequencies for answers to question or item 10

histogram of the teachers' responses to question 9 is shown in Fig. 5. This design indicates that the children were willing to use a device with a haptic interface (joystick) without hesitation as the device was practical and helped in triggering sensation to the children in a realistic way.

Question or item 10 of the questionnaire was: "Do you think that colours are important in the daily life of the autistic children?" The purpose of this question or item was to investigate the importance of colours in the life of the autistic child. The language of colours may be used as a tool for social interaction and communication with the children. Normally, autistic children are interested in colours and they respond positively to varying colour palettes. Moreover, children at the early age of 6 months are able to learn and distinguish colours much more quickly as toddlers will reach out for attractive and eye-catching colours. It has been shown that autistic children are attracted to colours. Approximately, 75% of the respondents that is nine out of twelve teachers, answered "Yes" to question 10. Figure 6 shows a histogram of the frequency of responses to question 10.

Question or item 11: "Does the autistic child play alone or with others?" This question yielded an overwhelming number of "Alone" answer where approximately 75% of the respondent teachers or nine out of twelve teachers, chose this answer.

Figure 7 shows a histogram of the teachers' feed back for question or item 11 which shows that young children

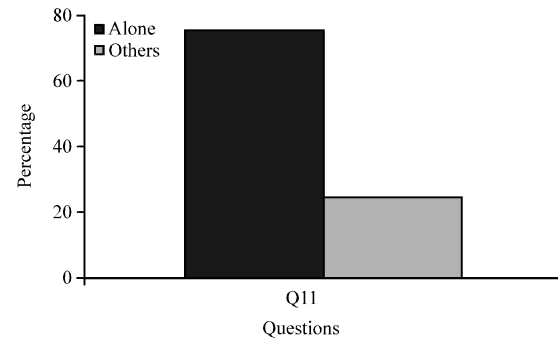


Fig. 7: Frequencies for answers to question or item 11

diagnosed with autism are frequently described as independent as they seek little assistance in difficult situations. For instance, a young autistic child may refuse to point at the desired toy but will weep or make effort to obtain the object himself. The results of Q11 indicated that there was lack of social contact, understanding of subtle rules of social behaviour and the tendency for autistic child to isolate him or herself rather than play with others.

## CONCLUSION

The observational checklist and questionnaire's findings were based on the data obtained from the teachers at the National Autism Society (NASOM) Kuala Lumpur, Malaysia. In this study, the teachers' responses to the items in the questionnaire appear to support and are matched with the researcher's observations. Further, the data generated from both the observational checklist and questionnaire enabled the researchers to gain comprehension on the actual impairment faced by the autistic children during social interaction. In fact, social interaction is among the major problems faced by these children and this is also substantiated by the literature review. Thus, the information obtained would be of value in helping these autistic children in improving their social interaction. Additionally, this study has also discovered that autistic children favour 3D games, colours and shapes and the incorporation of these favourite items has facilitated the creation of the Vibratory Haptic Interface Model (VHIM) design.

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