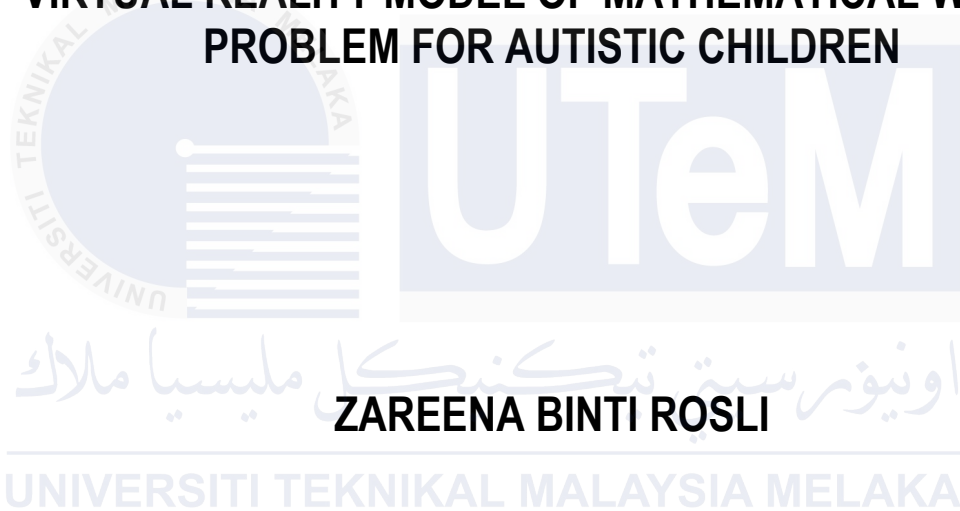




# **VIRTUAL REALITY MODEL OF MATHEMATICAL WORDS PROBLEM FOR AUTISTIC CHILDREN**



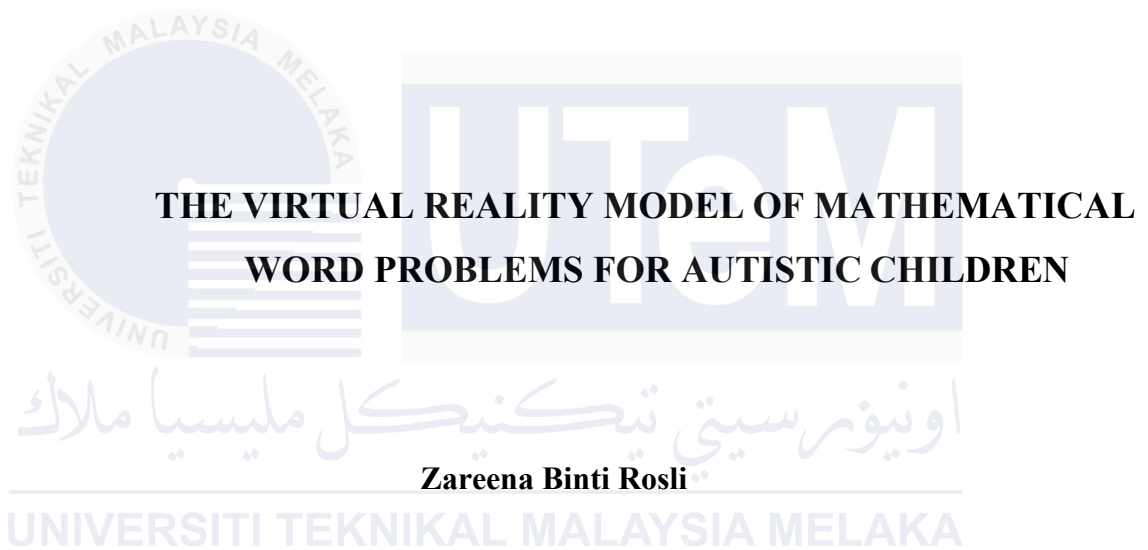
**ZAREENA BINTI ROSLI**

**DOCTOR OF PHILOSOPHY**

**2025**



**Faculty of Information and Communications Technology**



**Doctor of Philosophy**

**2025**

**THE VIRTUAL REALITY MODEL OF MATHEMATICAL WORD PROBLEMS  
FOR AUTISTIC CHILDREN**

**ZAREENA BINTI ROSLI**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2025**

## DECLARATION

I declare that this thesis entitled “Virtual Reality Model of Mathematical Word Problems For Autistic Children” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree..



