DESIGN OF VIRTUAL REALITY-BASED VIDEO MODELLING INTERVENTION IN ADAPTING TO A NEW SCHOOL ENVIRONMENT FOR AUTISTIC CHILDREN

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NOVEMBER 2024

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By

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A dissertation submitted to the

Faculty of Information and Communication Technology,

Universiti Tunku Abdul Rahman,

in partial fulfillment of the requirements for the degree of Master of Science (Computer Science)

in November 2024

ABSTRACT

DESIGN OF VIRTUAL REALITY-BASED VIDEO MODELLING INTERVENTION IN ADAPTING TO A NEW SCHOOL ENVIRONMENT FOR AUTISTIC CHILDREN

Ang Yi Ling

A personalised support that applies Virtual Reality (VR) in Video Modelling (VM) designed as an augmentative support to help autistic children adapt to new schools. Difficulties during the school transitions were identified, as they often face adaptation issues. Point-of-view VM demonstrates behaviours from the child's perspective for imitation. A customisable Virtual Reality Video Modelling support was designed in this research to address school adaptation, presenting appropriate learning behaviours in a class, and the proper way of making new friends. The immersive experience, facilitated by Google Cardboard Goggles, aimed to attract children. Additionally, the customisation feature allowed parents to customise the classroom's background and furniture settings to enhance virtual school realism. The input of actual school images and the child's name in the storylines heightened the immersion of autistic children. A total of 7 participants were involved in the training sessions before

the opening of the school. The results of the support's performance were identified using the Social Responsiveness Scale (SRS-2), and the Behaviour Assessment System for Children (BASC-3). Cohen's *d* value to determine the effect size of the personalised support in each scale was calculated as *d*=1.247 for hyperactivity indicating high effect size, suggesting that autistic children had reduced their hyperactivity in the class; *d*=0.739 for behavioural symptom index from BASC-3, indicating autistic children are better able to pay attention in the class and reduced abnormal behaviours, and *d*=0.546 for social awareness from SRS-2, indicating a medium effect where the results show improvement in their understanding of reciprocal social situations.

Keywords: virtual reality, video modelling, autistic children, school adaptation, SRS-2, BASC-3.

Subject Area: T1-995 Technology (General)

ACKNOWLEDGEMENTS

The funding for this study was provided by Universiti Tunku Abdul Rahman Research Fund under project number IPSR/RMC/UTARRF/2023-C1/A06. The borrowing of devices by Universiti Tunku Abdul Rahman is appreciated, as it ensures the smooth running of the development stage. Furthermore, the assistance in carrying out the assessment by Eunice Chong Yi Xuan, a trainee clinical psychologist was greatly appreciated and significantly contributed to the research.

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LIST OF ABBREVIATIONS

ASD	Autism Spectrum Disorder
VM	video modelling
POV	point-of-view
VR	Virtual Reality
HMD	head-mounted display
VRVM	virtual reality-based video modelling
SS	social story
SRS-2	Social Responsiveness Scale - Second Edition
BASC-3	Behaviour Assessment System for Children - Third Edition
SUS	System Usability Scale
CBT	Cognitive Behavioural Therapy
PC-CARE	Parent-Child Care
BBI	Brief Behavioural Intervention
PCIT	Parent-Child Interaction Therapy
IFP	Individual Fitness Program
MASSI	Multimedia Anxiety and Social Skills Intervention
PMI	Peer Mediated Intervention
CARS-2	Childhood Autism Rating Scale - Second Edition
HF	High Functioning
ST	Standard
ADOS	Autism Diagnostic Observation Schedule
PRS-P	Parent Rating Scale version for Preschool
PRS-C	Parent Rating Scale version for School Age Children

CHAPTER 1

INTRODUCTION

1.1 Background and Motivation

Autism Spectrum Disorder (ASD) is a common childhood neurodevelopmental disorder. The American Psychiatric Association (2022) defines ASD as significant deficits in social communication and social interaction abilities, as well as the presence of dysfunctional repetitive and restrictive behaviours. Autistic children often face significant challenges while transitioning to school due to their cognitive and behavioural challenges. They are normally having difficulty expressing their feelings [1].

There are some treatments have been found to improve their communication skills in their daily life. By having the treatments, appropriate reactions in different situations can be learned [2]. Video modelling (VM) is a videotape demonstrating certain behaviours that are imitable by watching it. There is some research proving that VM effectively assists autistic children in imitating targeted behaviours such as increased eye contact [3], sharing board games with peers [4], and positive interaction with peers [5]. Several forms of VM are available such as basic VM, video self-modelling, point-of-view VM, and video prompting. In this research, point-of-view (POV) VM is implemented as it is

designed from autistic children's perspective and presented from their viewpoint, which aims to be more effective than the other forms of VM [6].

In the technological generation, Virtual Reality (VR) may be an effective tool to help autistic children learn appropriate behaviour and interactions in different situations [7]. Autistic children explore the virtual world safely to understand new concepts, learn how to perform tasks, and interact with objects and people in 3D simulation experiences [8, 9]. In the virtual but realistic school environment, autistic children prepare themselves for adapting to a new environment in the future. By being aware that the environment is virtual, autistic children are able to explore the new environment without fear. Thus, producing a less hazardous virtual environment, and reducing training accidents since the environment is safe to conduct some unsafe training [9, 10].

Virtual reality-based video modelling has a high usability for autistic individuals although virtual reality-based video modelling itself is not sufficient to be a stand-alone support that helps autistic individuals to improve their social skills [11]. In fact, virtual reality-based video modelling personalised support can be used as an augmentative support that enhances and prolongs the effect of the main therapy that autistic individuals attend. Compared to 2D-VM, virtual reality-based video modelling enhances participants' sense of presence within the virtual environment [9]. By wearing a head-mounted display (HMD), they are able to immerse themselves in the virtual school environment and enjoy the VM. In contrast, fully immersive VR offers a more flexible experience in which the participants can rotate their heads and bodies, their motion is tracked, and the VR view updates accordingly; the virtual reality-based video modelling provided in this research restricts the rotation and movement of participants in

the VM to diminish the occurrence of possible distractions [6]. Preventing autistic children from rotating their heads, moving away from the targeted objects in the VM but focusing on the storyline of the video.

Therefore, this research aims to design a VR-based VM (VRVM) personalised support that provides safe and repeatable training for autistic children in order to familiarise them with the social situations that may potentially happen in the school environment. A few possible social situations may arise in the new school environment, resulting in the design and creation of the VRVM storylines. Providing immersive VR experiences to autistic children to attract them and enhance their willingness to participate in the training sessions [9].

1.2 Problems Statements

In this research, there are three research questions are compiled as follows:

RQ1: How was the Virtual Reality (VR) technique implemented in Video Modelling (VM) to help autistic children adapt to a new school?

Recently, the implementation of VR in VM which focuses on Malaysia's autism population remains limited. However, the respective use of VR and VM in training autistic children shows an improvement to help them improve their social communication skills [3, 4, 5, 7]. Integrating VR into social stories helps autistic children behave appropriately in social situations [7], while the use of VM contributes to assisting them to learn the appropriate way to communicate with peers in school settings [12]. Therefore, the effect of the implementation of VR in VM which contributes to helping autistic children adapt to a new school is the focus of the dissertation.

RQ2: To what extent could the parents of the autistic children customise the VRVM?

Nevertheless, the different needs of autistic individuals result in a variety of different designs of virtual reality-based personalised support [13]. A virtual reality-based support that is personalised for each user requires a long process of collecting their needs and requirements and developing the completed product of the support. This process may offer a real-time personalisation of the support based on participants' reactions [14]. In this situation, the training process requires an expert, which may make the home training inefficient. Therefore, a time-consuming data collection and development process and experts required during training may be the challenges in order to minimise autistic children's school adaptation stress by using virtual reality-based support. Thus, the customisation features provided for parents may enhance the efficiency of the training. However, the extent to which parents are allowed to customise the VRVM is one of the focuses of the research.

RQ3: How was the effectiveness of the personalised support?

Moreover, the effectiveness of the designed personalised support is one of the concerns in this dissertation. After the training sessions, the focus is to assess the improvement of the participants and determine whether the improvement persists as they transition to the new school. In order to evaluate the effectiveness of personalised support, certain tools are required to analyse both the external and internal performance of children [15].

1.3 Objectives

The objectives of this research are listed down below:

- To develop a VRVM personalised support for autistic children.
- To allow customisation by the parents/guardians of autistic children in the VRVM personalised support .
- To evaluate the effectiveness of the VRVM personalised support by using related assessment tools.

The first objective is to develop personalised support that applies VR technology. For autistic children, it is challenging to adapt to new environments such as school. Before they go to school, they require more time compared to typically developing children, as they have a higher rate of anxiety [10]. Training is required before they step into the next stage of their journey. The use of VR in the training process is improving its effectiveness, as proven by the researchers [10]. Yet, there is a lack of VR-based personalised support specifically designed for the training process of autistic children in Malaysia. Some parents may use the social story (SS) to train their children in adapting to the new environment. [16] Moreover, VM has also been implemented to boost the positive interaction of autistic children with their peers [3], share toys with their peers [4], and develop their social skills in school settings. Autistic children are told about possible situations they might encounter in school and are prepared to face different kinds of situations. Although various types of personalised support are available, this research aims to shift from VM to a VR-based VM approach.

A customisation feature is aimed to provide personalised support for parents of autistic children to better tailor the program according to their children's needs

[16]. By applying technology-based personalised support, customisation can be done more easily and efficiently, such as inserting pictures that are favourable to autistic children and enhancing their engagement in the training sessions. Nevertheless, a simple customisation process that can be done by the parents of autistic children without the need for technological background knowledge may be preferred by the parents [17]. A personalised virtual reality social story is designed for autistic participants according to their needs, where the dialogues of the social stories can be modified in real-time to facilitate the different training needs. [14] Therefore, customisation according to autistic children's preferences aims to improve the training results by enhancing their engagement in the training [16].

Different kinds of assessment tools are available to evaluate autistic children's performance. In order to identify the effectiveness of the designed personalised support, two types of assessments are used: the Social Responsiveness Scale - Second Edition (SRS-2), and the Behaviour Assessment System for Children - Third Edition (BASC-3). These assessments are chosen because of their well-established reliability and validity in evaluating the effectiveness of personalised support for autistic children. In order to determine whether there is an improvement in the children's performance, pre-tests and post-tests are conducted, and the results are compared.

1.4 Contribution

This research helps Malaysia's autism population by providing them a home-based training to assist in adapting to a new school. Firstly, this research extends the limited studies by providing technological personalised support specifically

for autistic children in Malaysia, to help them prepare before attending a new school. With few VRVM storylines designed, they can learn appropriate behaviour in certain social situations by imitating the actions presented through VRVM training sessions. This personalised support may contribute to reducing their schooling adaptation stress by familiarising them with the potential social situations and allowing them to practice appropriate behaviours repeatedly.

With customisation features provided to the parents of autistic children, they can customise the virtual school environment to enhance the realism of the virtual world, such as modifying the classroom settings, inputting the actual school image, and selecting the preferred language used. Therefore, this increased realism may improve autistic children's engagement in the training sessions [16]. Moreover, there is research mentions that autistic children are normally sensitive to colour [18]. Therefore, the modification of the classroom background colour may attract them in participating the training sessions. In this research, the efficient customisation process allows the personalised support to be implemented easily and effectively, without requiring technological knowledge from the parents.

Moreover, this research aims to determine the relationship between the usage of personalised support and its effectiveness in helping autistic children adapt to a new school by using relevant assessment tools, such as BASC-3 and SRS-2. It will identify which scales of the assessment tools show improvement after autistic children complete the training sessions. The assessments provide various evaluations across different scales, identifying the internal and external issues, and the skills the children have learned. Therefore, by analysing the

results from the assessments, the advantages of personalised support can be determined.

1.5 Organisation of the Dissertation

The dissertation is organised as follows: Chapter 2 reviews relevant personalised support for autistic children. Chapter 3 describes the research materials and methods, including the VRVM personalised support and assessment tools, along with the training design and participants' selection. Chapter 4 and Chapter 5 analyse and discuss the results of the training sessions. Finally, Chapter 6 presents the recommendations and conclusion of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Current Trend in Personalised Support

Recently, many kinds of support have been used to help autistic children adapt to social communities, such as occupational therapy, social skill training, music therapy, and social stories. Traditionally, occupational therapy helps autistic children perform their daily living tasks based on their needs and abilities. However, it is a lengthy process to carry out occupational therapy, which often takes up to 12 months to complete [19]. Occupational therapists apply their unique perspectives to enhance autistic children's skills in social participation [20].

Music therapy offers immediate and lasting effects on behavioural and emotional problems by utilising different musical instruments [21, 22]. Music therapy has a positive impact on improving autistic children's language communication and social skills [23] while their coordinated joint engagement improves after therapy [22]. Some parents prefer creating meaningful social stories according to their children's needs, such as giving precautions for some kinds of activities, guiding them in doing new tasks, teaching them a proper way of greeting, etc [24].

In the technological era, many researchers apply technology to traditional support in order to enhance effectiveness and improve efficiency. A computed-mediated cognitive behavioural therapy is designed to teach autistic children in learning the way to solve social issues. This computer-mediated support offers audio and visual support to autistic children, and they need to answer questions after watching the relevant video which focuses on preschool activities. However, it is mentioned that unnecessary stimuli may distract autistic children as they have high sensory sensitivity [25].

Compared to the traditional way of presenting social stories, the digital presentation method attracts autistic children to watch. Presenting social stories using an iPad shows a significant improvement in autistic children's understanding and anxiety issues [26]. Moreover, the implementation of VR in social stories addresses the capability of social skills teaching by showing some short stories in first-person perspective. Autistic children can learn the appropriate behaviour from the virtual school settings and enhance their understanding of each situation [7].

2.2 Virtual Reality

As VR is a repeatable and safe tool to train special needs children in daily living tasks, the Oculus Quest 1 is used to train them in separating objects into the correct bin. In this research, they are able to use the controller to move the objects to a bin. By repeating the practices, they improve in the task. Moreover, it is worth mentioning that the skills children learn from VR are transferable to the real world. However, this does not indicate that VR training is better than

real-world training. Also, the participants focused on this study are individuals with intellectual disabilities instead of autistic children [27].

Furthermore, there is research that focuses on the use of immersive VR to teach autistic individuals police interaction skills. In this safety interaction training program, autistic individuals can immerse themselves in the virtual world by wearing the headset while the police officer's behaviour can be modified in real-time based on the individual's performance [28]. By practising communication with virtual police officers, they gain the confidence to interact with police officers in actual life. However, this study mentions that it focuses on one single situation which is the situation when interacting with police officers and it does not carry out an examination to test the occurrence of long-term negative side effects, such as sleep issues [28].

There is research implementing VR in social skill training in order to compare the effectiveness of this implementation in adaptive and non-adaptive prompting. A single-case experimental design is utilised, involving 4 autistic participants in eight social skill training sessions. The scenarios included in the VR-based social skill training sessions are: understanding facial expressions in a school gallery, resolving conflict with peers, role-playing as a waiter, etc. By conducting systematic behaviour analysis, the behaviours of the participants are observed and coded to assess their targeted social skills occurrences, including social interaction initiation, responding to social interactions, interpersonal negotiation and self-identity. The research shows that VR-based social skill training has both positive and negative results on social skills in responding to social interactions, interpersonal negotiation and self-identity. However, some parents provide feedback that their children's social skills improve after the

training. For example, the children express their desire to continue the training. This research mentions that only a specific group of autistic children who join the training have the chance to experience the desktop-based VR-based social skills training. This limits the ability to access the generic effectiveness of the training in a broader population [29].

2.3 Video Modelling

VM is implemented to assist autistic children in developing social skills in the school environment [4, 6, 12]. To help autistic children develop social skills in the school environment, paper [12] proposes support to teach them an appropriate method of playing with friends and greeting someone at school by using VM. VM demonstrates suitable behaviour for the child on a screen, which can be imitated by the child. There are 4 participants involved in the training sessions, of which two of them are targeted to be trained for playing with friends appropriately in the school, and the other two are targeted to be trained for greeting people appropriately during school day interactions. Therefore, 2 videos are created: 1) showing appropriate playing behaviour with peers in the school and 2) showing appropriate meeting and greeting methods at school. Both videos are presented on a television to the children. During the baseline phase, all participants are observed before watching the video, and the observational data are recorded. During the intervention phase, the videos are presented to the participants, and they are observed after watching the video for a completed phase of 5 weeks. A follow-up phase follows. and no videos are presented, but observation is conducted. To identify the effectiveness of the support acts on the children, appropriate behaviours, inappropriate behaviour,

and no interaction behaviours are all observed and recorded to compare the frequency of each behaviour during the baseline phase, intervention phase, and follow-up phase. The effectiveness of the video modelling support is exceeding expectations even though there is minor fluctuation. Furthermore, it is mentioned that the video was shot in a different school to the children's school, but the result was not affected by this factor.

This research focuses on VM with the use of classroom peers as the model to enhance the social communication skills of autistic children in the preschool environment. The researchers integrate VM and peer-mediated intervention to create a video model using classmate peers. Two peers are recorded as the video model after they practice the targeted skills a few times with the coaching provided by the training team. The targeted skills are as follows: 1) sharing puzzle pieces, 2) cooperative block building, and 3) transitioning to clean up the toys. An iPad is used to record and display the video models, and three video models are recorded for each targeted skill. The peers are involved in the video model shooting process before the start of the intervention. After the creation of video models, a baseline phase is conducted to observe and record the participants' responses to each targeted skill before the intervention. During the intervention phase, the participants are presented with the video models that show peers performing the target behaviour. The baseline phase is then returned to observe their responses after the intervention. A second intervention is conducted as follows. A last intervention is carried out one-on-one with a clinician and participants' responses are recorded during the follow-up phase after having three phases of intervention. The correct rate of the targeted behaviours is calculated and presented in a graph for each participant. In this

research, the VM using classroom peers as the video models can be an effective intervention that helps autistic preschool students in social communication. The participants who receive the intervention treatment indicate an improvement in the targeted social behaviours. However, the researcher mentions that the treatment options should be individualised for the participants, but the VM created in this study is not individualised for each participant. Moreover, the severity of the autistic level is not known in the study as they do not utilize any assessment tools before the start of intervention treatment [4].

Point-of-view VM is presented to teach social initiation skills to autistic children. An iPad is utilised to film the video models. During the filming phase, an investigator's voice is recorded in the video to indicate the verbal greeting to be taught to the participants, but the face of the investigator is not shown in the video to create a point-of-view video. Five autistic participants are involved in the experiment. During the baseline phase, participants are observed to record the presence of targeted behaviours. This is followed by the intervention phase in which the participants receive the point-of-view VM training, and a daily probe is conducted immediately after the experiment to identify the presence of targeted behaviours such as initiating a conversation with a communication partner in the same setting as the VM. Generalization probes are conducted before and after the experiment to observe the presence of greetings with another communication partner in a novel setting from the VM. A maintenance phase replicates the baseline phase to observe the presence of targeted behaviour from the participants. The correct rate of targeted behaviour is calculated and presented in a graph for each participant. From the results, it is proved that this support is helping autistic individuals in greeting, interacting, and

communicating with others. Nevertheless, the data collected is minimal in the experiment which is a total number of five participants involved [6].

For the research mentioned above, the participants are observed and recorded for appropriate and inappropriate behaviour in particular situations [4, 6, 12]. However, observer bias may occur in this circumstance, leading to unreliable observation results [30]. Also, the severity of the autism level for each participant is undefined in the paper [4], with no related assessment tools being utilised.

2.4 Virtual Reality Implemented in Video Modelling

By utilising Virtual Reality technology, presenting a spherical video to autistic individuals to teach them adaptive skills is the focus of this paper. The researchers wish to use 360-degree video to present the virtual environment to the individual by wearing a head-mounted display (HMD). In order to create this kind of video, a 360-degree video camera is required. By watching the 360-degree video, autistic individuals may process the information in the video visually and imitate the appropriate social behaviours. In this research, an SVVR public transportation application is developed to assist autistic individuals to adapt to the use of public transportation, such as 1) determining the shuttle stop, 2) walking to the shuttle stop, 3) identifying the shuttle's schedule, and 4) getting onto the shuttle. Five autistic participants are involved in the usage testing stage. The participants use the SVVR application with a Google Daydream HMD, a Google Cardboard HMD, and without a VR headset. Structured interview questions are asked, and the System Usability Scale (SUS) is conducted after the usage testing. From the results, the SUS score for Google

Cardboard is higher than Google Daydream in the ease-of-use aspect. The participants mention that they are less likely to face head strap discomfort or press the wrong button when experiencing the Google Cardboard compared to Google Daydream. Moreover, the participants experiencing the application without a headset needed more assistance than others, while the participants using Google Cardboard require the least assistance. There is a report of discomfort when using Google Daydream, in which a participant experiences cybersickness. By comparing the delivery type of the spherical video to the individuals, Google Cardboard is recommended as it provides immersive experiences to the users, is easy to use, has fewer errors occurring and is low-cost [11].

There is research applying VR in VM to help the autistic individual develop their social communication skills. By using a 360-degree camera, they shoot the video content for this study. Combining first-person and third-person perspectives, there are a total of 10 videos prepared to improve autistic individuals' social communication skills. They observe the appropriate behaviour from their viewpoint when watching the first-person perspective's VM and observe the task being completed by the others from a third-person perspective. A total of 5 physical sessions involve watching the VM without a headset, and 3 physical sessions involve experiencing the spherical video-based VR by wearing a Meta Quest 2 VR headset, forming the complete cycle. After completing the training, a semi-structured interview is conducted in order to collect their suggestion and identify user experience in the designed VM. The implementation of VR in VM benefits in cost-effectiveness and decreases the side effects associated with the VR headset, such as cybersickness [31].

However, a lack of interactive elements in the support to attract autistic individuals to the training exists, which may reduce the participants' sense of presence in the virtual environment and affect the effectiveness of the support [9]. Yet, this research focuses more on the user experience instead of the effectiveness of the support in improving their social communication skills and providing customisation that may better personalise the support to meet participants' needs [16].