Signature :.....

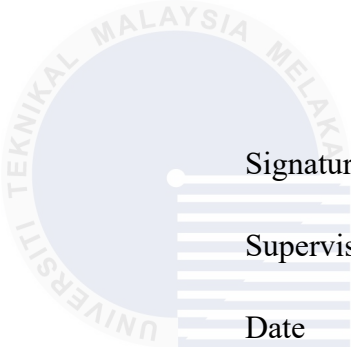
Name : ZAREENA BINTI ROSLI

Date : 02/07/2025

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## APPROVAL

I hereby declare that I have read this thesis and, in my opinion, this thesis is sufficient in terms of scope and quality for the award of Doctor Philosophy.

	Signature	.....
	Supervisor Name	PROF. TS. DR FAAIZAH BINTI SHAHBODIN
	Date	: 02/07/2025

اونيورسيتي تېكنيكل مليسيا ملاك

---

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## DEDICATION

This thesis is dedicated with deepest gratitude to Allah, for His endless guidance and blessings throughout this journey.

To my beloved father, whose strength and prayers have always been a source of inspiration.

To my sons, Farhan, Fahmi, and Faris for being my greatest motivation and joy.

In loving memory of Musanif, whose presence is felt in every step of this journey.

To my respected supervisor, for their invaluable guidance, encouragement, and unwavering support throughout this research.

And to my dear friends, for their continuous motivation, understanding, and companionship during this research.

---

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## ABSTRACT

This research addresses the challenge of enhancing contextual knowledge and problem-solving abilities in everyday mathematics activities among autistic children. The study developed and evaluated the effectiveness of a Virtual Reality Model (VRMath), which integrates relevant learning theories and multimedia principles to provide an interactive learning experience. The primary objective is to investigate the impact of VRMath on learners' contextual knowledge, mental representation, and problem-solving skills. A mixed-methods design was employed, combining quantitative and qualitative approaches. The quantitative component utilized a single-subject research design, while the qualitative component included semi-structured interviews and participant observation. Three autistic children, aged 9 to 10 years, were purposefully sampled based on their ASD profiles and received individualized instruction over three months. The findings indicate that VRMath significantly improved the participants' contextual knowledge and problem-solving abilities. The main contribution of this research lies in demonstrating the potential of virtual reality as an effective educational tool for autistic children, thereby contributing to the Body of Knowledge (BOK) in special education and educational technology. This study provides valuable insights for educators and researchers seeking innovative methods to support the learning needs of autistic students.

اونيورسيتي تېكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# **MODEL REALITI MAYA UNTUK MASALAH PERKATAAN MATEMATIK DIKALANGAN KANAK-KANAK AUTISTIK**

## **ABSTRAK**

*Penyelidikan ini menangani cabaran meningkatkan pengetahuan kontekstual dan kebolehan menyelesaikan masalah dalam aktiviti matematik harian di kalangan kanak-kanak autistik. Kajian ini membangunkan dan menilai keberkesanan Model Realiti Maya (VRMath), yang mengintegrasikan teori pembelajaran yang relevan dan prinsip multimedia untuk menyediakan pengalaman pembelajaran interaktif. Objektif utama adalah untuk mengkaji kesan VRMath terhadap pengetahuan kontekstual, representasi mental, dan kemahiran menyelesaikan masalah pelajar. Pendekatan penyelidikan yang digunakan dalam kajian ini menggabungkan kaedah kuantitatif dan kualitatif. Komponen kuantitatif menggunakan reka bentuk penyelidikan subjek tunggal, manakala komponen kualitatif melibatkan temu bual separa berstruktur dan pemerhatian peserta. Tiga kanak-kanak autistik, berumur 9 hingga 10 tahun, dipilih secara sengaja berdasarkan profil ASD mereka dan menerima pengajaran individu selama tiga bulan. Dapatan kajian menunjukkan bahawa VRMath secara signifikan meningkatkan pengetahuan kontekstual dan kebolehan menyelesaikan masalah peserta. Sumbangan utama penyelidikan ini adalah dalam menunjukkan potensi realiti maya sebagai alat pendidikan yang berkesan untuk kanak-kanak autistik, dengan itu menyumbang kepada Badan Pengetahuan (BOK) dalam pendidikan khas dan teknologi pendidikan. Kajian ini memberikan pandangan berharga untuk pendidik dan penyelidik yang mencari kaedah inovatif untuk menyokong keperluan pembelajaran pelajar autistik.*

UNIVERSITI TEKNIKAL MALAYSIA MELAKA



## ACKNOWLEDGEMENT

I am deeply grateful to all those who have played a crucial role in the completion of this thesis. The unwavering support, guidance, and encouragement I have received from them have been invaluable throughout this journey. I express my heartfelt gratitude to my supervisor, Professor Ts. Dr. Faaizah binti Shahbodin, for her expertise, guidance, and constructive feedback that have shaped and enhanced the quality of this thesis. I am also indebted to my family for their unconditional love, unwavering support, and endless sacrifices, which have been a constant source of inspiration. The financial support provided by the Ministry of Higher Education has allowed me to fully dedicate myself to this research. Additionally, I extend my heartfelt appreciation to my friends and colleagues for their unwavering support, insightful discussions, and constant motivation throughout this journey. To all those mentioned and others who have contributed to my academic growth and the completion of this thesis, I extend my deepest gratitude for your unwavering support, guidance, and belief in me. Your presence in my life has made this achievement possible, and I am truly grateful. Thank you, Allah.

## TABLE OF CONTENTS

	PAGES
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>DEDICATION</b>	
<b>ABSTRACT</b>	i
<b>ABSTRAK</b>	ii
<b>ACKNOWLEDGEMENT</b>	iii
<b>TABLE OF CONTENTS</b>	iv
<b>LIST OF TABLES</b>	ix
<b>LIST OF FIGURES</b>	xi
<b>LIST OF ABBREVIATIONS</b>	xiii
<b>LIST OF APPENDICES</b>	xiv
<b>LIST OF PUBLICATIONS</b>	xv
 <b>CHAPTER</b>	
<b>INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Problem Statement	3
1.3 Preliminary Study	5
1.4 Research Question	10
1.5 Research Objective	11
1.6 Research Contributions	11
1.7 Scope of Research	13
1.8 Significance of study	14
1.9 Limitation of study	15
1.10 Research Framework	16
1.11 Operational Definition	19
1.12 Organization of study	20
1.13 Summary	22
 <b>LITERATURE REVIEW</b>	 <b>26</b>
2.1 Introduction	26
2.2 Overview of Autism Spectrum Disorder	26
2.2.1 Cognitive and Behavioral Challenges in ASD	27
2.2.2 Language Comprehension and Abstract Reasoning	29
2.2.3 Executive Functioning	30
2.2.4 Impact on learning Mathematical Word Problems	31
2.3 Mathematical Word Problems and Their Importance	33
2.3.1 Cognitive Process in Learning Mathematical Word Problems	34
2.3.2 Metacognitive Strategies	36
2.3.3 Real-life Problem Solving	37
2.4 Learning Difficulties in Mathematics among ASD Children	39
2.5 Factors Affecting Mathematical Word Problems Learning in ASD	43
2.5.1 Everyday Mathematics Knowledge	44
2.5.2 Sentence Comprehension	47