2.5 Relevant Support Used for Autistic Children

Cognitive Behavioural Therapy (CBT) is one of the personalised supports commonly used to help autistic children [32]. During the pandemic, CBT is transformed into an online delivery mode in which the effectiveness of the mode transition of the therapy and its effect on autistic children is evaluated by using the assessment tool, Behaviour Assessment System for Children - Third Edition (BASC-3) for comparing the results of pre-test and post-test [33]. Parent-Child Care (PC-CARE), Brief Behavioural Intervention (BBI), and Parent-Child Interaction Therapy (PCIT) are parent-coaching supports that improve children's behaviour [34, 35], minimise disruptive behaviours [36], and enhance parent-child engagement. Licensed therapists are involved in the PC-CARE and PCIT support to observe parent-child interaction and strategies are taught to the parent [34, 35]. The ImPACT program is conducted by psychological therapists to introduce new skills to parents and provide personalised solutions for each parent experiencing interaction issues with their child [37]. Individual Fitness Program (IFP) introduces physical activity support that offers personalised fitness training sessions to autistic individuals to improve their behavioural and

physical issues [38]. Meanwhile, Multimedia Anxiety and Social Skills Intervention (MASSI) is a school-based treatment designed to minimise anxiety and social deficits for autistic children [39]. Peer Mediated Intervention (PMI) is a personalised support that teaches normally developing peers to assist autistic children in engaging in social interactions. In this research, the Social Responsiveness Scale – Second Edition (SRS-2) is used to evaluate the effectiveness of personalised support in helping autistic children [40].

2.6 Chapter Conclusion

There are various personalised support available for autistic children nowadays, such as music therapy, occupational therapy and social stories. Each treatment has different requirements and methods of implementation. Some are carried out traditionally, while others incorporate technology, such as computers, and iPads [25, 26]. Depending on their abilities and conditions, parents can choose the type of personalised support that perfectly meets their requirements.

Since VR is a safe tool to use, some personalised supports utilise this technology in order to be conducted safely and repeatedly. Carrying out police interaction skills training on the road is dangerous, and managing emergencies can be challenging. Therefore, the use of VR in this kind of training is helpful. Repeated training ensures autistic children get ample practice. Furthermore, the skills learned from the virtual world are transferable to the real world, which is beneficial to them and eases the training process [27].

An imitable VM is beneficial for autistic children in learning appropriate behaviour in particular social situations. Point-of-view VM shows the first-person perspective VM to them and enhances the immersion in the virtual world

[6]. Some research shows an improvement in helping autistic children learn social skills through watching VM. However, it is also worth mentioning that the observation methods used in the training to monitor their behaviours may lead to unreliable observation results.

Since both VR and VM assist autistic children in different aspects, combining VR and VM aims to make the training process more efficient while maintaining the effectiveness of personalised support. Some research implements VR in VM to assist autistic individuals in using public transportation and develop their social communication skills [11, 31]. Watching VM in a virtual world enhances their engagement and the high immersion makes the virtual world feel more realistic. However, both studies emphasize more on the user experience than on the effectiveness of personalised support. It is important to note that the Google Cardboard HMD is cost-effective and provides users with an immersive experience. Also, inputting some attractive elements in the VRVM may improve user engagement.

Various supports are used to improve children's behaviour and help them engage in social interactions, such as the online mode of CBT [32], PC-CARE [34], BBI [36], PCIT [35], ImPACT program [37], IFP [38], MASSI [39], and PMI [40]. These personalised supports also utilise assessment tools like BASC-3 and SRS-2 to identify individuals' autistic behaviours. Comparing autistic children's behaviours across different personalised supports can be done by evaluating the assessment results. The use of the same assessment tools ensures the consistency of the comparison.

CHAPTER 3

METHODOLOGY AND MATERIALS

The research methodology is shown in Figure 3.1 including the literature review to research similar personalised supports, and requirement collection to assess children's needs in the school. Next, the draft of the storylines was designed after gathering the needed data from online sources, and expert advice. In the VRVM storylines, three languages are used: English, Chinese and Malay. The experts reviewed the language used for each story to ensure the terms used were understandable by children aged 5 to 7. After getting some suggestions from the experts, the refinement of the storylines was conducted followed by the VRVM scenarios development using Unity.

Participant selection was carried out to filter the participants based on autism severity and age. Autistic children who fulfilled the requirement were involved in the training sessions. The pre-training test was conducted by using the assessment tools which will be discussed in the following sub-chapter. The training was then carried out and the post-training tests were conducted twice. The results collected for each participant were analysed and the effectiveness of personalised support will be discussed in the following chapter.

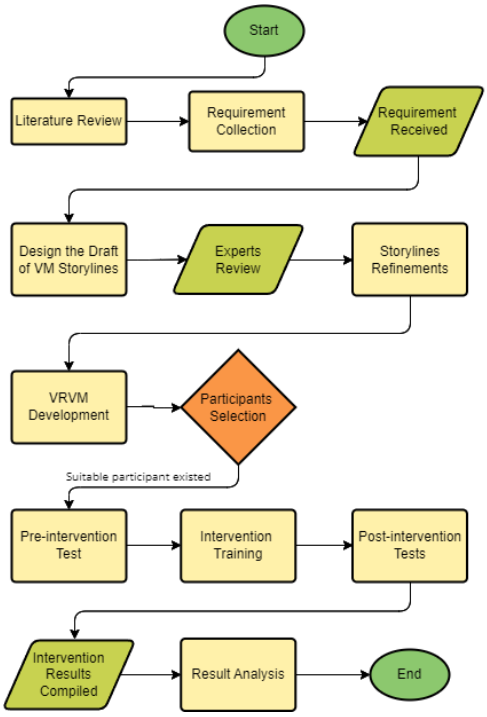

Figure 3.1 Flow chart of the research

3.1 The Design of the Virtual Reality Video Modelling (VRVM) Personalised Support

In order to assist autistic children in the new school adaptation, some stories needed to be designed to familiarise them with possible social situations. For example, making new friends in class, social contact with classmates, etc. Some of them may face difficulties in understanding other's feelings in social situations [7], and this personalised support was aimed at enhancing their understanding of such situations. An augmentative customisable Virtual Reality Video Modelling (VRVM) application was developed as an Android application to present three different stories in the school settings, which aimed to assist autistic children in getting familiarised with the school environment that was new to them. By presenting the stories in the first-person point-of-view, autistic children could immerse themselves in the school environment and the storyline.

The flow in using the VRVM personalised support designed is shown in Figure 3.2. There are two targeted users: parent and child. As a parent, various customisation features were facilitated, including the modification of the classroom such as modifying the classroom background colour, the selection of the preferred language to be used in the VRVM stories, the inputting of the child's name and uploading of the actual school image in which both name and image were usable in the storylines. While the child role was selected, there were three VRVM storylines that could be chosen. The chosen VRVM story would be played, and the training sessions would be conducted by letting autistic children wear the Google Cardboard head-mounted display (HMD). By considering the cost of VR goggles hardware, the VRVM applied the use of a Google Cardboard HMD which was affordable for most families and provided an immersive experience to the users.

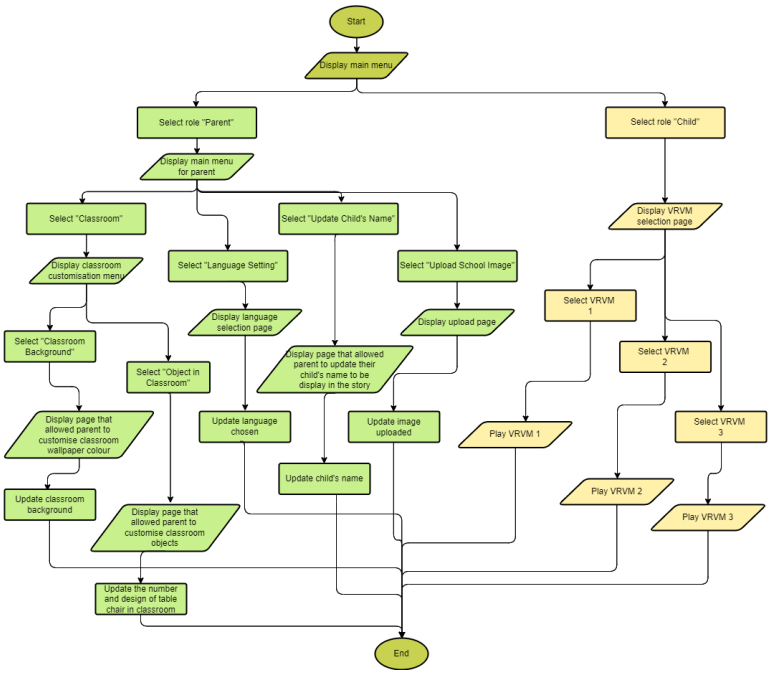

Figure 3.2 The flow of the VRVM Personalised Support

The requirements of the training sessions were drafted to fulfil their needs in the school environment, and the possible situations were designed accordingly.

For the purpose of helping autistic children adapt to a new school, several possible scenarios were created, allowing them to practice their behaviours before attending school. By installing the VRVM application on an Android device, parents could turn on the videos and start the training for autistic children in any place, at any time. In this circumstance, parents saved time by not having to visit a therapist for the training sessions. The VRVM application was developed in Unity, and it provided three storylines in the VM format as follows:

1. Going to a new school

2. Make new friends in the class

3. Behaviour during the lesson.

3.1.1 Story 1: Going to A New School

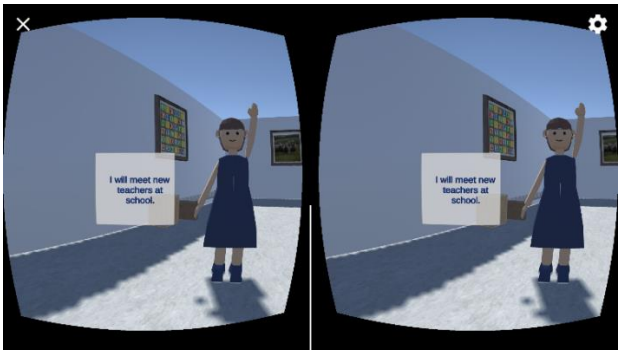

Figure 3.3 The scene captured in the first video modelling

The first VM aimed to assist autistic children in adjusting to a new school. They were shown the new school they would attend soon to help them prepare and introduce them to new virtual teachers and virtual classmates, as shown in Figure 3.3. The virtual avatar greeted the children, demonstrating the appropriate greeting way, which aimed to enhance their greeting skills by

imitating the avatar. In the first story, the children were introduced to the new school they would soon be attending. They were brought to the school by car, and the teacher welcomed and greeted them. The teacher brought them to the school, where they met new teachers and new friends. This experience gave them a chance to prepare for meeting new people. During the lesson, they are expected to sit properly and listen to the teacher. Whenever the children had issues, they were required to raise their hands and ask the teacher's permission to do something. After school, all the students said goodbye to each other. Therefore, autistic children received a general idea of the new school before attending.

3.1.2 Story 2: Make New Friends in the Class

Figure 3.4 The scene captured in the second video modelling

A few short conversations with classmates were shown in the second VM to familiarise them with the communication method with their classmates, as shown in Figure 3.4. When first entering the class, the teacher introduced the autistic children to their classmates, and the classmates introduced themselves by name. This scenario aimed to enhance their skills in introducing themselves when meeting new classmates. Other conversations were presented, including a conversation about borrowing stationaries to help them build relationships with

classmates. Additionally, situations where other classmates made fun of autistic children were presented, which allowed the children to learn how to react in such situations.

3.1.3 Story 3: Behaviour During the Class

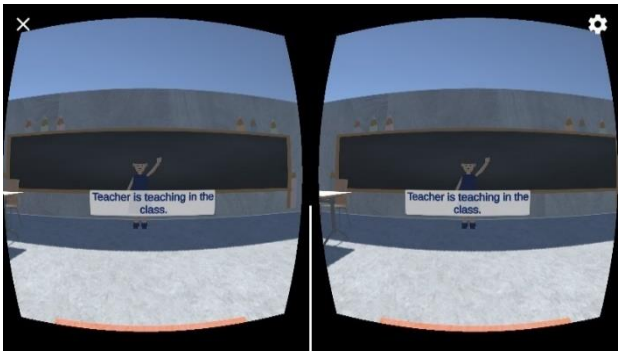

Figure 3.5 The scene captured in the last video modelling

Lastly, appropriate behaviours in the classroom, which is focusing on the teacher during the lessons, were depicted in the third VM to prevent them from disrupting the lesson, as shown in Figure 3.5. By showing this VM to them, they had the opportunity to learn the appropriate learning behaviour in class. When autistic children were in the classroom, they had to listen to the teacher. Whenever they had questions, they could ask for the teacher's help. In this VM, autistic children learned how to ask for help, and it was not difficult for them to do so.

3.1.4 Customisation Features Provided

Generally, autistic children were sensitive to colour changes, so it was a good idea to allow their parents to customise the support's colour settings [18]. Other than that, more customisation features ensured the realism of the virtual school. The customisation features provided aimed to minimise the unwillingness of

autistic children to participate in the training sessions. Therefore, the VRVM application offered a few customisation features for parents to improve the virtual school's realism and enhance the children's engagement. However, the VRVM application was still limited in some advanced customisation features, such as the modifying of the virtual teacher's face by inserting the actual teacher's photo. The customisation features provided were shown as follows:

1. Uploaded the actual school image, as shown in Figure 3.6 and the image was placed in the story and shown to autistic children.

2. Inputted the autistic child's name, which would be used in the storyline.

3. Adjusted the wallpaper colour of the classroom.

4. Modified the number and colour of table chairs in the classroom, as shown in Figures 3.7 and 3.8.

5. Selected the language used in the storyline.

Figure 3.6 Customisation feature: Upload actual school image

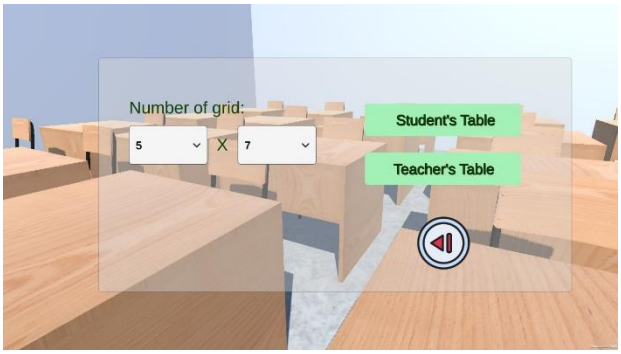

Figure 3.7 Customisation feature: Adjust the number of tables

Figure 3.8 Customisation feature: Select the design of the table

3.1.5 Experts Reviews

In the VRVM storylines, three languages were used: English, Chinese and Malay. Since the VRVM personalised support focused on Malaysia's autism population, some of the children were attending Chinese schools, some were attending Malay schools, and some were attending English schools. Therefore, the language selection enhanced the extent of customisation to fulfil their different needs. Psychology experts reviewed the contents, and the language used in this personalised support to ensure the appropriateness of the language and terms for better understanding by autistic children aged 5 to 7. In a physical meeting with the experts, the language used for Chinese and English versions of the VRVM was discussed, while a Malay expert reviewed the Malay version via email. The completed storylines for each language were attached in

Appendices A to I. For example, the word “stationary” used in the first draft of the VRVM story might not have been understood by the children, so the words “eraser” or “pencil” were suggested by the experts. In the Chinese version, the word “欺负 (qi-fu),” meaning “bully,” might not have been understood by them, so a suggestion “触摸我(chu-mo-wo)” was given as a modification to convey a similar meaning. In the Malay version, the phrase “memperkenalkan diri,” meaning “self-introduction,” might not have been understood by them, so it was modified to “bagi tahu nama,” to convey the meaning of “introduce self by name,”. The experts’ suggestions were considered, and further amendments were made.

3.2 Assessment Tools Used

In this research, three types of assessment tools were used: the Childhood Autism Rating Scale - Second Edition (CARS-2), the Behaviour Assessment System for Children - Third Edition (BASC-3) and the Social Responsiveness Scale - Second Edition (SRS-2). Before the training sessions, the assessment tool CARS-2 was used during the demographic collection stage to filter out participants who did not fulfil the required autism severity level. In this training sessions, children with mild or severe levels of autism severity were recruited based on the CARS-2 results.

The assessment tools BASC-3 and SRS-2 were used to conduct pre-training and post-training tests for improvement comparison after the training sessions. The purpose of using BASC-3 was to identify the behaviour and emotions of the children in both problem behaviour and adaptive skills. The problem behaviours included are anxiety, depression, hyperactivity and attention problems. With

these data provided, it was easier to track children's improvement in the new school, such as whether they were too hyperactive in class or had any focusing issues. The adaptive skills included social skills, adaptability and functional communication to assess children's ability to adapt to new environments and their ability to social contact.

The use of SRS-2 was to identify the social impairment that is related to autism and determine any conditions that affect social functioning. It was commonly used to identify the effectiveness of personalised support aimed to improve an individual's social skills and minimise their autistic symptoms. Furthermore, using BASC-3 and SRS-2 ensured consistency in benchmarking with other personalised support and helped identify internal and external behaviour improvements through the scales.

3.2.1 Childhood Autism Rating Scale - Second Edition (CARS-2)

The Childhood Autism Rating Scale - Second Edition (CARS-2) was involved in the participants' demographic collection stage. It was a 15-item clinician-rated scale that objectively quantified children's direct behavioural observation. Each scale was rated on a scale of 1 to 4, with 1 indicating behaviour within normal limits for that age and 4 indicating severely abnormal behaviour for that age and mid-points were used when the behaviour fell between the two categories. CARS-2 consisted of two rating forms, where the High Functioning (HF) was used for children who had relatively good verbal skills and were above six years old, while the Standard (ST) version was used for children with notably impaired communication or were younger than six years old. In a recent study, both versions of CARS-2 were reported with significant concurrent

validity with the gold standard diagnostic tool for ASD, the Autism Diagnostic Observation Schedule (ADOS) among children in Korea, highlighting its efficacy in identifying children with ASD in a relatively brief amount of time [41].

3.2.2 Behaviour Assessment System for Children - Third Edition (BASC-3)

The Behaviour Assessment System for Children - Third Edition (BASC-3) measured the behaviour and perceptions of children and young adults ages 2 to 25 via a multimethod and multidimensional system [42]. It consisted of 105 to 165 items questionnaire completed by a parent, teacher, or other adult who regularly interacted with the child. In this research, the Parent Rating Scale version for Preschool (PRS-P) was used for toddlers aged 2-5 years old. The Parent Rating Scale version for School Age children (PRS-C) was used for children aged 6 to 18 years old to identify the children's adaptive and problem behaviours from the parent's perspective. The scale assessed various factors in this assessment tool such as hyperactivity, anxiety, etc. The score for each scale indicated the severity of each scale. Therefore, the effect of the VRVM could be examined by contrasting the scales' scores before and after the training sessions.

3.2.3 Social Responsiveness Scale - Second Edition (SRS-2)

The Social Responsiveness Scale - Second Edition (SRS-2) was a standardised assessment tool designed to measure the severity of social impairment associated with autism spectrum disorder [43]. It was widely used in both clinical and research settings due to its robust psychometric properties and comprehensive evaluation of social behaviour [44]. The SRS-2 consisted of 65

items that were completed by the parents of autistic children on a 4-point Likert Scale ranging from “Not True” to “Almost Always True”. In this research, the items in SRS-2 were translated into a Simplified Mandarin Version to adapt to the parents’ limited understanding of the English language. The total score produced was clustered into 5 subscales such as social awareness, social cognition, social motivation, social communication, and repetitive restricted interests and behaviours. The scale was proven to have a strong test-retest reliability internal consistency, $\alpha = 0.93$ [45]. The total score generated for the pre-training and post-training was compared to identify the effectiveness of personalised support used.

3.3 Participants Selection

Table 3.1 Participant Demographics

Participants	**Age**	**Gender**	**CARS-2 T-Score**
P1	5	Female	33; mild
P2	7	Female	29.5; mild
P3	5	Male	38.5; severe
P4	6	Male	29.5; mild
P5	7	Female	36.5; mild
P6	7	Male	32.0; mild
P7	6	Male	30.5; mild

Before conducting the pre-training test, participant selection was carried out to filter the participants who met the requirements of the training sessions. In this research, autistic children aged 5 to 7 years old were recruited, as children in this age range were about to attend primary school, where they might face many adaptation issues in the new school. Therefore, training sessions was necessary before they attended school. Also, high-functioning autistic children were

involved to ensure they could understand the storylines and the instructions given. In order to recruit suitable participants, some strategies were conducted such as carrying out an online briefing to the parents to explain the process, reaching out to nurseries with autistic children from several states including Perak, Selangor, Kedah and Penang, and sharing the recruitment poster in autistic-related Facebook groups. Unfortunately, due to a low response rate, only 10 participants agreed to join the personalised support training and 2 of them did not meet the requirement as they have developmental delay instead of autism, and 1 participant was unable to schedule a timeslot to join. After the participants' selection, the visiting timeslots were allocated for each participant based on their availability. Thus, the pre-training test was conducted during the first visit, and the participants who did not fulfil the requirements were excluded, such as autism severity outside the required range based on the CARS-2 results, low IQ, an inability to understand the contents of the VRVM, or failure to schedule the available timeslot to join the training. As a result, a total of seven participants who fulfilled the requirements were involved in the training sessions, as shown in Table 3.1.

3.4 The Process of the Training

The training sessions were conducted from January 2024 to March 2024 with several weekly sessions separated. All the personal data collected from the training sessions were approved by the Universiti Tunku Abdul Rahman, Scientific and Ethical Review Committee. The training was conducted in the following phases:

Pre-training Phase: During the first visit, the parents of autistic children were required to complete the pre-training assessment by using the assessment tools: CARS-2, SRS-2 and BASC-3. The data collected from CARS-2 ensured that the children's autism severity was within the required range.

Personalised Support Training Phase: The training sessions were conducted once per week before the opening of school in March 2024. Each session was conducted for about 1 hour and individually for each participant. The number of training sessions ranged from 3 to 6, depending on the participants' availability and training performance. After the training at the venue, parents were encouraged to let their children continue experiencing the VRVM at home. However, some children may have refused to engage with the VRVM repeatedly at home, which leads to the necessity of additional training. During the training sessions, autistic children were required to wear the Google Cardboard HMD to experience the VM.

Post-training Phase: Two post-training tests were carried out using SRS-2 and BASC-3 with the assistance of a trainee clinical psychologist. The first test was conducted after the final training session, while the second test was conducted one week after autistic children attended school. The purpose of conducting post-training tests twice was to assess the lasting effectiveness of the VRVM personalised support and identify the persistence of the VRVM personalised support until the opening of school.

Evaluation: After collecting the pre- and post-training assessment results, a trainee clinical psychologist was involved in evaluating the assessments. The

effectiveness of the VRVM was assessed by comparing and interpreting the results.

3.5 Chapter Conclusion

In this chapter, the research questions were identified in guiding the design of the personalised support to solve the research questions. The design of the VRVM personalised support was discussed, including the stories designed and the customisation features provided. After the first draft of the personalised support was developed, it was reviewed by a few psychological experts in order to assess whether the support was suitable for autistic children aged 5 to 7.

During the personalised support training stage, three assessment tools were involved, namely CARS-2, which was implemented during the demographic collection stage, and BASC-3 and SRS-2, which were utilised to collect participants' pre- and post-training results. The CARS-2 was used to identify the severity of autism in children. Moreover, the BASC-3 was used to assess the children's adaptive and problem behaviours, while the SRS-2 was used to measure the severity of social impairment.

The participants' selection was discussed in the following paragraph. The data collected before the training sessions were shown, including their age, gender and the CARS-2 score indicated their autism severity. In this research, children with mild and severe levels of autism were recruited to participate.

Furthermore, the completed training process was assessed, including the pre-training phase, personalised support training phase, post-training phase and evaluation phase. The data collected from the participants in the pre- and post-

training phases by using BASC-3 and SRS-2 were evaluated and analysed in the evaluation phase.

CHAPTER 4

RESULTS

4.1 The Overall Result of Pre- and Post- Training

4.1.1 The Comparison of Participant Outcomes in Each Scale

After the personalised support training sessions, the pre-training results are compared with the post-training results. Figures 4.1 and 4.2 show the number of participants who show improvement in each scale of the BASC-3 and SRS-2. As shown in Figure 4.1, the scales of BASC-3 where more than 50% of participants show improvement are hyperactivity, externalising problems, anxiety, somatisation, internalising problems, atypicality, withdrawal, behavioural symptoms index, adaptability, social skills, functional communication, activities of daily living, and adaptive skills. Notably, the scale of adaptive skills, where 7 out of 7 participants show improvement after the training sessions. This indicates that they are better able to adapt to new environments and interact with friends or adults. Moreover, the scale of social skills, with 6 out of 7 participants improving after the training sessions, indicates that they are more capable of interacting with peers, and adults in different settings, including home, school, and community. Similarly, the withdrawal scale, with 6 out of 7 participants showing improvement, indicates a reduction in the tendency to evade others to avoid social situations. The internalising problem scale, which combined the scales of anxiety, depression and

somatisation, has 5 out of 7 participants showing improvement after the personalised support training sessions. This indicates that the participants who completed the personalised support training sessions experienced less worry and stress. Therefore, making them less sensitive to some minor physical problems.

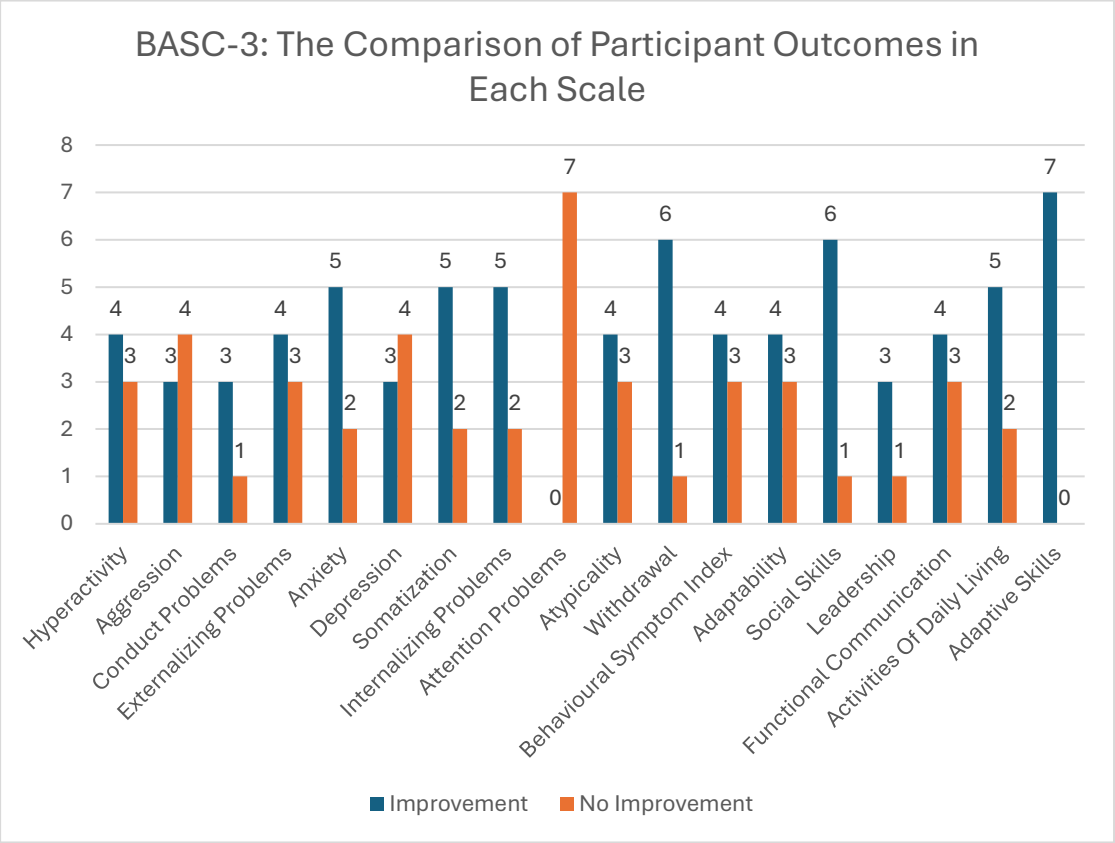

Figure 4.1 The number of participants that have improved compared to those without an improvement in BASC-3

Figure 4.2 indicates that the scales of SRS-2 where more than 50% of participants show improvement are social motivation, and restricted interests and repetitive behaviour. The improvement in the scale of social motivation indicates that the participants are calmer when alone, more confident when interacting and more willing to join group activities. In addition, the improvement in the scale of restricted interests and repetitive behaviour shows

that the participants minimised strange behaviours and abnormal sensory interests, like mouthing or repeatedly flapping their hands.

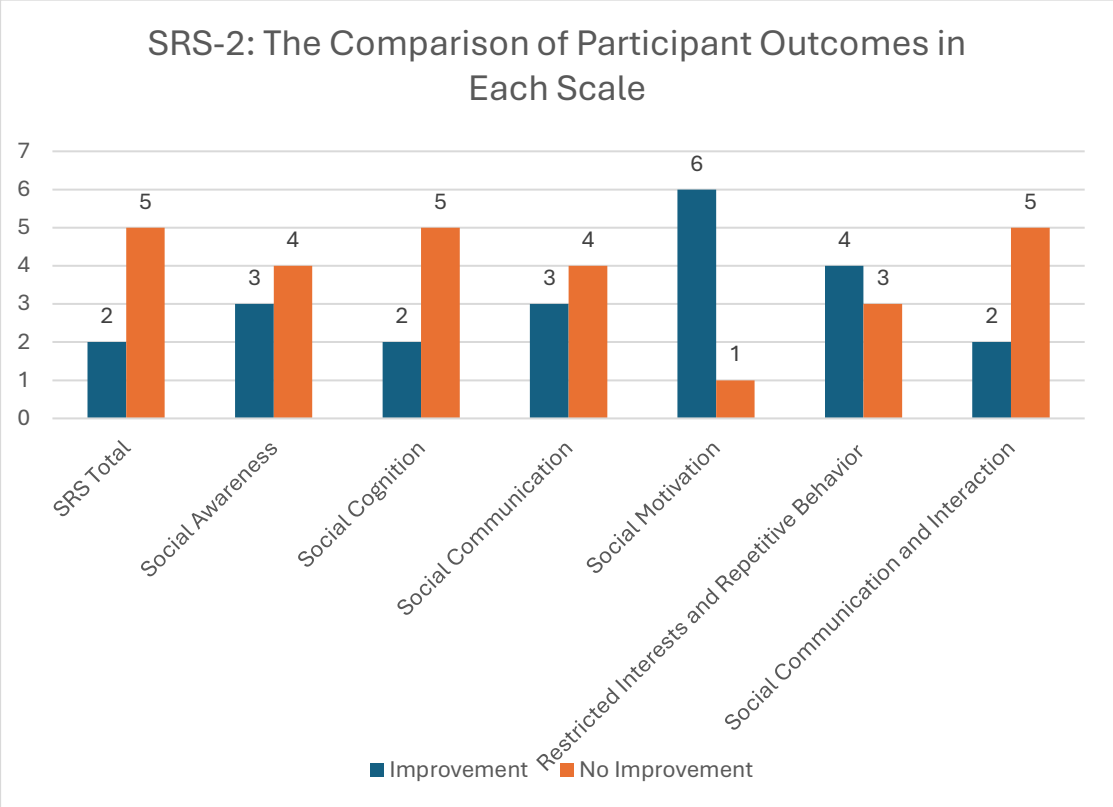

Figure 4.2 The number of participants that have improved compared to those without an improvement in SRS-2

4.1.2 The Effect Sizes for Each Assessment Scale

Figure 4.3 shows the mean scores of the pre-training result, first post-training result, and second post-training result for each scale of BASC-3. The effect size for each scale of BASC-3 is calculated using Cohen's d value, based on the formula provided below.

$$d = \frac{M_1 - M_2}{\sqrt[2]{\frac{(\sigma_1^2 + \sigma_2^2)}{2}}} \qquad (4.1)$$

where, M_1= mean scores of the pre-training result,

M_2= mean scores of the latest post-training result,

σ_1 = standard deviation of the pre-training result,

σ_2 = standard deviation of the latest post-training result.

Scales with an effect size, represented by Cohen's d value greater than 0.200, are considered practically significant, with a d value greater than 0.5 indicating a medium effect, and greater than 0.8 indicating a large effect [46, 47]. Cohen's effect size is a standardised measurement that measures the magnitude of an effect, and it is not directly affected by the sample size, making it appropriate for this research given the small sample size in the personalised support training sessions [48]. The following scales of BASC-3 show a practically significant effect size: hyperactivity, conduct problems, externalising problems, anxiety, internalising problems, atypicality, withdrawal, behavioural symptom index, social skills, leadership, functional communication, activities of daily living, and adaptive skills. The greatest effect size, in the hyperactivity scale, with a d value of 1.247, shows that the participants significantly decreased hyperactivity in class. With a nearly large effect size of d = 0.739, the behavioural symptom index scale, which combined the scales of attention problems, atypicality, and withdrawal, indicates that the participants are better able to concentrate in class and exhibit fewer odd behaviours.

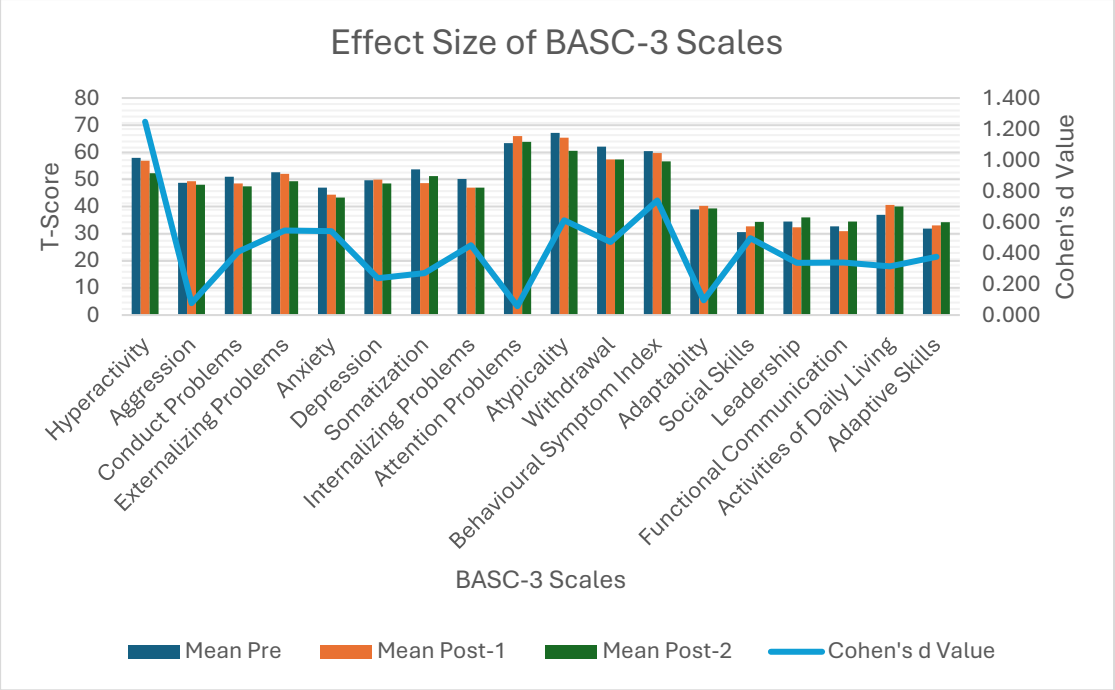

Figure 4.3 Effect size of BASC-3 Scales

Figure 4.4 shows the mean scores of the pre-training result, first post-training result, and second post-training result for each scale of SRS-2. The effect size for each scale of SRS-2 is calculated using Cohen's d value, as outlined earlier. The scales of SRS-2, social awareness, social motivation, and restricted interests and repetitive behaviour are practically significant, with effect sizes of d = 0.546, 0.493, and 0.434, respectively. With a practically significant effect size in the social awareness scale, it shows that the participants improve their understanding of reciprocal social situations, which also highlights a positive indication of their improvement in adapting to a new environment.

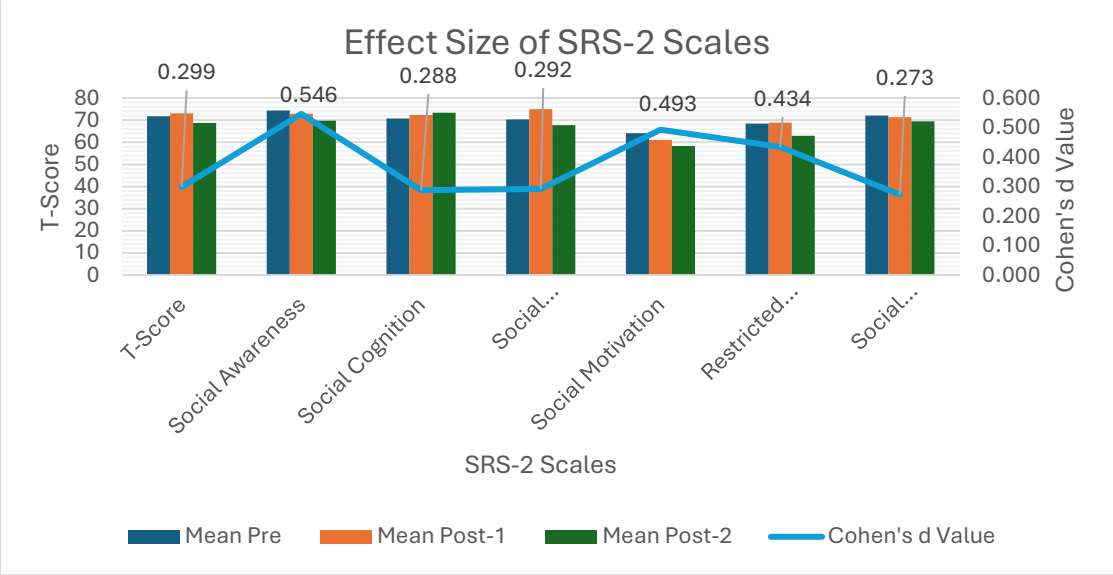

Figure 4.4 Effect size of SRS-2 Scales

4.2 Analysis of the Results for Each Participant

4.2.1 Behaviour Assessment System for Children - Third Edition (BASC-3)

The personalised support training results in significant improvements across various BASC-3 scales for all participants, as shown in Figures 4.6 to 4.7. For Participant P1, the improvements are shown in the scales of atypicality, withdrawal, activities of daily living, and adaptive skills. The improvement in the withdrawal scale indicates that Participant P1 decreases the tendency to evade others to avoid social contact with them, suggesting a positive change in social engagement. Social engagement is critical for school adaptation, as social contact is one of the primary challenges in transitioning to a new school [49]. Also, the reduction of abnormal behaviour is highlighted in the atypicality scale. This may reduce the chance of autistic children being teased for their “odd” behaviour. For Participant P2, a great improvement is exhibited in the scales of hyperactivity, aggression, conduct problems, anxiety, somatisation, atypicality, social skills, and adaptive skills while Participant P3 shows improvement in

hyperactivity, anxiety, somatisation, withdrawal, and functional communication. The decreases in anxiety and somatisation issues for both Participants P2 and P3 result in fewer worries and complaints by autistic children as physical complaints such as headaches and stomachaches are often due to emotional distress [50]. The improvement is leading the participants P2 and P3 to feel more comfortable and reducing their insecurity when adapting to the new school. The improvement in the hyperactivity scale for both Participants P2 and P3 highlights the reduction in hyperactive behaviour in class. This improvement indicates that VRVM personalised support may effectively help autistic children in promoting their self-regulation skills, leading them to focus in the classroom and engage in school activities.

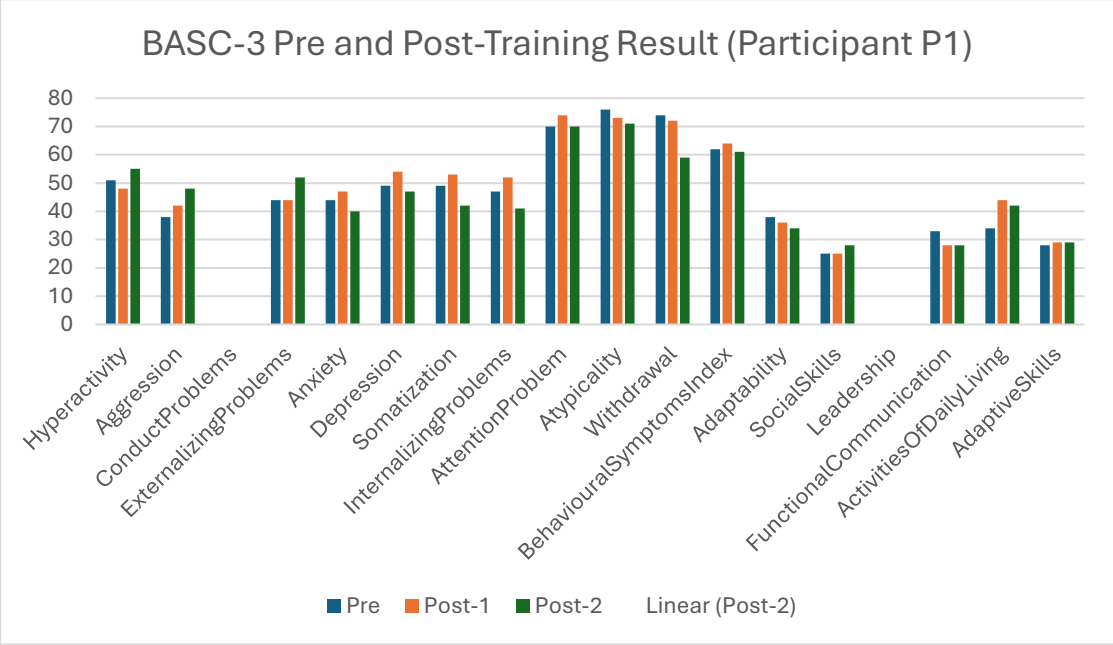

Figure 4.5 BASC-3 Pre- and Post-Training Result for Participant P1

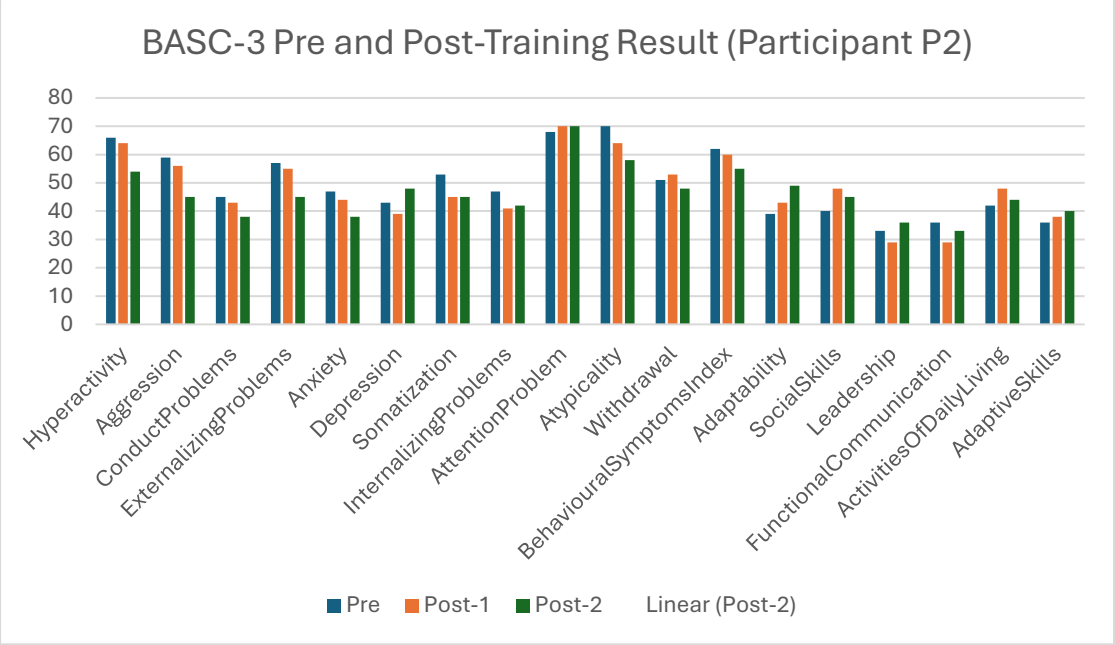

Figure 4.6 BASC-3 Pre- and Post-Training Result for Participant P2

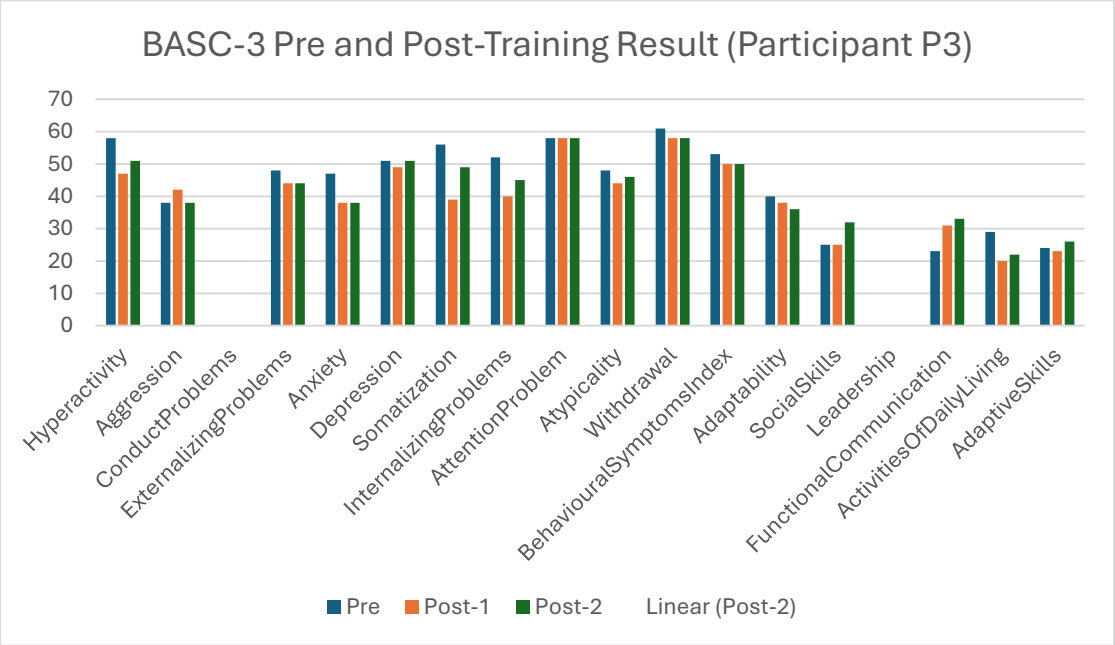

Figure 4.7 BASC-3 Pre- and Post-Training Result for Participant P3

As presented in Figures 4.8 and 4.9, Participant P4 improves in the scales of anxiety, depression, somatisation, adaptability, and social skills, while Participant P5 shows improvement in the scales of aggression, conduct problems, anxiety, atypicality, withdrawal, activities of daily living, and

adaptive skills improved. From the improvement shown in Figures 4.8 and 4.9, both Participants P4 and P5 are less likely to be nervous and fearful about attending school suggesting the improvement in confidence and emotional regulation. Also, the improvement in the depression scale for Participant P4 highlights the reduction of stress results in being unable to carry out daily tasks which will be helpful for autistic children to perform their tasks in school. Generally, high stress levels may cause difficulty in carrying out tasks like participating in classroom activities, and completing homework given by teachers [51].