2.5.3	Mathematics Vocabulary	49
2.5.4	Computational Skills	52
2.6	Instructional Strategies and Interventions	55
2.6.1	Visual Supports and Graphic Organizers	56
2.6.2	Explicit Instruction and Scaffold Support	57
2.6.3	Social Stories and Social Scripts	57
2.6.4	Technology-Assisted Instruction	58
2.6.5	Cognitive-Behavioral Interventions	58
2.6.6	Schema Based	60
2.6.7	Graphic Organizers	61
2.6.8	Mapping of Strategies and Factors to VRMath Features	61
2.7	Assistive Technology for ASD	63
2.7.1	Communication and Social Interaction	64
2.7.2	Learning and Education	64
2.7.3	Sensory Integration and Self-Regulation	64
2.8	Virtual Reality in ASD Learning	65
2.8.1	Significance of VR in Mathematics Education	65
2.8.2	Theoretical Framework for Mathematics Learning in VR	69
2.8.3	Components and Element of VR Environments for Mathematics Learning	72
2.8.4	Designing Effective VR Environments for Mathematics Learning	73
2.8.5	Integration of VR in Mathematics Word Problem Learning	74
2.8.6	Justification for Using VR over Other Technologies	76
2.9	Summary	78
<b>METHODOLOGY</b>		<b>80</b>
3.1	Introduction	80
3.2	Research Design	80
3.2.1	Single-Subject Design	84
3.2.2	Pretest-Posttest Approach	86
3.2.3	Quantitative Design Approach	87
3.2.4	Qualitative Design Approach	88
3.3	Research Procedure	88
3.3.1	Ethical Approval and Consent	89
3.3.2	Participant Screening and Selection	90
3.3.3	Intervention and Implementation	91
3.3.4	Data Collection and Analysis	97
3.4	Research Variables and Treatment Condition	100
3.4.1	Independent Variable	100
3.4.2	Moderator Variable	101
3.4.3	Dependent Variable	101
3.4.4	Experimental Treatment	102
3.5	Research Sampling	103
3.5.1	Sampling of Participants	103
3.5.2	Participants	107
3.5.3	Research Site	117

3.6	Research Instrument, Content and Activities	119
3.6.1	Research Instruments	119
3.6.2	Research Contents	121
3.7	Validity and Reliability	124
3.7.1	Validity	124
3.7.2	Reliability	125
3.8	Data Collection	126
3.8.1	Baseline (A)	127
3.8.2	Intervention Phase (B)	128
3.8.3	Withdrawal or Reversal Phase (A)	128
3.8.4	Data Management and Ethics	129
3.9	Pilot Test	129
3.9.1	Participants and Setting	130
3.9.2	Procedure	130
3.9.3	Findings and Revisions	130
3.10	Techniques of Data Analysis	131
3.10.1	Descriptive Statistics	131
3.10.2	Quantitative Data Analysis	132
3.10.3	Qualitative Analysis	133
3.10.4	Triangulation Process	134
3.11	Summary	137
<b>DESIGN AND DEVELOPMENT OF VRMATH PROTOTYPE</b>		<b>139</b>
4.1	Introduction	139
4.2	Instructional Design Framework	140
4.2.1	Analyze Learners	141
4.2.2	State Objectives	142
4.2.3	Select Methods, Media, and Materials	143
4.2.4	Utilize Media and Materials	143
4.2.5	Require Learner Participation	143
4.2.6	Evaluate and Revise	143
4.3	Theoretical Alignment	144
4.3.1	Constructivism	144
4.3.2	Situated Learning Theory	145
4.3.3	Cognitive Theory of Multimedia Learning (CTML)	145
4.3.4	Integration of Theories in VRMath	145
4.4	VRMath Model	147
4.4.1	Model Structure and Components	147
4.4.2	Learning Flow	151
4.4.3	Pedagogical Integration	152
4.5	Development Process	159
4.5.1	Hardware and Software	160
4.5.2	Creation of Virtual Environments and Scenarios for Word Problems	160
4.5.3	Interactive Elements and Feedback	163
4.5.4	Comparison Between Initial and Final VRMath Model Versions	165