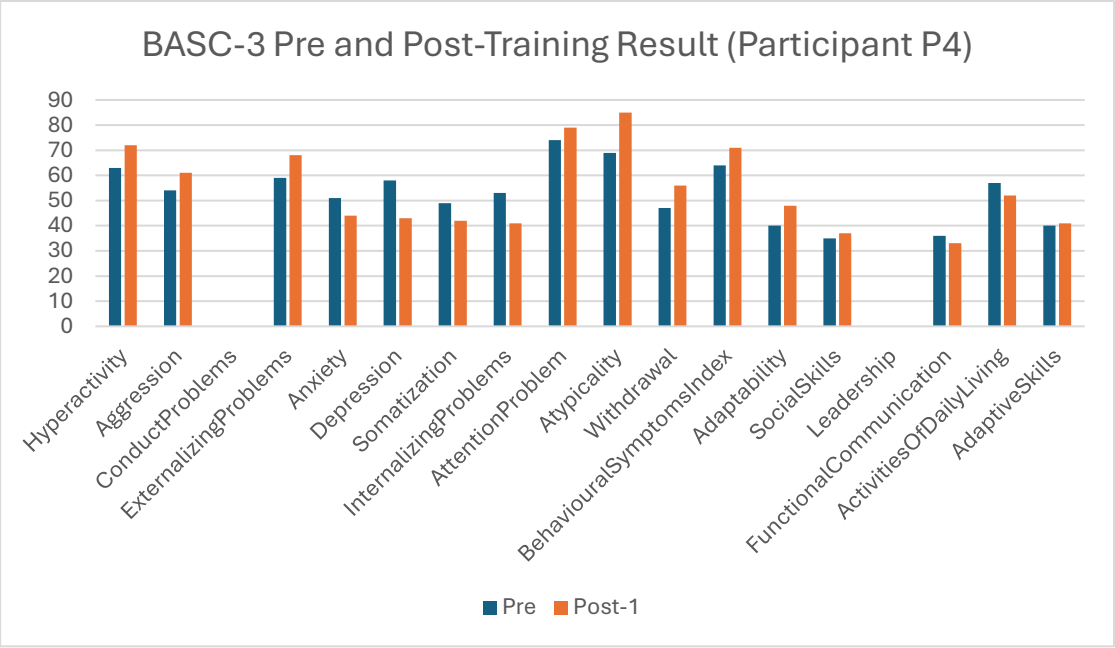

Figure 4.8 BASC-3 Pre- and Post-Training Result for Participant P4

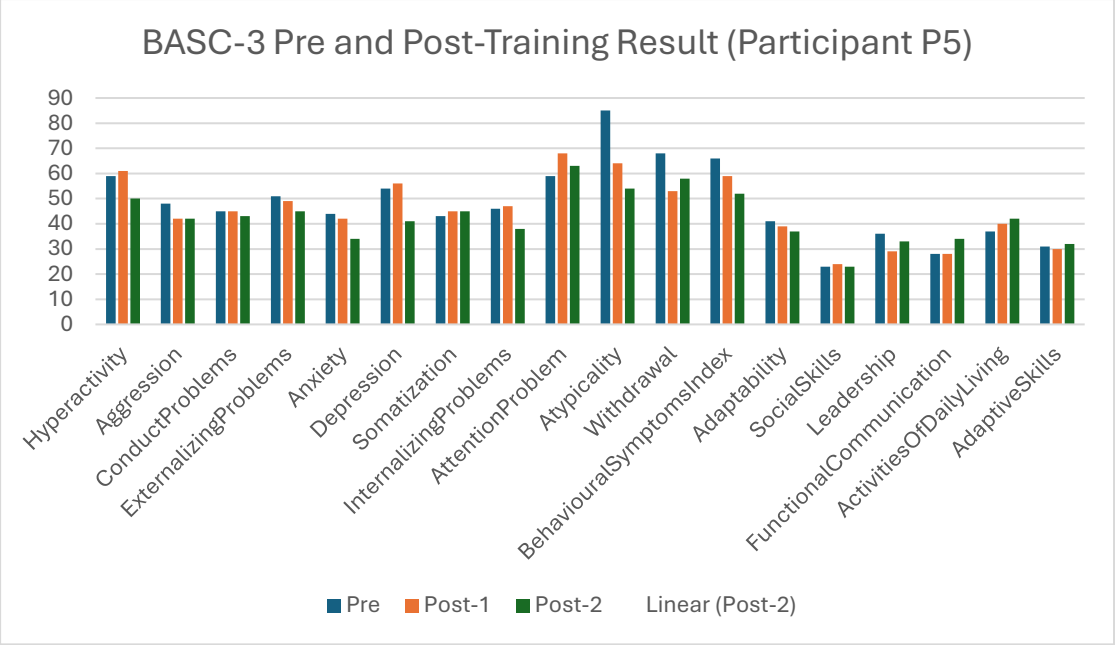

Figure 4.9 BASC-3 Pre- and Post-Training Result for Participant P5

As shown in Figures 4.10 and 4.11, Participant P6 shows improvement in the BASC-3 scales of withdrawal, adaptability, social skills, leadership, activities of daily living, and adaptive skills as well as Participant P7 improves in hyperactivity, aggression, conduct problems, somatisation, withdrawal, social skills, activities of daily living, and adaptive skills. As shown in the improvement in the withdrawal scale, participants P6 and P7 enhance their tendency to meet new friends. As they are more open to forming a connection with peers, enhances their friendship quality and builds a sense of belonging to the school [49]. Meanwhile, the improvement in the scale of social skills indicates that the ability to interact with people is improved. This scale is critical for a long-term school adaptation as it allows autistic children to build

connections with friends, and work collaboratively in classroom activities with their classmates.

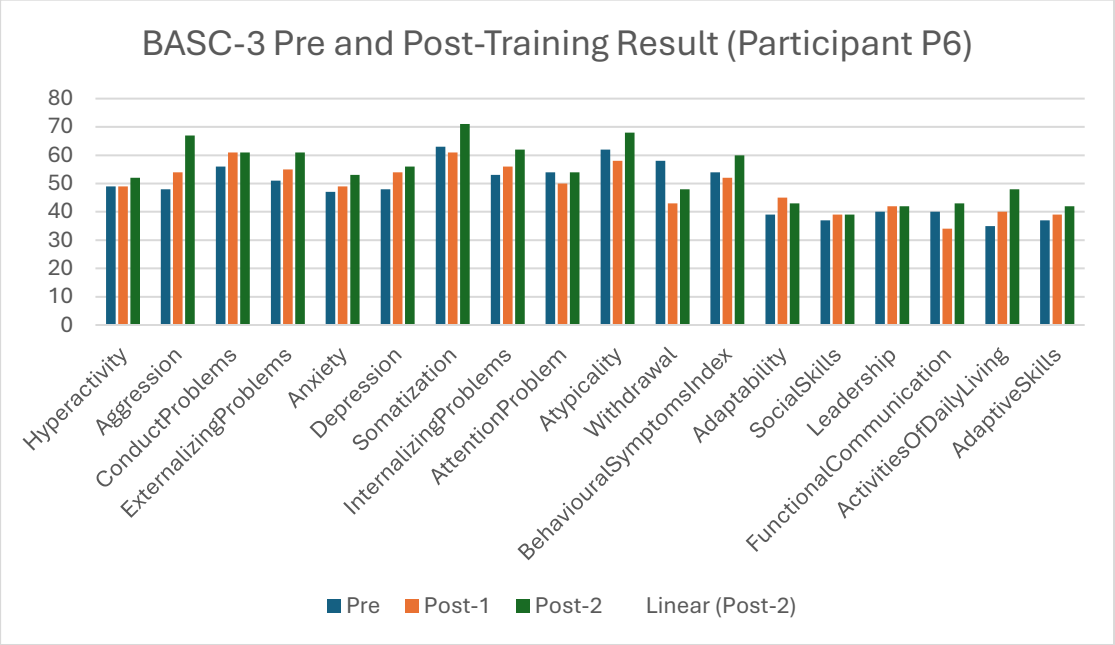

Figure 4.10 BASC-3 Pre- and Post-Training Result for Participant P6

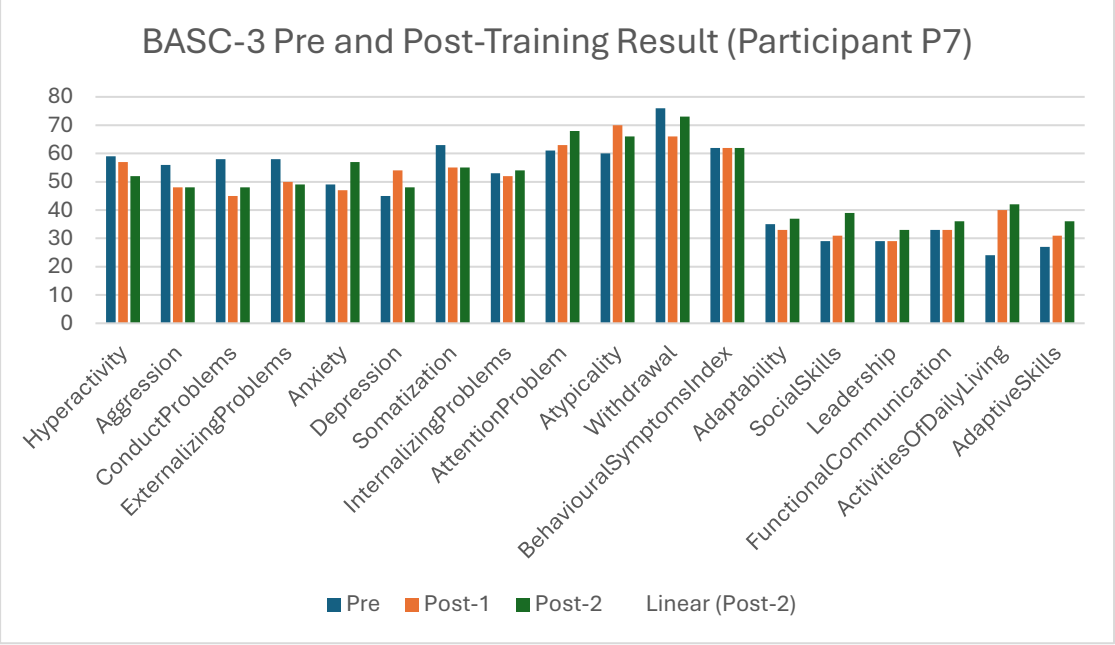

Figure 4.11 BASC-3 Pre- and Post-Training Result for Participant P7

4.2.2 Social Responsiveness Scale - Second Edition (SRS-2)

Participant P1 improves on the SRS-2 scale for restricted interest and repetitive behaviours, as shown in Figure 4.12. On this scale, a lower score indicates fewer related issues. Participant P1 improved from a score of 86 to 78 but there is a slight increase to 80 after attending the actual school. This fluctuation may be caused by other factors that occur in the actual school environment which are not fully replicated in the personalised support. For example, there are some unpredictable environmental stimuli presented in the real school context such as crowded spaces, and noise levels.

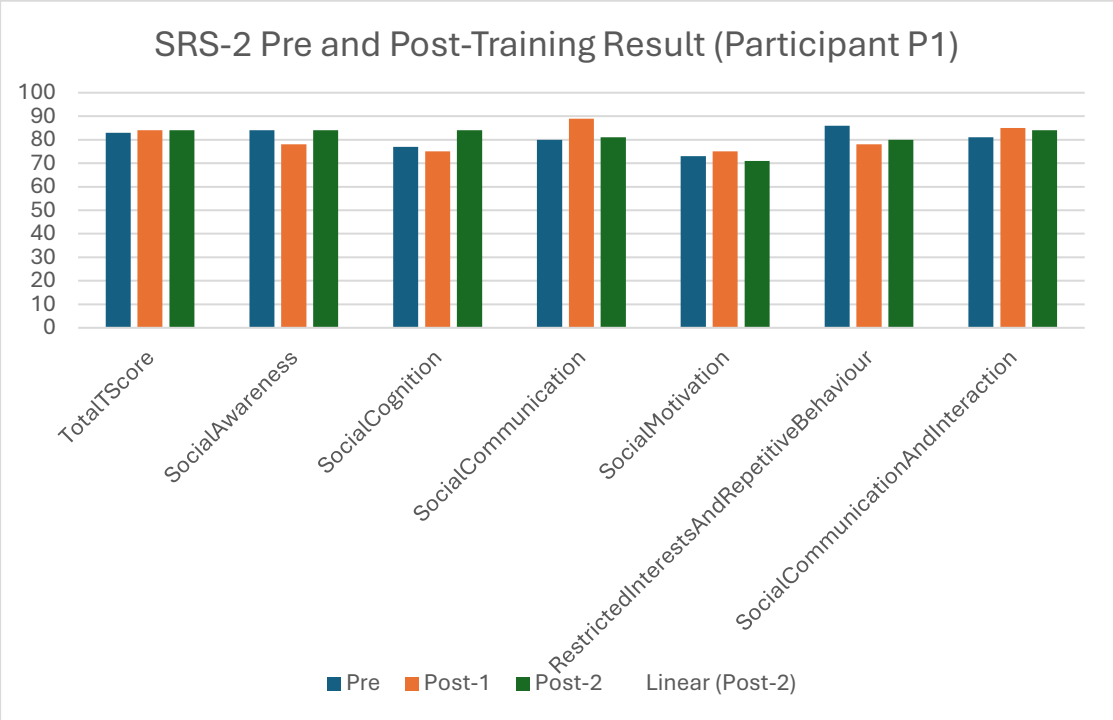

Figure 4.12 SRS-2 Pre- and Post-Training Result for Participant P1

As shown in Figure 4.13, Participant P2 improves on the scale of social motivation from a score of 51 to 45 after completing the personalised support training sessions. The enhancement in this scale indicates that the participant is more motivated to participate in social interaction, with less anxiety. The motivation in social interaction suggests that the willingness to connect with

people of participant P2 is improving which can effectively affect the participant's overall social competence in the new school environment [40].

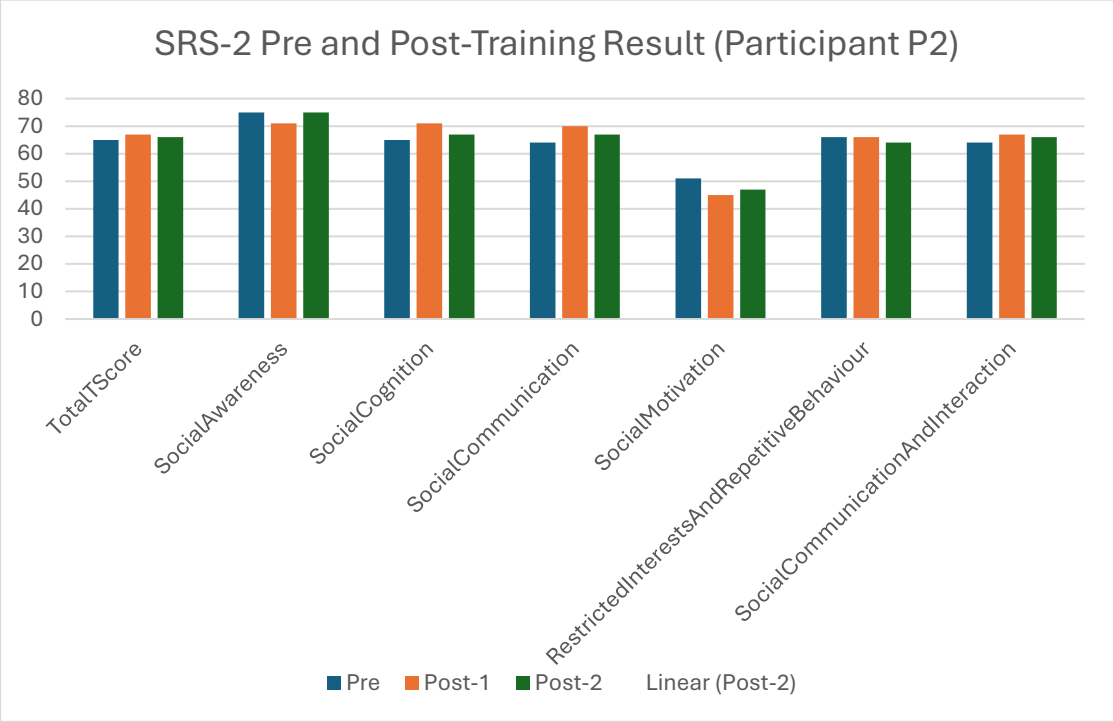

Figure 4.13 SRS-2 Pre- and Post-Training Result for Participant P2

Participant P3 improves greatly on the scale of social communication and interaction, from a score of 71 to 55 after completing the personalised support training sessions, as shown in Figure 4.14. However, the score increases to 63 after attending the actual school. In this situation, this may be influenced by other environmental factors at school. Meanwhile, VRVM personalised support does not aim to enhance participants' social and communication deficits which are addressed in the scale of social communication and interaction.

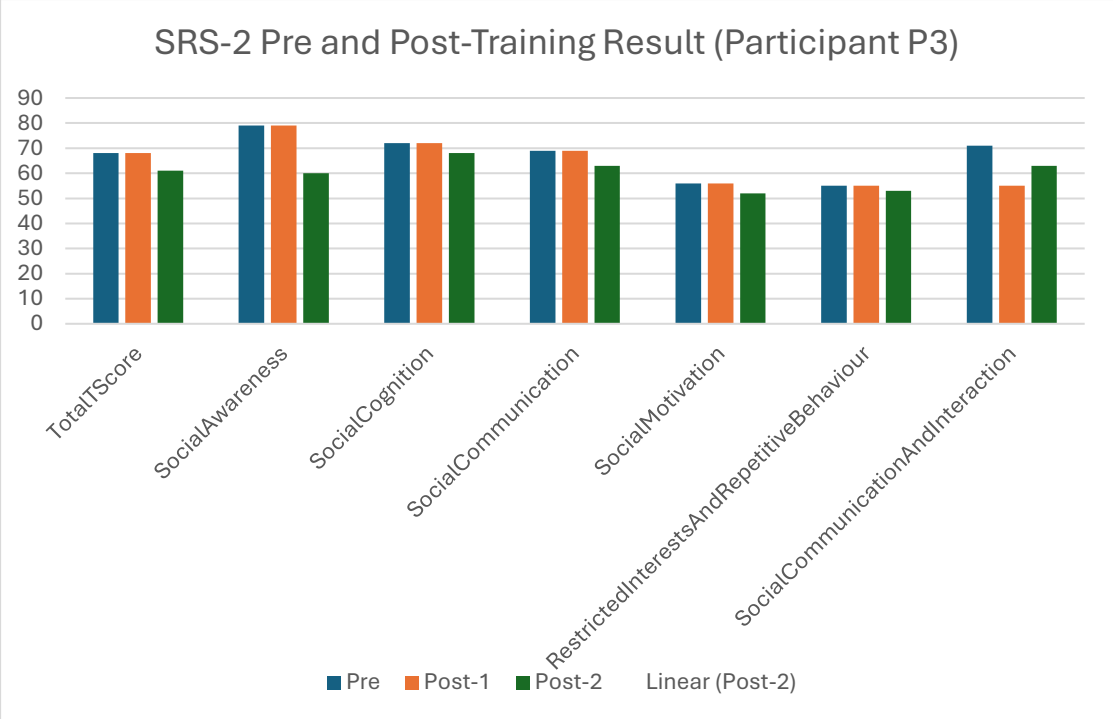

Figure 4.14 SRS-2 Pre- and Post-Training Result for Participant P3

After attending the personalised support training sessions, Participant P4 shows a slight improvement in the social motivation scale, indicating an increased motivation to engage in social situations, as shown in Figure 4.15. However, Participant P4 is absent from the second post-test due to personal scheduling conflicts and is unavailable to complete the second post-test before school opens.

Therefore, the effect of the personalised support after attending the school remains unknown for this participant.