4.5.5	Development Timeline	167
4.6	Implementation	168
4.6.1	Pilot Testing	168
4.6.2	User Experience Design Considerations	169
4.7	Evaluation	171
4.7.1	Testing Procedure	172
4.7.2	Visual Analysis Method	173
4.7.3	Qualitative Insights	174
4.8	Instructional Design Approach	176
4.8.1	Multimedia Principles	179
4.8.2	Key features and components	180
4.8.3	Integration of VR Technology	181
4.9	Summary	184
<b>RESULT AND DISCUSSION</b>		<b>186</b>
5.1	Introduction	186
5.2	Quantitative Analysis	186
5.3	The result on VR design requirements for supporting mathematics word problems solving.	187
5.3.1	Conceptual Framework: Integrating Virtual Reality with Constructivist and Situated Learning Theories for ASD Mathematics Instruction	189
5.3.2	Discussion	193
5.4	The result on design and development of VRMath Model	194
5.4.1	Result: Model Construction: Integrating Educational Theory into VR-Based Learning for Children with ASD	195
5.4.2	Discussion	196
5.5	The result on evaluating the effectiveness of the VRMath model in enhancing mathematical word problem comprehension among children with ASD.	198
5.5.1	Results of Word Problem Comprehension Scores	199
5.5.2	Discussion	205
5.6	The result assessing the impact of the VRMath model in mathematical word problem solving among children with ASD	207
5.6.1	Result of word problem accuracy and speed	208
5.6.2	Discussions	210
5.7	Summary	212
<b>CONCLUSIONS AND RECOMMENDATIONS</b>		<b>215</b>
6.1	Introduction	215
6.2	Summary of Research Objectives	216
6.3	Research Contributions	218
6.3.1	Development of the VRMath Model	218
6.3.2	Creation of a Learning Tool Adapted to Cognitive and Sensory Needs	219
6.3.3	Integration of Virtual Reality into Special Education Practice	219

6.3.4	Development of Practical Guidelines for VR-Based Instructional Design	220
6.4	Future Works	221
6.5	Recommendations	221
6.6	Conclusions	224
<b>REFERENCES</b>		<b>226</b>
<b>APPENDICES</b>		<b>245</b>



## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 1.1	Preliminary study on mathematical problem-solving tasks and executive function scores	7
Table 1.2	Relationship between Research Problem, Research Objective, Research Question, Method, and Research Outcome	24
Table 2.1	Learning Difficulties in Mathematics among Children with ASD	42
Table 2.2	Instructional Strategies and Intervention	59
Table 2.3	Mapping of Instructional Strategies and Learning Factors to VRMath Features	62
Table 3.1	Participant Demographic Information	111
Table 3.2	Learning Profiles for Each Participant	113
Table 3.3	Instruments and Materials Used in the VRMath Intervention Study	120
Table 3.4	Structured VRMath Activities for ASD Learners	122
Table 4.1	Comparison Between Initial and Final VRMath Model Versions	165
Table 5.1	Summary of Word Problem Comprehension Marks for Participant 1 across Phases	200
Table 5.2	Summary of Word Problem Comprehension Marks for Participant 2 across phases	202
Table 5.3	Summary of Word Problem Comprehension Marks for Participant 3 across phases	204
Table 5.4	Accuracy and Speed of Word Problems Solving for Participant 1	208
Table 5.5	Accuracy and Speed of Word Problems Solving for Participant 2	209

TABLE	TITLE	PAGE
Table 5.6	Accuracy and Speed of Word Problems Solving for Participant 3	209





## LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1	Agreement Levels Among Teachers on Academic Competencies in ASD Learners	9
Figure 1.2	Graphical Representation of the Research Framework	18
Figure 2.1	Theoretical Frameworks of the Study	72
Figure 3.1	Research Design	83
Figure 3.2	Structure of the A-B-A Single-Subject Design	86
Figure 3.3	Flowchart of the research procedure	89
Figure 3.4	Sampling process for participant selection in the VRMath intervention study	105
Figure 4.1	Design and Development Process of VRMath Prototype	140
Figure 4.2	The ASSURE Instructional Design Model	142
Figure 4.3	Theoretical Alignment of the VRMath Model	146
Figure 4.4	VRMath Scenario – Word Problem in a Canteen Environment.	148
Figure 4.5	VRMath Interactive Learning Tasks	149
Figure 4.6	VRMath Contextualized Problem Scenarios	150
Figure 4.7	VRMath Adaptive Feedback and Support	151
Figure 4.8	VRMath Main Menu Interface	161
Figure 4.9	VRMath Scenario – Word Problem Muffin Sales	162
Figure 4.10	VRMath Feedback Screen – Muffin Sales Problem	164
Figure 4.11	Development Stages of the VRMath	167
Figure 5.1	Research Process of Addressing Research Question 1	188