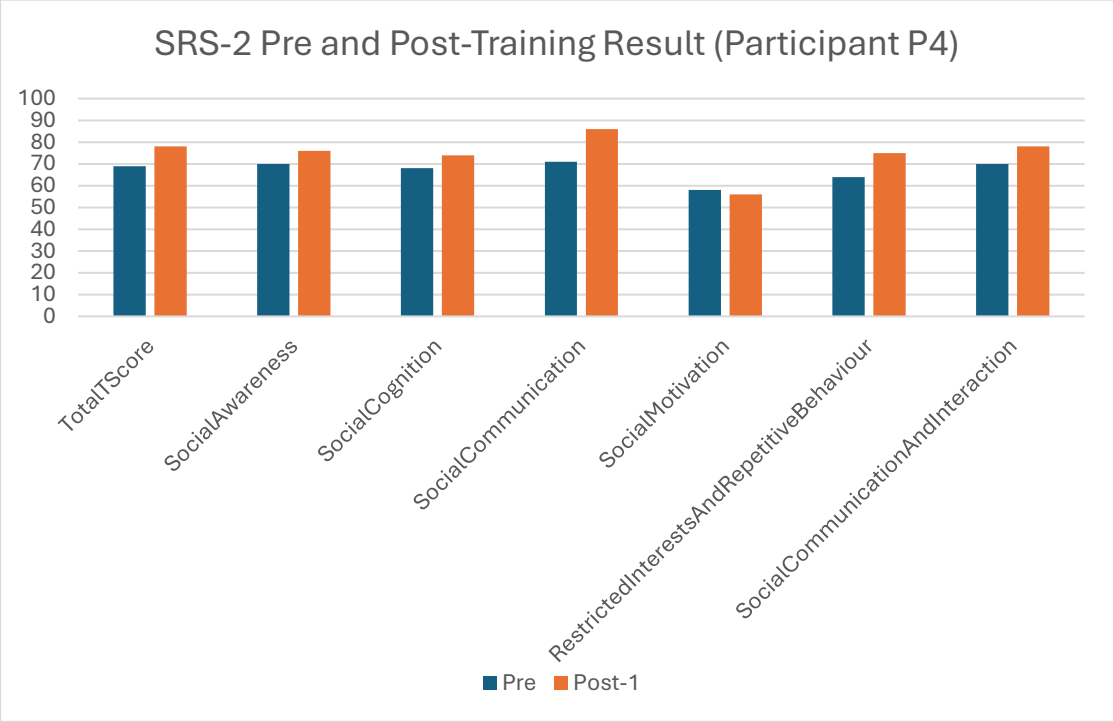

Figure 4.15 SRS-2 Pre- and Post-Training Result for Participant P4

Participant P5 shows an improvement across all the scales in SRS-2. The greatest difference between the pre-test and the first post-test is on the restricted interest and repetitive behaviour scale, which has a score difference of 22, as shown in Figure 4.16. For Participant P5, the stereotypical behaviours of autism, such as body rocking, toe walking and sniffing are minimised. Moreover, the enhancement in the social cognition scale, which is from a score of 88 to 82, indicates that Participant P5 improves the ability to interpret social cues in social interaction. Previous research showed first-person VM is helpful in enhancing their cognitive ability to understand other's feelings [31]. Social cognition plays a role in understanding and responding to social situations accordingly such as understanding facial expression, body language and tone of voice. Meanwhile,

the score improvement in the social communication scale indicates that Participant P5 is better able to express feelings to others.

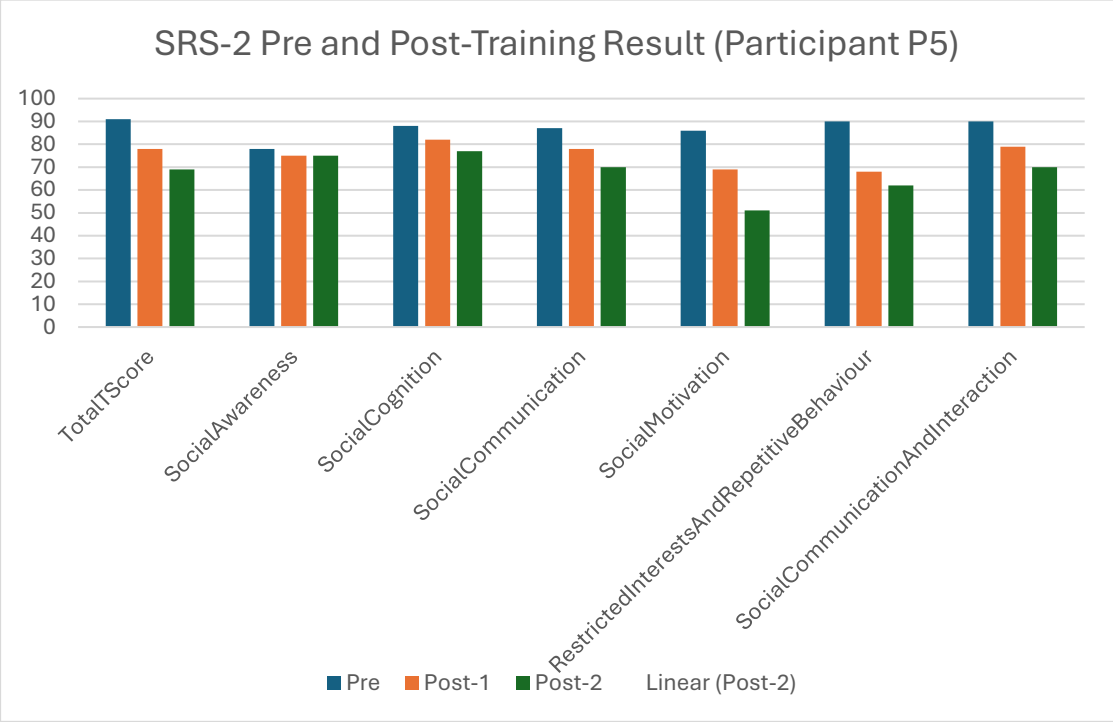

Figure 4.16 SRS-2 Pre- and Post-Training Result for Participant P5

As shown in Figure 4.18, Participant P6 has a slight improvement in the social communication scale, which indicates that the ability in expressive communication is improved. Furthermore, the improvement of Participant P7 after the personalised support training sessions is shown in Figure 4.19, including the scales of social awareness, social cognition and social motivation. In this circumstance, Participant P7 improves in picking up the social cues from others, interpreting the social cues and being willing to interact with them. Previously, difficulties in interpreting nonverbal cues may lead to an inappropriate response in a particular social situation [52]. The improvement of

participant P7 in interpreting enhances the appropriate responding capability and forms a better interaction with peers and teachers.

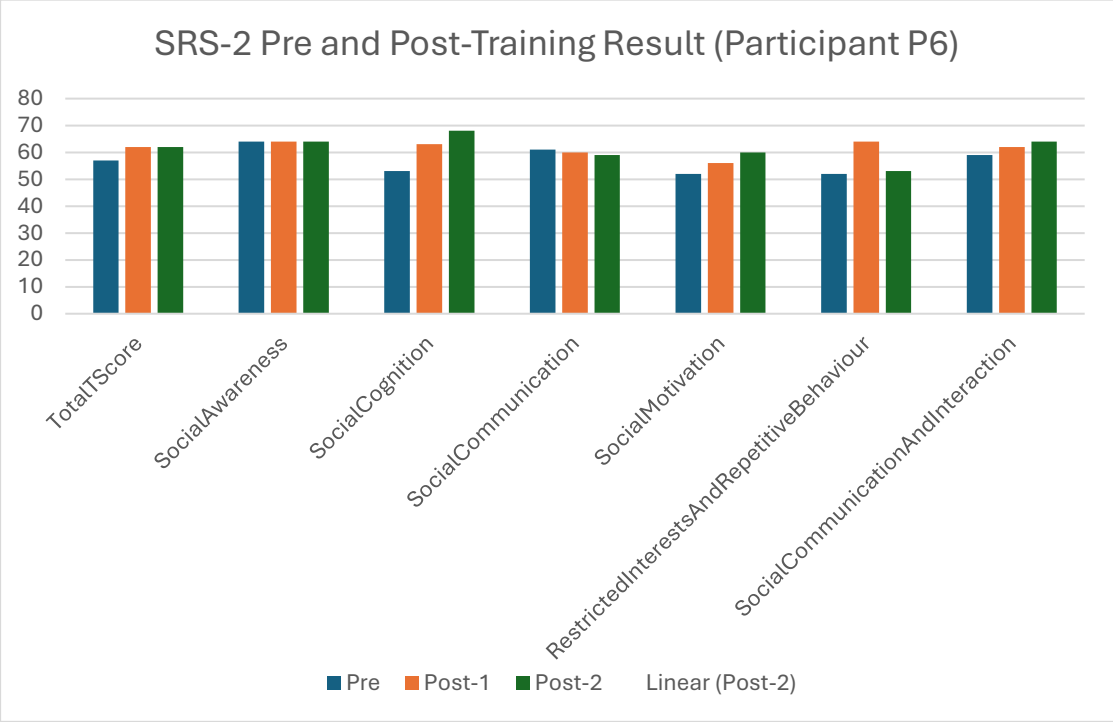

Figure 4.17 SRS-2 Pre- and Post-Training Result for Participant P6

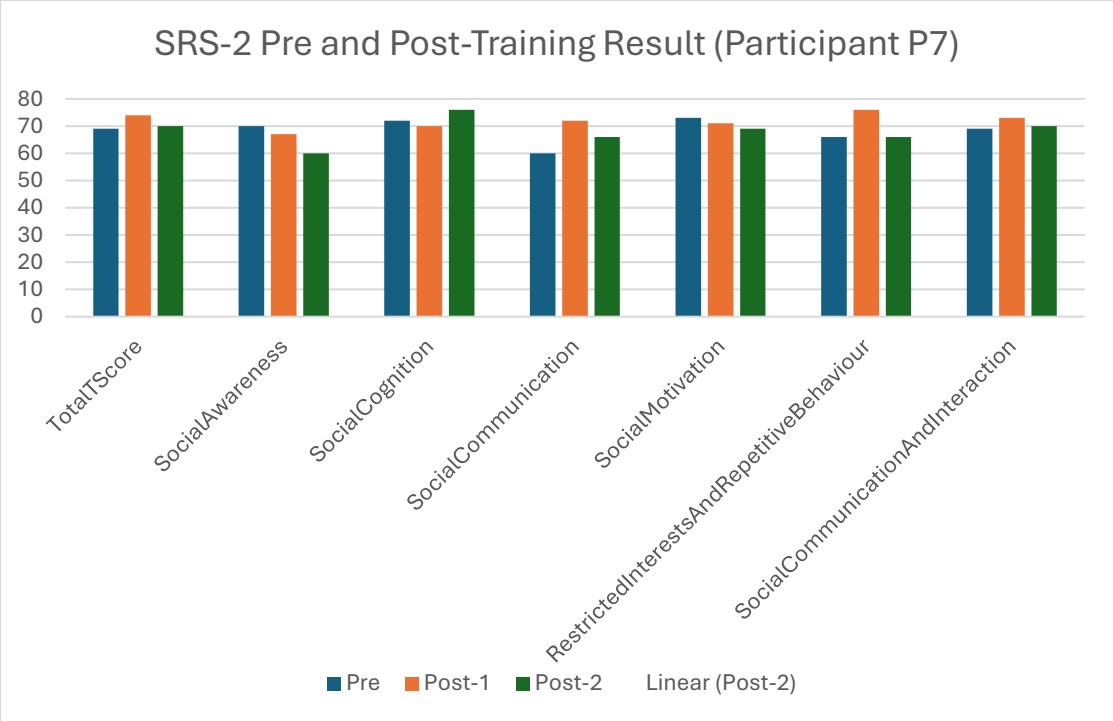

Figure 4.18 SRS-2 Pre- and Post-Training Result for Participant P7

4.3 Clusters Results of All Participants in BASC-3

4.3.1 Adaptive Skills Cluster

The adaptive skills cluster includes the scales of adaptability, activities of daily living, functional communication, social skills, and leadership from BASC-3. In this cluster, all participants show improvement when comparing the pre-training result to the latest post-training result. This cluster demonstrates the ability of autistic children to adapt to new environments, express their ideas, communicate with people effectively, and interact with peers or adults in home, and school settings. A higher score in this cluster indicates a greater ability of autistic children in adaptive skills. As shown in Figure 4.20, the latest post-training results are improved compared to pre-training results for each participant. According to the scores represented in the graph, Participants P4 and P6 improve from the at-risk class to the average class, while Participant P7 improves from the clinically significant class to the at-risk class.

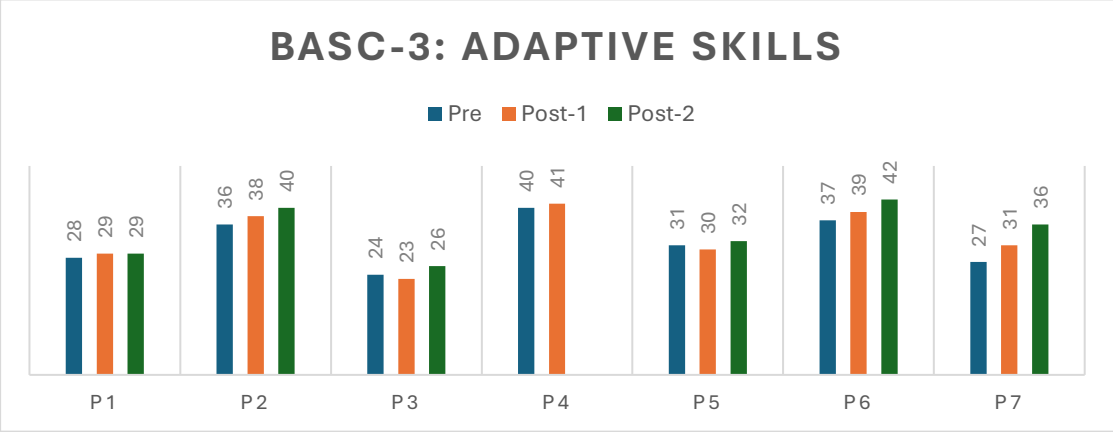

Figure 4.19 Adaptive Skills Cluster Results for Each Participant

4.3.2 Internalising Problems Cluster

The internalising problems cluster includes the scales of anxiety, depression, and somatisation as shown in Figure 4.21. This cluster shows the tendency of autistic children to be nervous, fearful, worried about certain problems, overly sensitive to problems, and to experience feelings of unhappiness, sadness, stress, and insecurity which may prevent them from carrying out daily tasks [51, 53]. A higher score in this cluster signifies more severe internalising problems. After the personalised support training sessions, 5 out of 7 participants show a decrease in their internalising problems score, indicating that the personalised support helps reduce feelings of stress, nervousness, etc. Participant P5 improves from the average class to the low class, implying that she has minimised internalising problems such as anxiety, and depression.

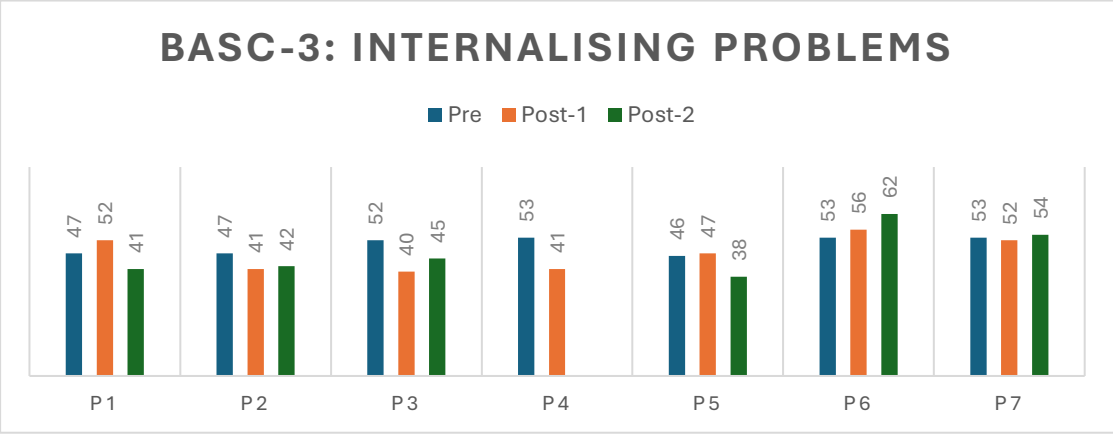

Figure 4.20 Internalising Problems Cluster Results for Each Participant

4.3.3 Behavioural Symptoms Index Cluster

The behavioural symptoms index cluster includes the scales of hyperactivity, aggression, depression, attention problems, atypicality, and withdrawal. This cluster reflects the tendency of autistic children to act in a hostile manner, be easily distracted, behave differently, be overly active, and evade others to avoid

social contact. The presence of such behaviours may cause difficulty in new school adaptation [54]. A lower behavioural symptoms index value implies fewer related problems in this cluster. As seen in Figure 4.22, the behavioural symptoms index value decreases for 4 out of 7 participants after the personalised support training sessions. Participants P2 and P5 improve from the at-risk class to the average class in this cluster.

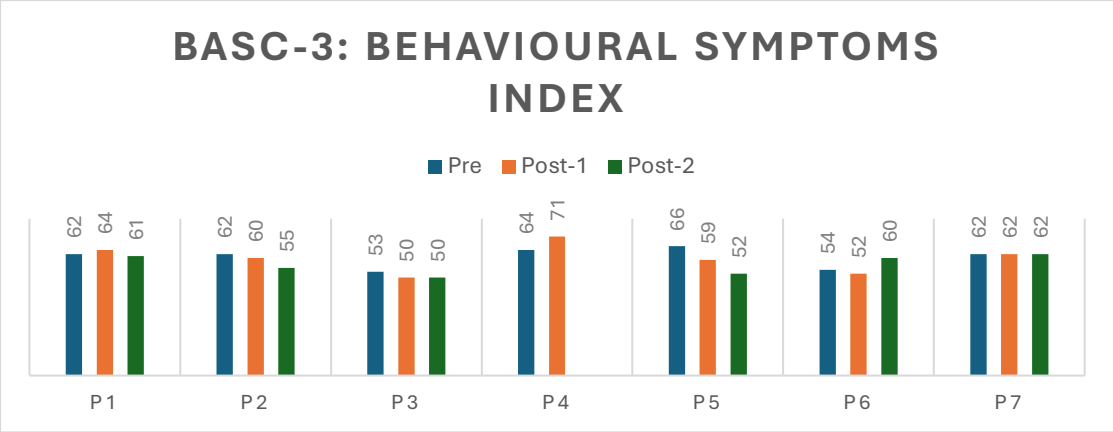

Figure 4.21 Behavioural Symptoms Index Cluster Results for Each Participant

4.3.4 Externalising Problems Cluster

The externalising problems cluster includes the scales of hyperactivity, aggression, and conduct problems. This cluster assesses the tendency of autistic children who act without thinking, threaten others, display antisocial behaviour, and break rules. Externalising-related behaviours are generally caused by the inability to control impulses and lead to disruptions in a structured environment like school [55]. Therefore, a higher score in the externalising problems cluster indicates more severe externalising problems in each participant. After the personalised support training sessions, 4 participants improve in this cluster as shown in Figure 4.23.

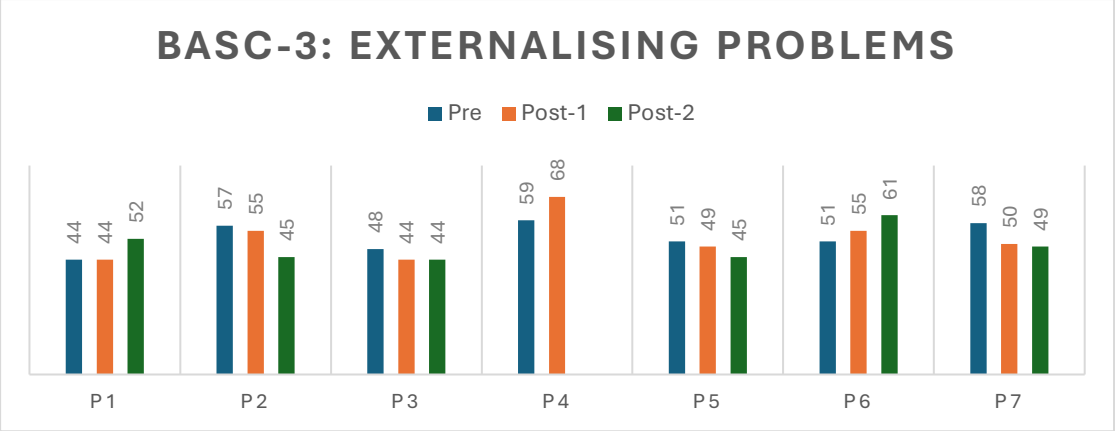

Figure 4.22 Externalising Problems Cluster Results for Each Participant

4.4 Scale Results of All Participants in SRS-2

4.4.1 Social Motivation Scale

However, some scales of SRS-2 show that the VRVM personalised support helps autistic children minimise related symptoms, such as social motivation, and restricted and repetitive behaviours. Symptoms in the social motivation scale include being more fidgety when alone, lacking confidence when interacting with others, being overly dependent on adults, being unlikely to join group activities, etc. As seen in Figure 4.24, 6 out of 7 participants show improvement after the personalised support training sessions, with the latest post-training results being lower than the pre-training results. Remarkably, participant P5's score dropped from 86 to 51, which implies the participant improves from the severe range to the normal range. The improvement in social motivation suggests that autistic children show a higher interest in social engagement after the personalised support training sessions. Through VRVM, they are allowed to practice and familiarise themselves with real-world interaction in a virtual environment which will slowly enhance their confidence in such situations [56].

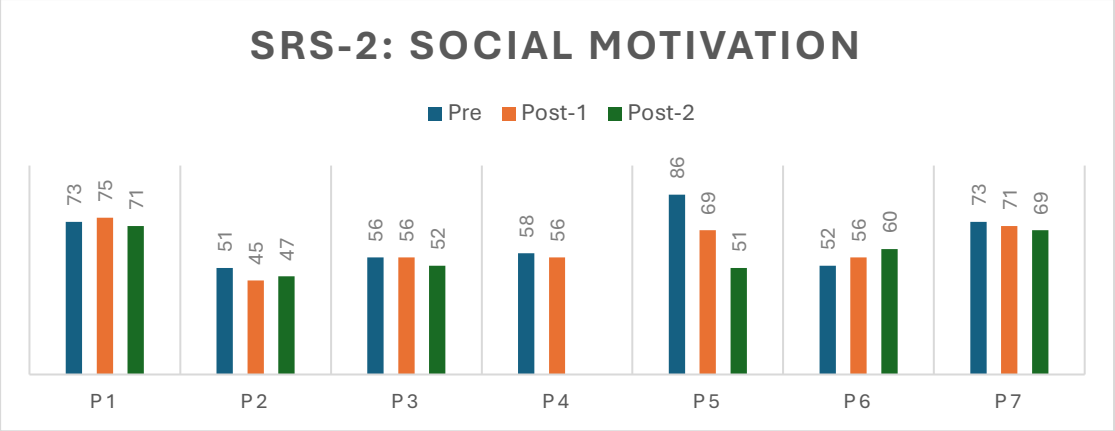

Figure 4.23 Social Motivation Scale Results for Each Participant

4.4.2 Restricted Interests and Repetitive Behaviour Scale

Moreover, the symptoms involved in the scale of restricted interests and repetitive behaviour include behaving strangely, showing abnormal sensory interest such as mouthing, and exhibiting repetitive and abnormal behaviours like flapping hands. Previously, the appearance of abnormal behaviours may have been driven by the self-stimulatory mechanisms that affect emotion regulation and empower feelings of discomfort in a new environment [57]. After the personalised support training sessions, 4 participants show improvement in this cluster by demonstrating a decrement in their latest post-training results, as shown in Figure 4.25. In this cluster, Participant P2 improves from the moderate range to the mild range, while Participant P5 improves from the severe range to the mild range.