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 5.2	Conceptual Framework	190
Figure 5.3	Alignment between Theoretical Frameworks and VRMath Features	192
Figure 5.4	Research Process of Addressing Research Question 2	194
Figure 5.5	VRMath Model	204
Figure 5.6	Research Process of Addressing Research Question 3	213
Figure 5.7	Visual Analysis Graph of Word Problem Comprehension Marks for Participant 1 across Phases	201
Figure 5.8	Visual Analysis Graph of Word Problem Comprehension Marks for Participant 2 across Phases	203
Figure 5.9	Visual Analysis Graph of Word Problem Comprehension Marks for Participant 3 across Phases	204

## LIST OF ABBREVIATIONS

AAC	-	Augmentative and Alternative Communication
ABA	-	Applied Behavior Analysis
ADHD	-	Attention Deficit Hyperactivity Disorder
AR	-	Augmented Reality
ASD	-	Autism Spectrum Disorder
CTML	-	Cognitive Theory of Multimedia Learning
EF	-	Executive Functioning
HMD	-	Head-Mounted Display
IEP	-	Individualized Education Plan
IQ	-	Intelligence Quotient
LINUS	-	Literacy and Numeracy Screening
MR	-	Mixed Reality
PND	-	Percentage of Non-Overlapping Data
SSRD	-	Single-Subject Research Design
UI	-	User Interface
UTeM	-	Universiti Teknikal Malaysia Melaka
VR	-	Virtual Reality
VRMath	-	Virtual Reality Mathematics Model

## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Permission Letter to Conduct Academic Research	245
Appendix B	Application Letter to Conduct Research at Special Needs Education School	246
Appendix C	Application Letter to Conduct Academic Research in Special Education Institutions under the Melaka State Education Department	247
Appendix D	Approval Letter for Conducting Research in Schools under the Ministry of Education Malaysia	248
Appendix E	Approval Letter for Conducting Academic Research in Melaka State Schools	249
Appendix F	Checklist Form for Evaluating a VR Math Model	250
Appendix G	Mathematic word problem rubric	252
Appendix H	Need Assessment Survey	253
Appendix I	Observation Form	254
Appendix J	Parent/Guardian Consent Form for Student Participation in VRMath Research for Mathematics Learning	256
Appendix K	VRMath Interface	257
Appendix L	Word Problem Sheet	260
Appendix M	Sample of Activity Log	261

## LIST OF PUBLICATIONS

The followings are the list of publications related to the work on this thesis:

Rosli, Z., Shahbodin, F., and Che Ku Nuraini C. K. M, 2023. Constructing A Conceptual Framework For Implementing Assistive Learning Technology To Enhance Word Problem Solving Skills In Children With Autism. *Scandinavian Journal of Information Systems*, 35(3), pp.326-333 (SCOPUS indexed).

Rosli, Z., Shahbodin, F., Yuwono, J., Gunarhadi, G., Yusuf, M., and Supratiwi, M., 2023. The Proposed Conceptual Framework to Enhance Mathematics Abilities on Children with Autism Spectrum Disorder ( ASD ) Through the Application of Virtual Reality Technology. *Journal of Namibian Studies*, 2(34), pp.1507–1520.

Rosli, Z., Shahbodin, F., and Che Ku Nuraini Che Ku Mohd., 2019. A Proposed Conceptual Framework of Word Problem Comprehension using Virtual Reality for Children with Autism. *Advances in Social Science, Education and Humanities Research*, 388, pp.316–321.

Rosli, Z., and Shahbodin, F., 2018 . Integrating Mathematics Problem Solving Process: A Virtual Reality Learning Approach. *5th LIS Liga Ilmu Serantau 2018*, pp.12–23.

Rosli, Z., and Shahbodin, F., 2018. A Conceptual Framework Study of Learning Mathematic Word Problem Solving using Virtual Reality Environment for Children with Autism. *Proceedings of Innovative Teaching and Learning Research Day 2018, Malacca, Malaysia, August 2018, UTEM*.