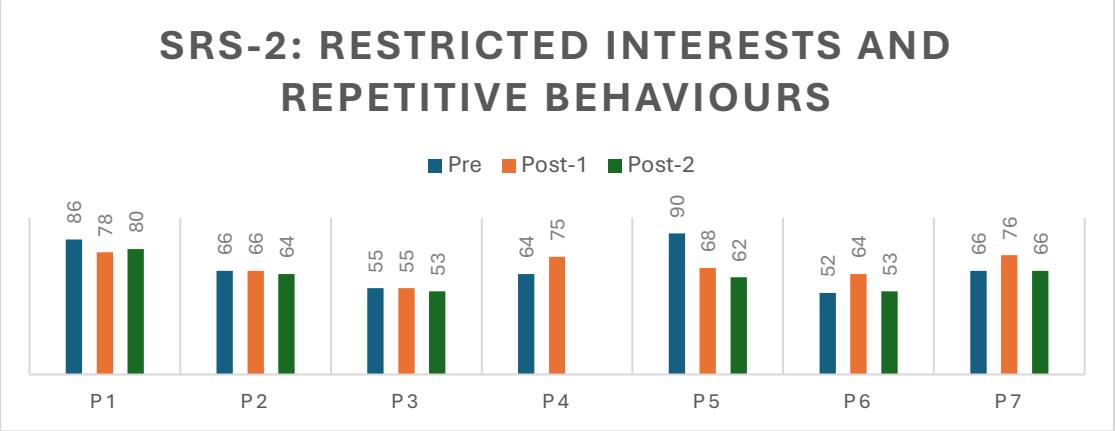

Figure 4.24 Restricted Interests and Repetitive Behaviours Scale Results for Each Participant

4.4.3 Social Awareness and Social Communication Scales

For both the social awareness scale and social communication scale, only 3 out of 7 participants are improving and showing a decrement in their latest post-training results as shown in Figures 4.26 and 4.27. The value of social awareness is to identify whether autistic children have the ability to pick up social cues. Symptoms involved in social awareness include mismatched facial expressions to speech, and not realising they are making too much noise. Additionally, avoiding eye contact and not focusing on the speaker within an interaction may lead to a meaningless conversation [3]. A higher social awareness score indicates more related symptoms. Participant P3 improves from the severe range to the mild range. Furthermore, the social communication scale includes expressive social communication such as avoiding eye contact, not playing with peers, and responding inappropriately to other's mood changes. Therefore, a greater score on this scale indicates that autistic children exhibit more related symptoms.

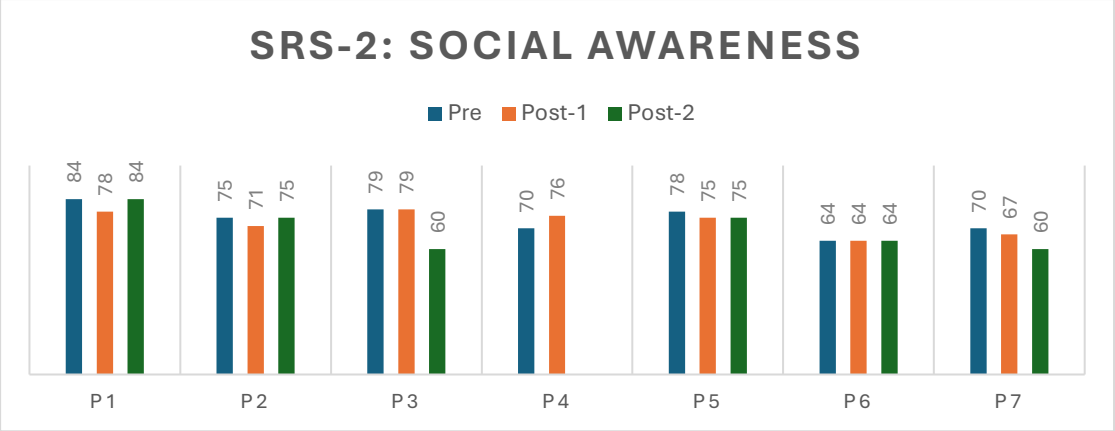

Figure 4.25 Social Awareness Scale Results for Each Participant

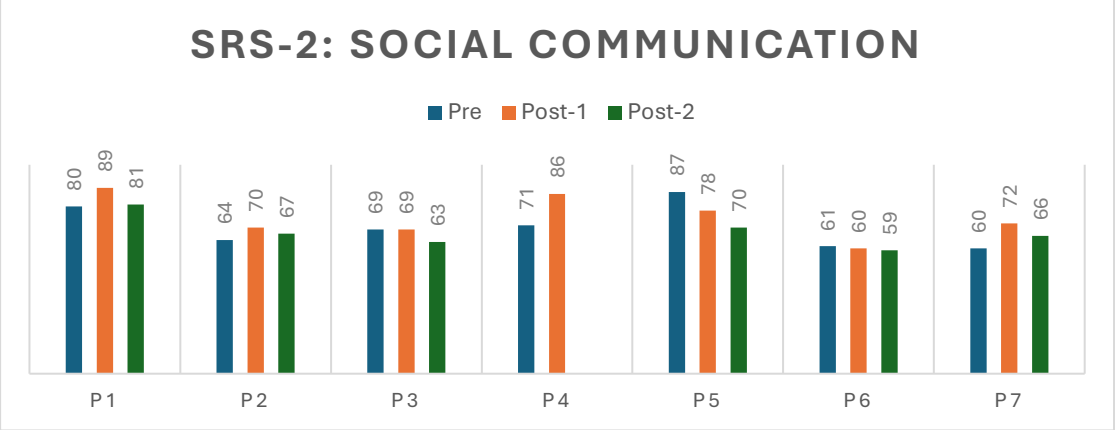

Figure 4.26 Social Communication Scale Results for Each Participant

4.4.4 Social Cognition Scale

The social cognition scale assesses the ability to interpret social cues after they are picked up, such as difficulties in understanding people's tone of voice and facial expressions or being overly sensitive to sounds, textures, or smells. As shown in the previous study, autistic children who are sensory sensitive will easily be distracted due to the background noise [25]. In this case, autistic children may face difficulty in focusing the conversation which leads to the missing of social cues. As seen in Figure 4.28, only 2 out of 7 participants show improvement in this scale.

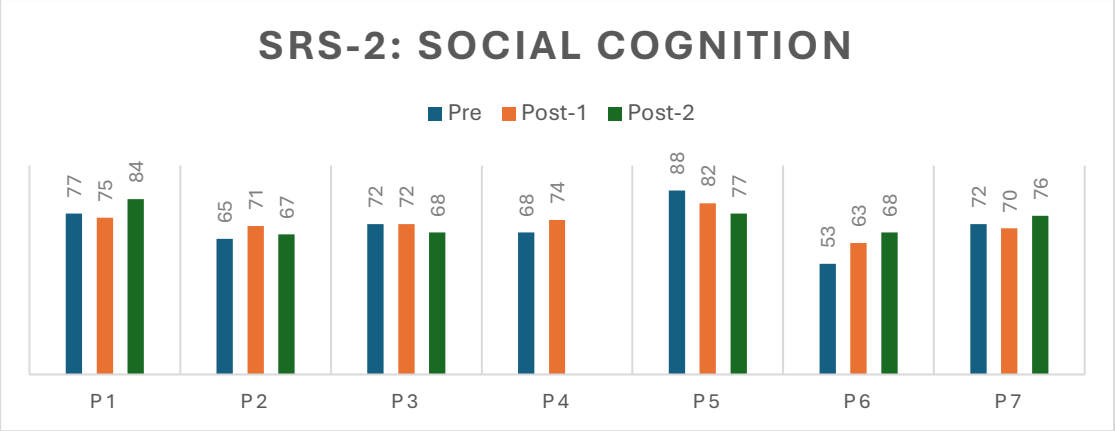

Figure 4.27 Social Cognition Scale Results for Each Participant

4.4.5 Social Communication and Interaction and T-Score Scales

The scale of social communication and interaction (SCI) measures children's social communication, interaction, and resulting T-Score, the overall improvement in participants may not be immediately evident, as demonstrated in Figures 4.29 and 4.30. The VRVM personalised support designed in this research does not aim to directly improve the social communication deficits instead to facilitate adaptation to changes and help autistic children transition more smoothly into new environments, such as school settings. While this personalised support is crucial in reducing anxiety and promoting behavioural adjustment during transitions, it does not explicitly focus on enhancing social communication or interaction skills, which are central to SRS-2 outcomes [43, 45].

As a result, the VRVM personalised support should be seen as an augmentative rather than a core personalised support. It primarily supports broader therapeutic efforts that address the social and communicative challenges faced by autistic children. Essentially, it may help maintain gains from primary personalised

supports but is insufficient on its own to substantially reduce social communication and interaction deficits.

However, it is noteworthy that Participant P5 demonstrates significant progress, showing improvements in both social communication and interaction scale, as well as in their overall T-Score. This participant's shift from the severe to the moderate range of autism severity suggests that while VRVM may not directly enhance social communication skills, it may be beneficial to some individuals. This improvement may reflect P5's increased ability to adapt to changes and transitions, potentially reducing stress and therefore improving overall social functioning.

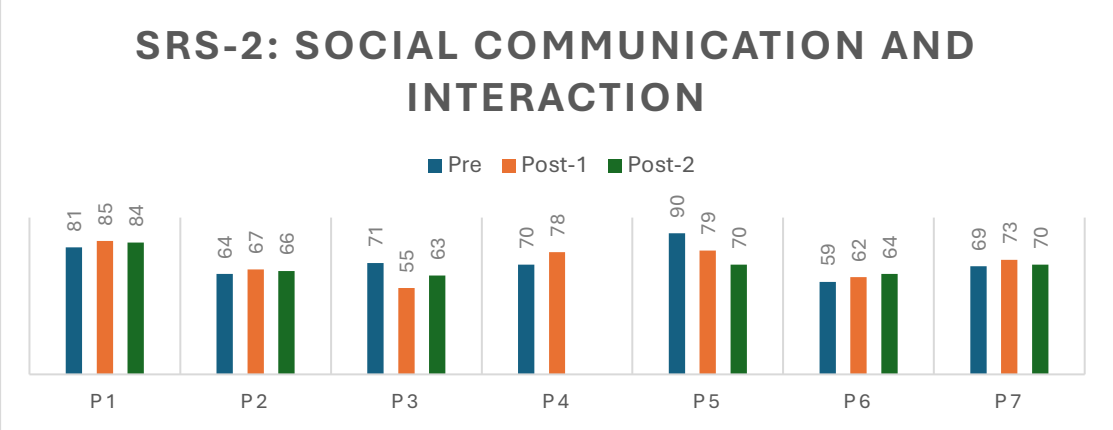

Figure 4.28 Social Communication and Interaction Scale Results for Each Participant

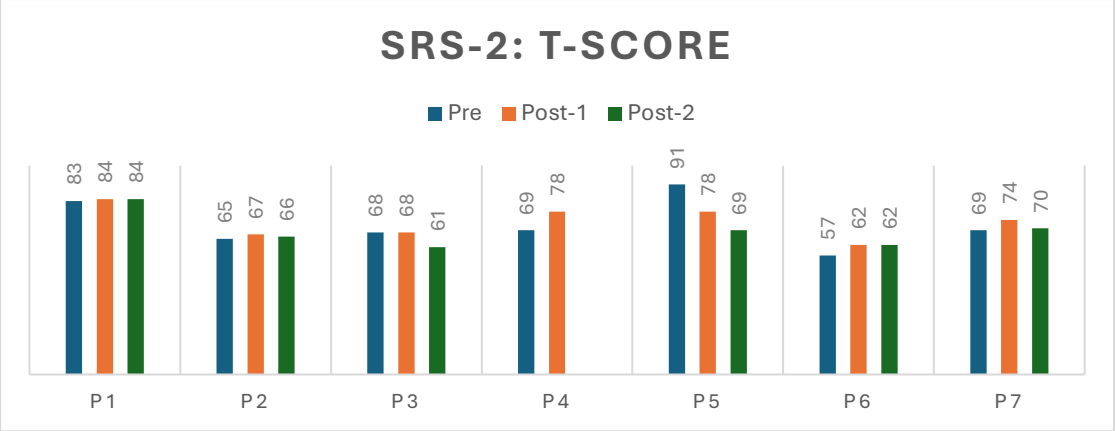

Figure 4.29 T-Score Results for Each Participant

4.5 Chapter Conclusion

The overall results of pre-training and post-training for all participants are presented. In the assessment tool, BASC-3, the scale of adaptive skill shows that all participants improve after the personalised support training, which indicates that they are better able to adapt to new environments and interact with friends or adults. Other than that, the scales of social skills and withdrawal, with 6 out of 7 participants improving after the personalised support training, indicate the improvement in interacting with people, and an increased willingness for social contact. The effect size of the hyperactivity scale, with a d value = 1.247, is practically significant in reducing autistic children's hyperactivity issues. The scale of the behavioural symptom index, with a d value = 0.739, indicates that autistic children are better able to concentrate in class. Moreover, the scale of social motivation from SRS-2 shows 6 out of 7 participants improving, which indicates that the participants are able to calm themselves when alone, and their confidence when interacting with people is enhanced. The effect sizes for social awareness and social motivation are d = 0.546 and 0.493 respectively, indicating

that autistic children better understand social situations and enhance their willingness to participate in social situations.

Looking at each participant's improvement across all the scales from BASC-3, Participant P1 is better able to fit into social situations. Participants P2 and P3 minimise their worries about attending school, while P4 and P5 are less fearful about attending school. Moreover, Participants P6 and P7 are more willing to meet new friends, and their interaction abilities improved. Across all the scale results from SRS-2, it shows that Participants P1 and P5 improve in minimising autistic stereotypical behaviours, such as toe walking, etc. Participants P2 and P4 show improvement in the social motivation scale, indicating they are more motivated to participate in social interaction with less anxiety. Participants P5 and P6 show enhancement in the social communication scale, indicating that they are better at expressing feelings after the personalised support training. Meanwhile, Participant P7 improves in picking up the social cues from others, interpreting those cues and being more willing to interact with them.

In addition, as presented from the result of the adaptive skills cluster, Participants P4 and P6 show improvement from the at-risk class to the average class, while Participant P7 enhances from the clinically significant class to the at-risk class. In this situation, they are more able to adapt to a new school. Five participants show a decrement in the internalising problems score, indicating that feelings of stress and nervousness about attending school are reduced. Remarkably, Participant P5 improves from the average class to the low class. The cluster of behavioural symptoms index show improvement in 4 participants, with Participants P2 and P5 improving from the at-risk class to the average class in this cluster.

As seen from the SRS-2 scale results, 6 out of 7 participants show improvement in the social motivation scale. Remarkably, Participant P5's score dropped from 86 to 51, implying that the participant improves from the severe range to the normal range, addressing that the participant is more confident when interacting with people and more willing to join group activities at school. For the scale of restricted interests and repetitive behaviour, 4 participants show improvement, with Participant P2 improving from the moderate range to the mild range, and Participant P5 improving from the severe range to the mild range. A minority of the participants also show improvement in the scales of social awareness, social cognition and social communication, which indicates that their ability to pick up and interpret social cues, and express themselves by using eye contact, etc has improved. The VRVM personalised support does not directly improve children's social communication, interaction and overall improvement, as shown in the social communication and interaction scales and T-Score, as it is designed to facilitate adaptation to changes and help autistic children transition more smoothly into new schools, rather than focusing on improving their social communication. Therefore, the VRVM personalised support should be viewed as an augmentative personalised support that supports broader therapeutic efforts that address the social and communicative challenges faced by autistic children.

CHAPTER 5

DISCUSSIONS

By extracting the data analysed from the personalised support training, and benchmarking the same scales of data from other research mentioned in Chapter 2; CBT [33], PC-CARE [34], PCIT [35], BBI [36], ImPACT [37] and IFP [38] to discuss the effectiveness of the VRVM, along with its strengths and weaknesses.

5.1 Benchmarking of the Externalising Problems Scale

By comparing the effect size of the externalising problems scale of BASC-3, the VRVM personalised support in this research has a practically significant effect size of $d = 0.545$, as shown in Figure 5.1. This scale identifies the severity of the children's hyperactivity and aggression, which is a critical aspect to determine their ability to function in the new school. However, PC-CARE shows a larger effect size of $d = 0.84$, indicating real-time suggestions given by the therapist to the parent may have a strong impact in addressing externalising problems [34]. Compared to PC-CARE, VRVM personalised support resulted in a smaller effect size, which suggests that VRVM may have a comparatively weaker impact in reducing the externalising problems. However, implementing VR into personalised support still offers unique advantages that traditional approaches like PC-CARE may not offer. PC-CARE relies on real-time

therapist suggestions for parents, while VRVM personalised support provides customisation features without requiring technological knowledge from parents. Compared to CBT support, VRVM demonstrates a better effect size, indicating that VR-based personalised support may offer an engaging experience which beneficial in minimising externalising problems. Additionally, more enhancement and further research may be required to convert some evidence-based methods into an online delivery mode [33, 37].

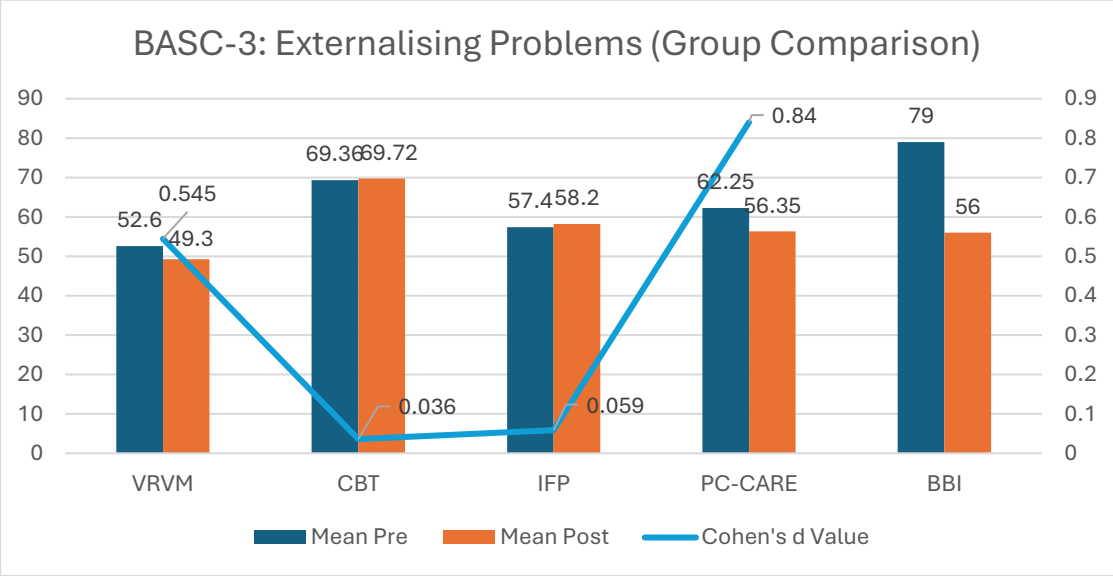

Figure 5.1 Bench Marking for Externalising Problems Cluster

5.2 Benchmarking of the Internalising Problems Scale

To identify the depression and anxiety levels of autistic children, the result of the internalising problems scale provided valuable insight. Figure 5.2 shows that VRVM has a practically significant effect size of $d = 0.450$ for internalising problems, compared to CBT ($d = 0.271$) [33] and IFP ($d = 0.025$) [38]. VRVM proves more effective in reducing internalising issues than CBT and IFP, which also suggests that VRVM provides a more engaging environment for emotion regulation [10]. The implementation of CBT may require further research to

identify a better way to conduct the therapy without requiring autistic individuals to attend physically. BBI only involves one participant, so the effect size cannot be calculated [36]. Compared to CBT, which focuses on verbal instruction through an online meeting to face their fear and generate confidence in facing the fear [33], VRVM personalised support provides a virtual but realistic environment for the participants to practice their behaviour in the immersive environment and generalise their skills safely.

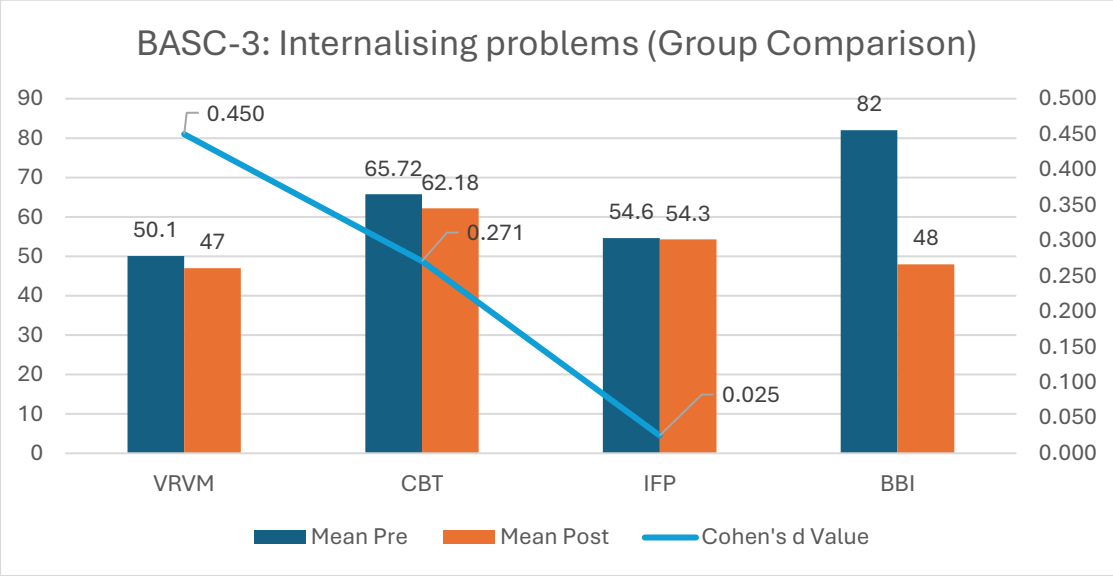

Figure 5.2 Bench Marking for Internalising Problems Cluster

5.3 Benchmarking of the Behavioural Symptoms Index Scale

Clustering attention problems, atypicality, and withdrawal, the behavioural symptoms index for VRVM demonstrates a practically significant effect size of $d = 0.739$, indicating a nearly large effect [46], as shown in Figure 5.3. Compared to IFP, VRVM is more effective in addressing related problems, with IFP showing a negligible effect size [38, 48]. Providing personalised fitness training sessions for autistic individuals may not effectively improve the behavioural symptoms index, such as withdrawal, which indicates challenges in

social contact. However, VRVM personalised support delivers the possible scenarios within a simulated school environment, which emphasises meeting new friends and new teachers in the school setting, which helps autistic children prepare themselves for social contact in the new environment [58]. Targeting the challenges that primary school students normally face, VRVM personalised support is able to minimise their withdrawal issues in a new school and improve their interaction with classmates and teachers, while IFP may contribute to general well-being but may not be comparatively effective in solving the related issues when autistic children transition to a new environment [38].

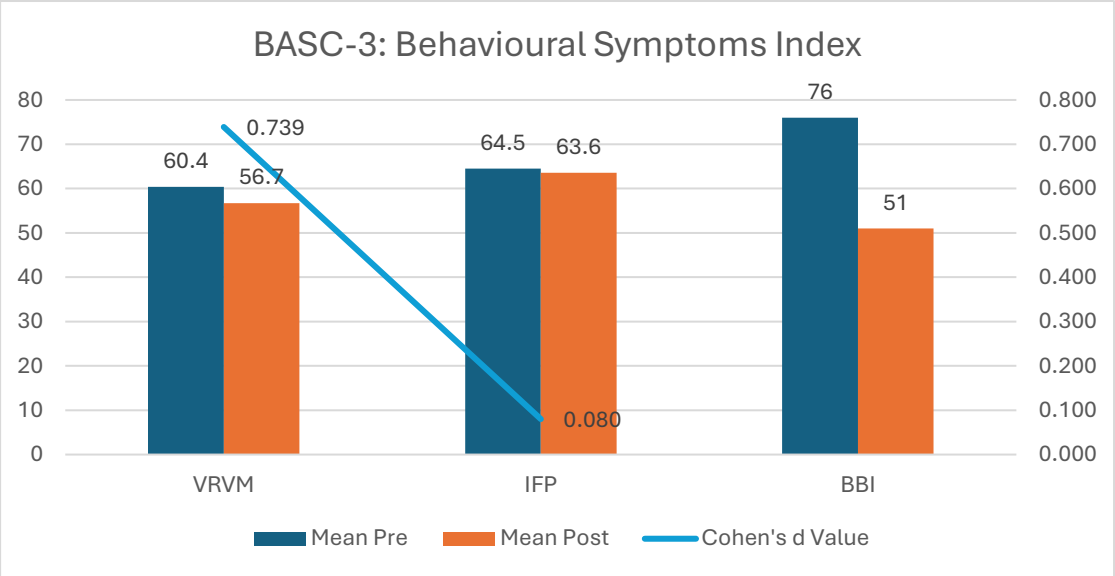

Figure 5.3 Bench Marking for Behavioural Symptoms Index Cluster

5.4 Benchmarking of the Social Motivation Scale

The scale of social motivation provided insight into identifying autistic children who are motivated to be involved in social-interpersonal behaviour. As shown in Figure 5.4, VRVM has an effect size of $d = 0.493$, which is slightly higher than ImPACT in the social motivation cluster from SRS-2 [37]. The effect size comparison indicates that symptoms in the social motivation cluster are reduced

after the VRVM personalised support training, such as being less fidgety when alone and more willingness to join group activities. Unlike ImPACT, which focused on real-time social engagement with the therapist to improve their social motivation [37]. Meanwhile, VRVM personalised support offers video modelling focused on scenarios like children attending school without parents accompanying and participating in class activities, autistic children are able to practice their behaviours in these situations and better handle similar real-world situations after VRVM personalised support training. VRVM personalised support allows autistic children to see modelled behaviour in particular situations before attempting them in the real-world context. The demonstration from the personalised support leverages their visual learning and imitation skills [11, 12]. Autistic children's confidence levels are boosted after practising their behaviour repeatedly in the virtual school environment, which causes them to be more motivated to participate in social interaction [56].

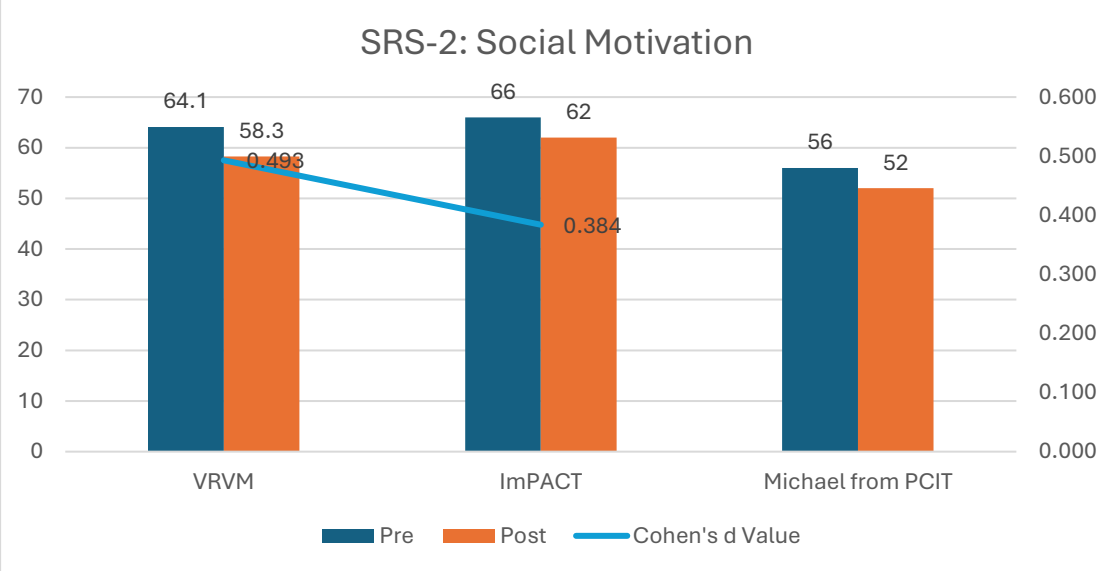

Figure 5.4 Bench Marking for Social Motivation Cluster

5.5 Benchmarking of the Restricted Interests and Repetitive Behaviours Scale

Moreover, stereotypical behaviours are identified through the scale of restricted interests and repetitive behaviours. When comparing VRVM's effect size for restricted interests and repetitive behaviours with IFP support, IFP has a higher score of effect size, d = 0.791, as shown in Figure 5.5 [38]. The VRVM personalised support, with a practically significant effect size of d = 0.434, signifies a decrease in the frequency of the participants behaving oddly and showing abnormal sensory interest. Compared to IFP, which focuses on physical fitness, VRVM incorporates the virtual environment for the participants to practice appropriate behaviours in each virtual scenario. The exposure to the scenarios may contribute to long-term behavioural improvement, while IFP may offer an immediate improvement in reducing stereotypical autism behaviours.

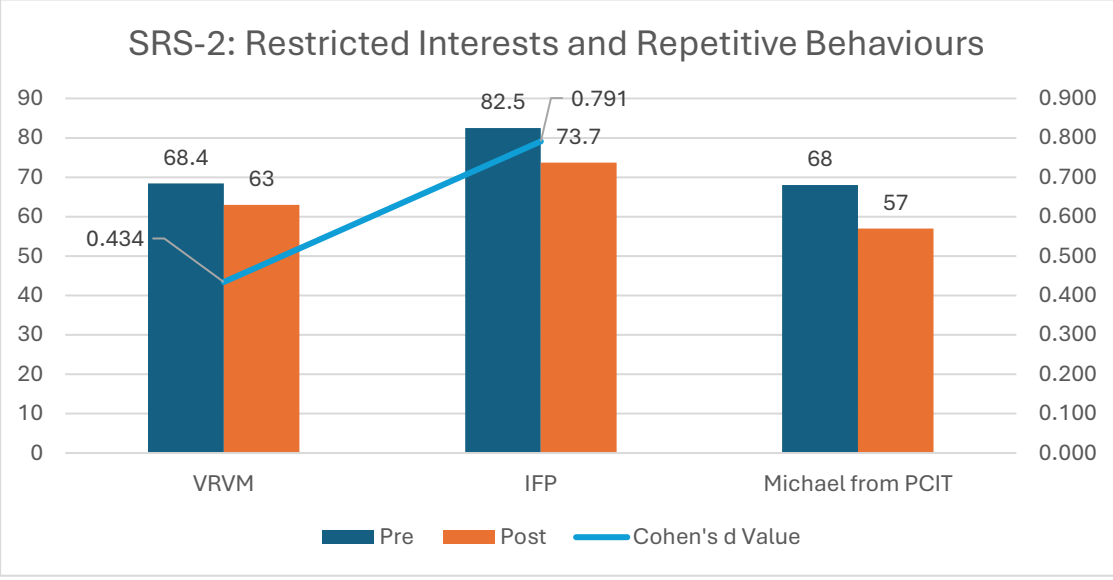

Figure 5.5 Bench Marking for Restricted Interests and Repetitive Behaviours Cluster

5.6 Chapter Conclusion

After analysing the data collected using the assessment tools, some data can be benchmarked against other personalised support. In externalising problems

scale of BASC-3, VRVM personalised support has a practically significant effect size of *d* value = 0.545, indicating that the participants are improving in hyperactivity issues and are less likely to be aggressive. When comparing the effect size with PC-CARE, which has a larger effect size which is d value = 0.840, suggesting that real-time consultation by a therapist may have a more impactful effect [34]. However, the uniqueness of VRVM, which implements VR into personalised support, still offers advantages that PC-CARE may not offer, such as customisation features provided without requiring technological knowledge from parents. VRVM personalised support addresses an engaging experience to be comparatively effective in minimising externalising problems compared to CBT.

Benchmarking in internalising problems scale of BASC-3, VRVM personalised support shows a practically significant effect size of $d = 0.450$, which is more effective than CBT [33] and IFP [38]. This may be because the mode conversion of CBT to an online format may require further research to assess the appropriate conducting method to improve its effect size. VRVM provides an engaging environment to help autistic participants by reducing their anxiety about attending school and making them less likely to feel nervous and fearful about the new school [10]. An immersive, virtual but realistic environment provided by VRVM personalised support allows autistic children to practice their behaviour and generalise their skills safely while CBT focuses on verbal instruction and interaction with a therapist through an online meeting to address the issues.

As presented from the effect size of VRVM personalised support in the behavioural symptoms index, it is practically significant, with the effect size of

d value = 0.739. This indicates that autistic participants are more likely to join group activities and show reduced abnormal behaviours. When compared to IFP, VRVM performs much better, as IFP presents a negligible effect size. This may be because the personalised fitness training sessions are not that effective in improving behavioural symptoms index, including encouraging autistic participants to engage in social activities. In contrast, VRVM personalised support delivers the possible scenarios within a simulated school environment, which emphasises meeting new friends and teachers and helps them engage with new people. It is comparatively effective in improving their ability to engage in social contact, as prior preparation in a virtual environment minimise their withdrawal issues in a new school and improves their interaction with classmates and teachers, while IFP may not be comparatively effective in solving the related issues when autistic children transition to a new environment [38].

The social motivation scale of SRS-2 assesses autistic children involved in social-interpersonal behaviour. VRVM shows a higher effect size, with a d value = 0.493, on the social motivation scale of SRS-2 compared to ImPACT [37]. This indicates autistic participants are more confident when engaging in social situations after the VRVM personalised support training. VRVM personalised support offers video modelling focused on scenarios which motivated them to involved in social-interpersonal behaviours, such as attending school without parents accompanying and participating in class activities. Therefore, the participants better able to handle related situations after the VRVM personalised support training compared to other supports since the demonstration from the personalised support leverages their visual learning and imitation skills [11, 12].

In the scale of restricted interests and repetitive behaviours of SRS-2, autism stereotypical behaviours are identified. The VRVM personalised support has a lower effect size, with a d value of 0.434, compared to IFP, which has a d value of 0.791 [38]. This is because IFP assists autistic participants exercise their bodies, which may result in reducing their abnormal sensory interest and odd behaviours such as hand flapping. Compared to IFP, which focuses on physical fitness, VRVM incorporates the virtual environment for the participants to practice appropriate behaviours in each virtual scenario. As shown from the effect size value, the exposure to the scenarios may contribute to long-term behavioural improvement, while IFP may offer an immediate improvement in reducing stereotypical autism behaviours.

CHAPTER 6

CONCLUSIONS AND FUTURE WORK

6.1 Conclusions

Since autistic children aged 5 to 7 are attending a new primary school, their adaptation to the new environment is a major concern for parents. Due to their stereotypical autistic behaviours, they may be avoided or teased by their peers. Typically, they feel stressed and fearful about attending school, so a personalised support is needed to help them prior prepare before the opening of school. Therefore, some personalised supports are available to be used to help them. For example, the use of VM demonstrates the correct method to handle tasks, which autistic children can imitate. VR can also be implemented in any way to attract them to experience and show teachable scenes to them. Thus, VR is aimed to be useful when implementing it in the VM with the purpose of assisting autistic children to adapt to a new school.

The implementation of VR in VM which focuses on Malaysia's autism population remains limited and this research focuses on that implementation. This implementation aims to help autistic children prepare for a new school by presenting relevant, imitable scenarios that demonstrate appropriate behaviours. Nevertheless, the different needs of autistic individuals result in many different designs of personalised support. A customisable approach that allows parents to

tailor the personalised support based on children's preferences and abilities. In order to make the personalised support efficient, a time-consuming data collection and development process is avoided in this research. Offering customisation features that can be carried out easily and without technological knowledge is preferred by the parents. Thus, the extent of customisation offered is one of the focuses of the research. In addition, this research determines the effectiveness of the personalised support designed and assesses the improvement of autistic children. Therefore, there are several assessment tools are available to identify its effectiveness.

The VRVM personalised support is successfully developed for the purpose of training autistic children in adapting to a new school. It provides three VRVM storylines that depict potentially happened scenarios, giving autistic children the opportunity to prior experience the virtual school environment before attending in real life.

The VRVM storylines include:

1. Going to a new school,

2. Make new friends in the class,

3. Behaviour during the lesson.

The first story aims to help autistic children in adjusting to a new school. After completing the training for this story, autistic children are able to imitate the greeting way to their friends and teachers. By getting a general idea of the new school beforehand, their acceptance of attending the actual school is aimed to increase. In the second story, a few conversations with classmates are presented

to teach them the appropriate communication methods in the following situations:

1. Introducing themselves to the others
2. Borrowing stationary from classmates
3. Responding appropriately when teased by classmates

The final story presents correct behaviours in class, which is to focus on the teacher when the teacher is teaching in the class. Also, they will learn to seek the teacher's help whenever they face issues, ensuring that asking for help feels manageable for them.

The customisation feature which allows parents to insert the actual school image attracts children, as most of them prefer videos with the school compared to other videos without it. In this circumstance, autistic children become familiar with the school that they will soon attend. The VRVM personalised support helps autistic children in different aspects, leading to new school adaptations, such as social interaction with new classmates, and joining group activities. Other than that, the modification of the classroom background colour and furniture in the classroom enhances the realism, improving the effectiveness of the personalised support. The insertion of children's names in the storyline enhances the immersion of the children and increases their engagement in the personalised support training.

By using the assessment tools, SRS-2 and BASC-3, the study concluded the VRVM personalised support has effectively improved autistic children's hyperactivity issues and behavioural symptom index, enabling them to make new friends and focus on the lesson. The nearly high effect size of the *d* value,

d = 0.739 in the behavioural symptom index indicates that this personalised support helps them engage in social contact with friends and teachers in the new school, leading to better school adaptation. The d value, d = 1.247 for hyperactivity indicates the reduction in related issues after the personalised support training. Therefore, they are able to attend school and able to remain calm during the lesson.

By benchmarking against other research, VRVM has been shown to help autistic children in terms of externalising problems and internalising problems, where it has a better performance compared to CBT and IFP [33, 38]. This indicates that VRVM is helping autistic children reduce their stress about attending school and minimise their abnormal behaviours when attending school. Although VRVM showed a slightly weaker performance in restricted interests and repetitive behaviours compared to IFP, it has a practically significant effect size on the scale of the behavioural symptoms index when compared to it. Also, VRVM had a better effect size on the social motivation scale compared to ImPACT [37].

In summary, the research provides the evidence in solving the research questions stated in Chapter 1:

RQ1: How was the Virtual Reality (VR) technique implemented in Video Modelling (VM) to help autistic children adapt to a new school?

The research successfully developed a VRVM personalised support that provides three storylines focusing on the possible scenarios in a new school. These storylines were designed to assist autistic children in adapting to the new school before attending in real life. By exploring these storylines, they gained a

general idea of the new school and were able to imitate the appropriate communication and learning methods in the school. Learning the appropriate behaviours through the VR-based VM was attractive to autistic children and offered realistic, imitable scenarios.

RQ2: To what extent could the parents of the autistic children customise the VRVM?

In this research, the customisation features that did not require technological knowledge provided were preferred by the parents. The customisation features provided in this research, as mentioned earlier, allow parents to insert an actual school image, which is then incorporated into the storylines to introduce the children to the new school. This ensures that autistic children can familiarise themselves with the new environment by completing the training. The modification of classroom background colour and furniture enhances their engagement in the training and increases the realism of the virtual environment.

RQ3: How was the effectiveness of the personalised support?

In order to identify the effectiveness of the personalised support, SRS-2 and BASC-3 were utilised. The findings showed that the personalised support successfully improved autistic children's hyperactivity issues, with the effect size of $d = 1.247$. This shows the reduction of related issues in children after the personalised support training. The personalised support also improved their engagement in social contact with people, with the effect size provided, $d = 0.739$. With the effect sizes proven, this personalised support effectively assists autistic children adapt to a new school environment.

6.2 Future Work

The current study is limited by a small sample size of seven participants, three of whom are girls, due to the time constraint in which the training needs to be carried out before the opening of school. The small sample size may lead to a reduction in the generalisation of the study. In addition, the absence of a control group within the personalised support training may lead to difficulty defining the causality of the personalised support and the observed improvement. Thus, future research is recommended to recruit more autistic participants to expand the sample size and generalise the results. Future VRVM personalised support enhancements should include more storylines to cover more possible scenarios in the school environment although only three VMs are currently available which still provide some meaningful insight from the personalised support training. Additionally, the improvement of virtual avatars and their movement could be done in the future to boost the engagement of the participants. Carrying out requirement collection from the parents to further enhance the customisation features is also suggested to be done in the future. Last but not least, long-term personalised support training is suggested to determine whether the improvement observed in a VR-based environment can be maintained over a longer period. This ensures consistency in the performance of autistic children when adapting to a new school.

REFERENCES

[1] Y. Ishizaki *et al.*, "Eye gaze differences in school scenes between preschool children and adolescents with high-functioning autism spectrum disorder and those with typical development," *BioPsychoSocial Medicine*, vol. 15, no. 1, Jan. 2021, doi: https://doi.org/10.1186/s13030-020-00203-w.

[2] L. Yang, "To What Extent 'Neurodevelopmental Disorder'and 'Neurodiversity'Provide Useful Frameworks for Understanding and Supporting the Learning Needs of Children with Autism," *International Journal of Social Science and Education Research*, vol. 4, no. 8, pp. 282-288, 2021.

[3] S. C. Polychronis, A. Johnson, R. J. Thelin, D. L. Eggett, and J. Christensen, "Use of an App With Embedded Video Modeling to Increase Eye Contact," *Focus on autism and other developmental disabilities*, vol. 38, no. 3, pp. 199–208, Sep. 2022, doi: https://doi.org/10.1177/10883576221124805.

[4] T. Cardon, N. Wangsgard, and N. Dobson, "Video Modeling Using Classroom Peers as Models to Increase Social Communication Skills in Children with ASD in an Integrated Preschool," *Education and Treatment of Children*, vol. 42, no. 4, pp. 515–536, 2019, doi: https://doi.org/10.1353/etc.2019.0024.

[5] V. A. Green *et al.*, "Use of Video Modeling to Increase Positive Peer Interactions of Four Preschool Children with Social Skills Difficulties," *Education and Treatment of Children*, vol. 36, no. 2, pp. 59–85, 2013, doi: https://doi.org/10.1353/etc.2013.0016.

[6] J. L. Kouo, "The Effectiveness of a Packaged Intervention Including Point-of-View Video Modeling in Teaching Social Initiation Skills to Children With Autism Spectrum Disorders," *Focus on Autism and Other Developmental Disabilities*, vol. 34, no. 3, pp. 141–152, Dec. 2018, doi: https://doi.org/10.1177/1088357618815887.

[7] A. Adjorlu, A. Hussain, C. Mødekjær, and Nicoline Warming Austad, "Head-Mounted Display-Based Virtual Reality Social Story as a Tool to Teach Social Skills to Children Diagnosed with Autism Spectrum Disorder," Jan. 2018.

[8] M. Bellani, L. Fornasari, L. Chittaro, and P. Brambilla, "Virtual reality in autism: State of the art," *Epidemiology and Psychiatric Sciences*, vol. 20, no. 3, pp. 235–238, 2011.

[9] E. Fitzgerald *et al.*, "Comparing the effectiveness of virtual reality and video modelling as an intervention strategy for individuals with Autism Spectrum Disorder: Brief report," *Developmental Neurorehabilitation*, vol. 21, no. 3, pp. 197–201, Feb. 2018, doi: https://doi.org/10.1080/17518423.2018.1432713.

[10] M. Sait, A. Alattas, A. Omar, S. Almalki, S. Sharf, and E. Alsaggaf, "Employing virtual reality techniques in environment adaptation for Children with autism," *Procedia Computer Science*, vol. 163, pp. 338–344, 2019.

[11] M. Schmidt, C. Schmidt, N. Glaser, D. Beck, M. Lim, and H. Palmer, "Evaluation of a spherical video-based virtual reality intervention designed to teach adaptive skills for adults with autism: a preliminary report," *Interactive Learning Environments*, pp. 1–20, Feb. 2019, doi: https://doi.org/10.1080/10494820.2019.1579236.

[12] T. Alhuzimi, "Efficacy of Video Modelling (VM) in Developing Social Skills in Children with Autism Spectrum Disorder (ASD) at School in Saudi Arabia," *International Journal of Disability, Development and Education*, vol. 69, no. 2, pp. 1–15, Jan. 2020, doi: https://doi.org/10.1080/1034912x.2020.1716962.

[13] J. Chen *et al.*, "Virtual reality enhances the social skills of children with autism spectrum disorder: a review," *Interactive Learning Environments*, pp. 1–22, Nov. 2022, doi: https://doi.org/10.1080/10494820.2022.2146139.

[14] K. I. Kotsopoulos, M. G. Katsounas, A. Sofios, C. Skaloumbakas, A. Papadopoulos, and A. Kanelopoulos, "VRESS: Designing a platform for the development of personalized Virtual Reality scenarios to support individuals with Autism.," *IEEE Xplore*, Jul. 01, 2021. https://ieeexplore.ieee.org/abstract/document/9555542

[15] Rachel Santos Levy, H. Fipp-Rosenfield, J. Lee, J. Grauzer, and M. Y. Roberts, "Understanding Internalizing and Externalizing Behaviors in Autistic Toddlers," American Journal of Speech-language Pathology, pp. 1–14, Sep. 2023, doi: https://doi.org/10.1044/2023_ajslp-23-00088.