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Autism spectrum disorder (ASD) affects approximately 1 in 54 children in the United States, making it one of the most prevalent developmental disorders (Maenner et al., 2020; Salari et al., 2022). It is characterized by impairments in social communication and interaction, along with the presence of restricted and repetitive behaviors (American Psychiatric Association, 2013). The population of students with ASD is diverse, with varying degrees of cognitive abilities, language skills, and sensory sensitivities (Maenner et al., 2020; Tan and Poon, 2022; Vogindroukas et al., 2022). This heterogeneity necessitates personalized and individualized approaches to education.

Students with ASD exhibit a unique learning profile characterized by strengths and challenges. While some individuals may have exceptional abilities in specific areas, such as pattern recognition or attention to detail, they often face difficulties in social communication, executive functioning, and cognitive flexibility (Kong, 2015; AlSalehi and Alhifthy, 2020). These challenges can impact various aspects of learning, including academic performance, problem-solving skills, and generalization of knowledge.

Academically, students with ASD may experience challenges in various subjects, including mathematics (Polotskaia and Savard, 2018; Wu, 2022; Polo-Blanco et al., 2024). They often exhibit difficulties in mathematical reasoning, problem-solving, and generalizing mathematical concepts. Word problem learning, in particular, poses challenges for students with ASD as it requires the application of mathematical concepts in real-life situations (Aziz

and Ahmad, 2015; Haghverdi and Wiest, 2016; Cox and Root, 2018). Difficulties in understanding word problems, extracting relevant information, and formulating solution plans can impede their mathematical problem-solving abilities. Additionally, students with ASD may struggle with reading comprehension, identifying key mathematical concepts, and comprehending contextual information within word problems (Cox and Root, 2018; Delisio et al., 2018; Root et al., 2018).

Assistive technology, including virtual reality (VR), has emerged as a promising tool to support the learning and development of students with ASD. VR provides an immersive, interactive, and customizable learning environment that can cater to the specific needs and challenges of students with ASD (Newbutt et al., 2016, 2017; Zhang et al., 2022). VR interventions have been explored in various aspects of ASD intervention, such as social skills training and therapy (Marozau et al., no date; Sideraki and Drigas, 2023), but their potential in academic learning remains relatively unexplored.

The integration of virtual reality (VR) technology into academic instruction tailored for students diagnosed with autism spectrum disorder (ASD) shows considerable promise in addressing the unique educational hurdles they face. Through the creation of interactive simulations and visually stimulating representations, VR platforms amplify comprehension, problem-solving abilities, and the extrapolation of mathematical principles. By immersing learners in virtual environments that closely emulate real-life scenarios, VR facilitates a learning environment abundant in contextual richness and multisensory engagement (Parsons, 2016; Sideraki and Drigas, 2023). Consequently, VR technology stands poised to provide substantial support to students with ASD in comprehending and resolving mathematical word problems, offering a highly captivating and customized educational setting.

Understanding the learning profile, academic challenges, and the potential of assistive technology such as VR is essential for developing effective instructional approaches to support the learning of students with ASD. By addressing the unique needs of this population, educators and researchers can enhance their academic experiences, promote skill development, and foster independence in learning. Further research is needed to explore the effectiveness of VR interventions and optimize the use of assistive technology in math education for autistic children, paving the way for inclusive and effective learning environments. Therefore, based on the above issue, this study intends to identify the difficulties in learning mathematical word problems among ASD children and how to design and develop a learning model for mathematical word problems using a virtual reality learning environment (VRMath) to overcome word problems comprehension, performance, and problems among ASD children in Malaysia.

## **1.2 Problem Statement**

Teaching mathematics to children with autism spectrum disorder (ASD) is a unique journey that requires tailored instructional methods. These students often encounter hurdles in mathematical reasoning, problem-solving, and applying mathematical concepts to different contexts. Research indicates that up to 60% of children with ASD struggle with various aspects of math, from basic arithmetic to more complex problem-solving tasks (Bae, 2017; Cox and Root, 2018; NeuroLaunch, 2024). Their challenges are further intensified by difficulties in reading comprehension and social interactions, which make understanding and solving word problems particularly tough (Delisio et al., 2018; Kalandadze et al., 2022; Vulchanova et al., 2023). Word problems are vital in math education because they connect