[16] D. Parsons, N. J. Wilson, S. Vaz, H. Lee, and R. Cordier, "Appropriateness of the TOBY Application, an iPad Intervention for Children with Autism Spectrum Disorder: A Thematic Approach," *Journal of Autism and Developmental Disorders*, vol. 49, no. 10, pp. 4053–4066, Jul. 2019, doi: https://doi.org/10.1007/s10803-019-04115-9.

[17] M. L. da Silva, D. Gonçalves, and H. Silva, "User-tuned Content Customization for Children with Autism Spectrum Disorders," *Procedia Computer Science*, vol. 27, pp. 441–448, 2014, doi: https://doi.org/10.1016/j.procs.2014.02.048.

[18] R. Bouhali, H. Al-Tabaa, S. Abdelfattah, M. Atiyeh, S. Esmaeili, and H. Al-Tabbakh, "Otisma: an integrated application and humanoid robot as an educational tool for children with autism," *Journal of Medical Engineering & Technology*, vol. 47, no. 1, pp. 44–53, Jul. 2022, doi: https://doi.org/10.1080/03091902.2022.2097327.

[19] S. Domínguez-Lucio, L. M. Compañ-Gabucio, L. Torres-Collado, and M. G. de la Hera, "Occupational Therapy Interventions Using New Technologies in Children and Adolescents with Autism Spectrum Disorder: A Scoping Review," J*ournal of Autism and Developmental*

Disorders, vol. 53, no. 1, Jan. 2022, doi: https://doi.org/10.1007/s10803-022-05431-3.

[20] C. Maas, "Improvisational Theatre and Occupational Therapy for Children with Autism Spectrum Disorder," *International Journal of Disability, Development and Education*, vol. 68, no. 1, pp. 1–16, Jul. 2019, doi: https://doi.org/10.1080/1034912x.2019.1634793.

[21] L. Zhang and H. Kim, "Revista de Cercetare si Interventie Sociala INTERVENTIONAL ANALYSIS OF MUSIC THERAPY ON EMOTIONAL BEHAVIOR IN CHILDREN WITH AUTISM," *Revista de Cercetare si Interventie Sociala*, vol. 86, pp. 74–85, 2024, doi: https://doi.org/10.33788/rcis.86.6.

[22] A. MacDonald-Prégent, F. Saiyed, K. Hyde, M. Sharda, and A. Nadig, "Response to Music-Mediated Intervention in Children with autism with Limited Spoken Language Ability," *Journal of Autism and Developmental Disorders*, Jan. 2023, doi: https://doi.org/10.1007/s10803-022-05872-w.

[23] Z. Shi, S. Wang, M. Chen, A. Hu, Q. Long, and Y. Lee, "The effect of music therapy on language communication and social skills in children with autism spectrum disorder: a systematic review and meta-analysis," *Frontiers in Psychology*, vol. 15, p. 1336421, May 2024, doi: https://doi.org/10.3389/fpsyg.2024.1336421.

[24] C. Gray, "What is a social story?," Carol Gray - Social Stories, 2015. https://carolgraysocialstories.com/social-stories/what-is-it/

[25] S. Eden and A. Oren, "Computer-mediated intervention to foster prosocial ability among children with autism," *Journal of Computer Assisted Learning*, vol. 37, no. 1, pp. 275–286, Sep. 2020, doi: https://doi.org/10.1111/jcal.12490.

[26] E. Smith, A. Constantin, H. Johnson, and M. Brosnan, "Digitally-Mediated Social Stories Support Children on the Autism Spectrum Adapting to a Change in a 'Real-World' Context," *Journal of Autism and Developmental Disorders*, vol. 51, no. 51, Jun. 2020, doi: https://doi.org/10.1007/s10803-020-04558-5.

[27] S. C. Michalski et al., "Improving real-world skills in people with intellectual disabilities: an immersive virtual reality intervention," *Virtual Reality*, Apr. 2023, doi: https://doi.org/10.1007/s10055-023-00759-2.

[28] J. P. McCleery et al., "Safety and Feasibility of an Immersive Virtual Reality Intervention Program for Teaching Police Interaction Skills to Adolescents and Adults with Autism," *Autism Research*, vol. 13, no. 8, pp. 1418–1424, Aug. 2020, doi: https://doi.org/10.1002/aur.2352.

[29] J. Moon and F. Ke, "Effects of Adaptive Prompts in Virtual Reality-Based Social Skills Training for Children with Autism," *Journal of Autism and Developmental Disorders*, May 2023, doi: https://doi.org/10.1007/s10803-023-06021-7.

[30] F. Blog, “Observer Bias: Definition. Effects and Mitigation,” www.formpl.us. https://www.formpl.us/blog/observer-bias#:~:text=Observer%20bias%20is%20when%20the

[31] M. A. F. A. Basri et al., “Development of a Social Communication Skills Intervention Using Video Modeling and Spherical Video-Based Virtual Reality for High Functioning Autism Spectrum Disorder Youth: A Preliminary Study,” *IEEE Access*, vol. 12, pp. 77976–77987, 2024, doi: https://doi.org/10.1109/access.2024.3407114.

[32] M. N. Fuselier et al., “Examining the Relationship Between Anxiety Severity and Autism-Related Challenges During Cognitive Behavioral Therapy for Children with Autism,” *Journal of Autism and Developmental Disorders*, Feb. 2023, doi: https://doi.org/10.1007/s10803-023-05912-z.

[33] V. Lee, F. Roudbarani, P. Tablon Modica, A. Pouyandeh, and J. A. Weiss, “Adaptation of Cognitive Behaviour Therapy for Children with autism During the Pandemic: A Mixed-Methods Program Evaluation,” *Evidence-Based Practice in Child and Adolescent Mental Health*, vol. 7, no. 1, pp. 1–18, Jul. 2021, doi: https://doi.org/10.1080/23794925.2021.1941432.

[34] B. N. Hawk, S. G. Timmer, L. A. F. Armendariz, D. K. Boys, A. J. Urquiza, and E. Fernández y Garcia, “Improving Children’s Behavior in Seven Sessions: A Randomized Controlled Trial of Parent-Child Care (PC-CARE) for Children Aged 2–10 Years,” *Child Psychiatry & Human Development*, vol. 55, no. 2, pp. 336–349, Aug. 2022, doi: https://doi.org/10.1007/s10578-022-01406-8.

[35] A. Peskin, W. A. Rothenberg, and J. F. Jent, “Harnessing Parent–Child Interaction Therapy for the Behavioral Treatment of a Child with Tuberous Sclerosis Complex and Autism Spectrum Disorder,” *Evidence-Based Practice in Child and Adolescent Mental Health*, pp. 1–17, Oct. 2022, doi: https://doi.org/10.1080/23794925.2022.2127134.

[36] R. H. Fein, G. G. Banks, M. N. Gragert, and M. E. Axelrad, “Brief Behavioral Intervention for Disruptive Behavior in a Child with a Hypothalamic Hamartoma: A Case Report,” *Journal of Clinical Psychology in Medical Settings*, vol. 26, no. 4, pp. 507–515, Nov. 2018, doi: https://doi.org/10.1007/s10880-018-9592-5.

[37] F. Li et al., “Effectiveness of Online-Delivered Project ImPACT for Children With ASD and Their Parents: A Pilot Study During the COVID-19 Pandemic,” *Frontiers in Psychiatry*, vol. 13, Mar. 2022, doi: https://doi.org/10.3389/fpsyt.2022.806149.

[38] S. L. J. Jackson, E. A. Abel, S. Reimer, and J. C. McPartland, “Brief Report: A Specialized Fitness Program for Individuals with Autism Spectrum Disorder Benefits Physical, Behavioral, and Emotional Outcomes,” *Journal of Autism and Developmental Disorders*, Jul. 2022, doi: https://doi.org/10.1007/s10803-022-05646-4.

[39] N. W. Ireri, S. W. White, and A. W. Mbwayo, “Treating Anxiety and Social Deficits in Children with Autism Spectrum Disorder in Two Schools in Nairobi, Kenya,” *Journal of Autism and Developmental Disorders*, vol. 49, no. 8, pp. 3309–3315, May 2019, doi: https://doi.org/10.1007/s10803-019-04045-6.

[40] B. Zhang et al., “Effectiveness of peer-mediated intervention on social skills for children with autism spectrum disorder: a randomized controlled trial,” *Translational Pediatrics*, vol. 11, no. 5, pp. 663–675, May 2022, doi: https://doi.org/10.21037/tp-22-110.

[41] S.-I. Ji, H. Park, S. A. Yoon, and S.-B. Hong, “A Validation Study of the CARS-2 Compared With the ADOS-2 in the Diagnosis of Autism Spectrum Disorder: A Suggestion for Cutoff Scores,” *Journal of the Korean Academy of Child and Adolescent Psychiatry*, vol. 34, no. 1, pp. 45–50, Jan. 2023, doi: https://doi.org/10.5765/jkacap.220027.

[42] C. R. Reynolds and R. W. Kamphaus, *BASC 3, Behavior Assessment System for Children: Manual*. 2020.

[43] K. Davis, A.-M. Iosif, C. W. Nordahl, M. Solomon, and M. K. Krug, “Video Game Use, Aggression, and Social Impairment in Adolescents with Autism Spectrum Disorder,” *Journal of Autism and Developmental Disorders*, vol. 53, no. 9, pp. 3567–3580, Jul. 2022, doi: https://doi.org/10.1007/s10803-022-05649-1.

[44] K. N. Gergoudis *et al.*, “Psychometric Study of the Social Responsiveness Scale in Phelan–McDermid Syndrome,” *Autism Research*, vol. 13, no. 8, pp. 1383–1396, May 2020, doi: https://doi.org/10.1002/aur.2299.

[45] H. Haraguchi, A. Stickley, A. Saito, H. Takahashi, and Y. Kamio, “Stability of Autistic Traits from 5 to 8 Years of Age Among Children in the General Population,” *Journal of Autism and Developmental Disorders*, vol. 49, no. 1, pp. 324–334, Oct. 2018, doi: https://doi.org/10.1007/s10803-018-3770-z.

[46] S. Pogrow, “How Effect Size (Practical Significance) Misleads Clinical Practice: The Case for Switching to Practical Benefit to Assess Applied Research Findings,” *The American Statistician*, vol. 73, no. sup1, pp. 223–234, Mar. 2019, doi: https://doi.org/10.1080/00031305.2018.1549101.

[47] C. C. Serdar, M. Cihan, D. Yücel, and M. A. Serdar, “Sample size, Power and Effect Size revisited: Simplified and Practical Approaches in pre-clinical, Clinical and Laboratory Studies,” *Biochemia medica*, vol. 31, no. 1, pp. 27–53, Feb. 2021, doi: https://doi.org/10.11613/bm.2021.010502.

[48] S. Mcleod, “Sampling Distribution,” *Simplypsychology.org*, Jul. 10, 2019. https://www.simplypsychology.org/effect-size.html

[49] D. Huang, W. Lin, and Y. Luo, “Factors Associated with Chinese Migrant Children’s Social Engagement during the COVID-19 Pandemic: A Case

Study in Guangzhou City, China," *Social Work*, vol. 68, no. 2, pp. 141–149, Jan. 2023, doi: https://doi.org/10.1093/sw/swad003.

[50] S. J. Howe, J. Baraskewich, and C. A. McMorris, "Anxiety in Autistic Youth: Understanding the Impact on Child, Caregiver, and Family Quality of Life," *Journal of Child and Family Studies*, vol. 32, no. 3, pp. 892–907, Mar. 2022, doi: https://doi.org/10.1007/s10826-022-02277-2.

[51] G. A. McQuaid, C. H. Weiss, A. J. Said, K. A. Pelphrey, N. R. Lee, and G. L. Wallace, "Increased perceived stress is negatively associated with activities of daily living and subjective quality of life in younger, middle, and older autistic adults," *Autism Research*, vol. 15, no. 8, pp. 1535–1549, Jul. 2022, doi: https://doi.org/10.1002/aur.2779.

[52] H. T. Pang, X. Zhou, and M. Chu, "Cross-cultural differences in using nonverbal behaviors to identify indirect replies," *Journal of Nonverbal Behavior*, vol. 48, no. 2, Feb. 2024, doi: https://doi.org/10.1007/s10919-024-00454-z.

[53] N. Greaves, "Emotion regulation difficulties and differences in autism including demand-avoidant presentations—A clinical review of research and models, and a proposed conceptual formulation: Neural-preferencing locus of control (NP-LOC)," *JCPP Advances*, Aug. 2024, doi: https://doi.org/10.1002/jcv2.12270.

[54] K. Lyall, J. B. Schweitzer, R. J. Schmidt, I. Hertz-Picciotto, and M. Solomon, "Inattention and hyperactivity in association with autism spectrum disorders in the CHARGE study," *Research in Autism Spectrum Disorders*, vol. 35, pp. 1–12, Mar. 2017, doi: https://doi.org/10.1016/j.rasd.2016.11.011.

[55] F. W. Paulus, S. Ohmann, E. Möhler, P. Plener, and C. Popow, "Emotional Dysregulation in Children and Adolescents With Psychiatric Disorders. A Narrative Review," *Frontiers in Psychiatry*, vol. 12, no. 1, Oct. 2021, doi: https://doi.org/10.3389/fpsyt.2021.628252.

[56] S.-I. Kim *et al.*, "Promoting Self-Efficacy of Individuals With Autism in Practicing Social Skills in the Workplace Using Virtual Reality and Physiological Sensors: Mixed Methods Study," *JMIR Formative Research*, vol. 8, p. e52157, Jan. 2024, doi: https://doi.org/10.2196/52157.

[57] Children's Hospital of Philadelphia, "Stimming: What Is It and Does It Matter? | CHOP Research Institute," *www.research.chop.edu*, May 29, 2020. https://www.research.chop.edu/car-autism-roadmap/stimming-what-is-it-and-does-it-matter

[58] Y. L. Ang, H. G. Goh, C. K. Lee, K. S. Pheh, and S. H. Saw, "Tailored Virtual Environments for Facilitating School Transition in Children with Autism," pp. 217–223, Aug. 2024, doi: https://doi.org/10.1109/icoict61617.2024.10698567.

Appendix A

English Version of Storyline Text for "Going to a new school"

I will ride a car to a new school.

Hi, I am Teacher Ann.

Bye enjoy your day in the school. Mum hugs me before I go into the school.

Follow me to go to the class.

I will meet new teachers at school. I will meet friends at school.

All students are sitting properly in the class. I and my classmates are sitting and listening to teacher.

I will try to focus when teacher is teaching.

If I don't understand, I may raise my hand and ask the teacher. Teacher, what does that mean?

If I want to go toilet, I may raise my hand and tell the teacher. May I go to toilet?

When the school is end, all students say goodbye to each other. Going to school will be fun.

Appendix B

English Version of Storyline Text for "Make new friends in the class"

When first come to the school, teacher may introduce me to the class.

This is our classmate, [child's name]. My new friends may introduce themselves. Hi, I am Ali.

I may make new friends at school.

My friend may borrow eraser from me.

May I borrow eraser from you?

When I forget to bring pencil, I may borrow from them.

May I borrow pencil from you?

Sure. Here you go.

It may fun when we learn together.

Sometimes, my friend may make fun of me.

Why you look different from the others?

I may not like it. It is ok.

They may touch my arm or hand.

It may be their way to make friends. It is ok.

It is still fun when playing with friends.

Appendix C

English Version of Storyline Text for "Behaviour during the lesson"

Teacher is teaching in the class.

When teacher is teaching, I will pay attention.

There are some questions I do not know. Teacher may help me in doing homework.

When I need teacher's help, I may raise my hand and ask for help.

Teacher, I need help. Yes? I do not know this question.

I may go for a rest after the lesson ends.

Today's lesson ends here.

It may not be hard for me to ask for help.

Appendix D

Chinese Version of Storyline Text for “Going to a new school”

我将乘坐汽车去一所新学校。

你好，我是林老师。

再见，放学后我会来接你。妈妈在我进学校之前给了我一个拥抱。

跟着我进入学校吧。

我会在学校认识新老师。我会在学校认识朋友们。

所有学生都在课堂上端正地坐着。我和同学们坐在班上，专心听老师讲课。

当老师在上课的时候，我会专心听课。

如果我不会，我可以举手发问。老师，我不会。

如果我想上厕所，我可以举手告诉老师。请问我可以去厕所吗？

放学时，所有学生互相说再见。上学会很有趣。

Appendix E

Chinese Version of Storyline Text for “Make new friends in the class”

当我第一次来到学校时，老师会向同学们介绍我。

这是我们的同学，[child’s name]。我的新朋友可能会向我自我介绍。哈咯， 我是阿明。

我可能会在学校结交新朋友。

我的朋友可能会向我借橡皮擦。

我可以向你借橡皮擦吗？

当我忘记带铅笔时，我也可以向他们借。

我可以向你借铅笔吗？

当然可以，给你。

当我们一起学习，学习可能会变得有趣。

有时，我的朋友可能会取笑我。

为什么你看起来和别人不一样？

我可能会不喜欢他们这样对我。没关系。

他们可能会触摸我的手臂或手。

这可能是他们交朋友的方式。没关系。

与朋友一起玩仍然很有趣。

Appendix F

Chinese Version of Storyline Text for “Behaviour during the lesson”

老师正在班上教课。

老师讲课的时候，我会专心听课。

有些问题我不会。老师可能可以教我做。

当我需要老师的帮助时，我可以举手并请求帮助。

老师，我需要帮助。需要帮忙吗？我不会这个。

上课结束后，我可以休息一下。

今天的课程到这里结束了。

请求帮助可能对我来说不会很难。

Appendix G

Malay Version of Storyline Text for "Going to a new school"

Saya akan menaiki kereta ke sekolah baru.

Hai, saya Cikgu Anna.

Sampai jumpa, selamat bermain hari anda di sekolah. Ibu memeluk saya sebelum saya masuk ke sekolah.

Ikut saya ke kelas.

Saya akan berjumpa dengan guru baru di sekolah. Saya akan berjumpa kawan-kawan di sekolah.

Semua pelajar duduk dengan betul di dalam kelas. Saya dan rakan-rakan sekelas saya sedang duduk dan mendengar guru.

Saya akan cuba fokus semasa cikgu mengajar.

Jika saya tak faham, saya boleh angkat tangan dan tanya cikgu. Cikgu, saya tidak faham.

Jika saya nak pergi tandas, saya boleh angkat tangan bagi tahu cikgu. Bolehkah saya pergi ke tandas?

Apabila sekolah tamat, semua pelajar mengucapkan selamat tinggal antara satu sama lain.

Pergi ke sekolah akan menjadi menyeronokkan.

Appendix H

Malay Version of Storyline Text for "Make new friends in the class"

Apabila kali pertama datang ke sekolah, cikgu akan bagi tahu nama saya kepada kelas.

[Child's name] adalah rakan sekelas kita. Kawan baru saya akan bagi tahu name mereka. Hai, saya Ali.

Saya mungkin akan mendapat kawan baru di sekolah.

Rakan saya boleh mintak pinjam alat tulis daripada saya.

Boleh saya pinjam pemadam daripada awak?

Apabila saya terlupa membawa alat tulis, saya juga boleh pinjam daripada mereka.

Bolehkah saya meminjam pensel daripada awak?

Pasti. Ini dia.

Seronok apabila kita belajar bersama.

Kadang-kadang, kawan saya mungkin mengejek saya.

Kenapa awak nampak beza dari yang lain?

Mungkin saya tidak suka mereka bercakap tentang saya. Tidak apa.

Mereka mungkin menyentuh lengan atau tangan saya.

Mungkin itu cara mereka untuk berkawan. Tidak apa.

Masih seronok bila bermain dengan kawan-kawan.

Appendix I

Malay Version of Storyline Text for "Behaviour during the lesson"

Guru sedang mengajar di dalam kelas.

Apabila guru mengajar, saya akan memberi perhatian.

Ada beberapa soalan yang saya tidak faham. Guru mungkin akan membantu saya untuk habiskan soalan.

Apabila saya memerlukan bantuan guru, saya boleh mengangkat tangan dan meminta bantuan.

Cikgu, saya perlukan bantuan. Ya? Saya tidak faham.

Saya boleh pergi berehat selepas pelajaran tamat.

Pelajaran hari ini tamat di sini.

Mungkin tidak susah bagi saya untuk meminta bantuan.

Appendix J

Experts' Review of VRVM

Reviewer	Reviewer 1	Reviewer 2	Reviewer 3
Section A: Demographic Data Collection			
Name	Fan Say Ken	Cecilia Tsang	Lim Suat Wei
Email Address	fansayken@gmail.com	tyycecilia@gmail.com	suatwei86@gmail.com
Gender	Male	Female	Female
Highest degree you have graduated from	Bachelor's Degree	Master's Degree	Bachelor's Degree
Title or name of the degree you graduated from	Bachelor of Speech Sciences with Honours	Postgraduate Diploma in Piano Performance	Bachelor of Speech Sciences With Honours
Your profession	Speech and Language Pathologist	Lived Experience Expert (Parents)	Speech and Language Pathologist
Section B: Review			
Clarity of the Video Modelling's Direction			
The vocabulary level, language structure, and conceptual level of the Video Modelling suits the level of autistic children. The Video Modelling is designed in a clear and understandable manner.	3	2	3
Organization and Presentation of the Video Modelling			
The Video Modelling is organized and presented in a logical and sequential manner.	2	3	2
Suitability of Video Modelling			
The Video Modelling	4	2	1

appropriately represent the substance of the autistic children's daily life in school. The Video Modelling is designed to help autistic children in adapting to new schools.			
Adequateness of Content per Video Modelling			
The content represents the coverage of each story adequately. The content is representative enough of the concept defined for the research. The content is not too short or too long for the Video Modelling.	4	4	2
Attainment of Purpose			
The Video Modelling as a whole fulfill the objective of the research.	3	2	1
Objectivity			
The Video Modelling has no aspect of bias (such as gender stereotyped, etc) on the part of the content.	4	3	2
Experts' Feedback			
Comments and Suggestions	perhaps it is better to use pictures that are specific to the targeted child for him to relate to the story. Also, the audio might be confusing to the child as the voices for all characters are the same.	The movement of the 'camera' is fast which may cause cybersickness The speed of narrative may be too fast for some of the individuals with ASD Background music can be softer to avoid distraction	Social Story is personalized. This resource can be used as a guideline/ template for the development of an indidualized Social Story that fits the context/skills/ knowledge of an audience. For e.g.: "I will ride a car to new

			school", some audience may ride a car/ motorbike/ walk to school. Hence, the social story may not be giving the accurate informations to the audience. As for the animation in the video, it would be clearer to have different set of sound (audience VS "dialogue/ speech" of others).