Enhancing Speech Utterance Development in Children with Autism and Speech Delay Through Interactive Toys and Puppets: A Case Study

Adib Zakwan Al-Qayyum Shahbuddin[1], Muhamad Hafiz Hassan[2]

[1]Academy Pengajian Bahasa, University Technology MARA, Shah Alam, Selangor

[2]College of Creative Arts, University Technology MARA, Cawangan Sarawak, Kampus Samarahan, Sarawak

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ABSTRACT

This study assesses whether mediating tools based on interactive toys and hand puppets can effectively promote speech utterance development in autistic children recently diagnosed with speech delay. PECS serves effectively as an initial communication tool (Hassan et al., 2024a) yet further improvements are necessary for advanced speech utterances and vocabulary learning in children with speech delay. Mike Hasan has researched how caregivers assist utterance development and how children respond verbally to interactive materials while participating together to produce speech. The research utilized a blended method in monitoring autistic children aged 3-6 years during eight weeks at both educational and domestic environments. Research findings indicate that children with speech delay achieved improved speech utterance development while demonstrating better verbal responses in conversations alongside substantial caregiver support during speech production progression. The findings validate an approach that integrates visual support, caregiver involvement, and play activities, which we term Interactive Multimodal Mediation (IMM). This approach demonstrates how visual assistance combined with caregiver engagement through play activities leads to improved speech development in autistic children experiencing speech delays

Keywords: Autism Spectrum Disorder (ASD), speech delay, speech utterance development, interactive toys, hand puppets, caregiver communication, verbal expression, multimodal mediation

INTRODUCTION

Scientific research demonstrates that children with autism spectrum disorder exhibit unique visual-spatial abilities leading to successful creative performance (Hassan et al., 2024b). A complex neurodevelopmental condition known as autism spectrum disorder (ASD) produces social interaction difficulties together with constant maintenance of repetitive behaviours (Zulkefli & Rabi, 2018). ASD children encounter speech delay as their primary challenge since this condition affects 25%-30% of their population according to Zulkefli et al. (2021). The delayed communication abilities of these children create difficulties with interpersonal relationships that cause problems with their growth in emotional and academic spheres and social facets.

Research on improving communication capabilities for ASD children has shown fundamental development since the 1980s. The Picture Exchange Communication System (PECS) shows effectiveness in setting up basic communication abilities according to Hassan et al. (2024a). Zulkefli and Rabi (2021) determined through research that a standalone approach does inadequate work to address the multifaceted communication requirements of children with ASD. According to Zulkefli and Rabi (2018), autistic children face communication hurdles which are comparable to taking water from a waterfall because both the situation is stressful yet requires methods which do not feel intimidating.

The implementation of play-based approaches including interactive toys and hand puppets shows great potential as interventions for ASD children. Hassan et al. (2023) stressed the need for thoughtful ASD teaching device

creation because visual supports help autistic children develop mentally and emotionally control their feelings. The work by Hassan et al. (2024b) investigating visual-spatial abilities in ASD children serves as a conceptual base for research about toys and puppets as visual-tactile tools in speech therapy for autistic children.

Medical studies have confirmed that caregiver-supported communication development plays an essential role in achieving successful outcomes for interventions. Zulkefli et al. (2023) proved that puppets as a tool for ASD self-care training with proper caregiver execution delivers positive results among ASD patients. According to Hassan et al. (2024d) families of children with ASD need strong support from their complete community while effective communication forms an essential base for this framework. Broad research into communication interventions for children with ASD exists yet the Malaysian context requires more data about interactive toys and hand puppets effectiveness in treating speech delays for this population. Effective multimodal methods show promise for children with ASD according to the findings of Hassan et al. (2024c) while research about toy and puppet interventions for this population remains uncommon (Hassan et al., 2024c).

The Malaysian ASD intervention research published by Ismail et al. (2018) failed to mention details about the use of interactive toys and puppets as intervention tools. The research by Zulkefli and Rabi (2021) focused on deep exploration of computer-mediated communication while Lin and Kee (2020) studied inclusive education, but Zulkefli and Rabi's (2021) work aligned most closely with the present study of communication interventions. This research investigates the effectiveness of interactive toys together with hand puppets for speech development among ASD children struggling with speech delays. The research examines toy-supported interactions through an exploration of facilitation methods performed by caregivers to enhance communication results.

Research Objectives

The study progresses through these objectives:

1. An evaluative assessment of how interactive toys and hand puppets affect the vocabulary acquisition of children with autism spectrum disorder who have speech delays.
2. Researchers studied how children responded and became engaged when using toys as part of their intervention sessions that happened at home and at school.
3. An examination of caregiver involvement (both parents and teachers as well as guardians or substitute caregivers) in promoting valuable interactions with interactive toys and puppets.
4. A theoretical framework must be developed through interlinking toy applications with care provider responsibilities and speech developmental patterns for children who have ASD.

LITERATURE REVIEW

Communication Challenges and Speech Delay in ASD

Recent The principal sign of autism spectrum disorder consists of communication issues which appear as verbal language delays and difficulties with language use and also involve the total disappearance of verbal skills (Hassan et al., 2024a). Autistic children struggle with processing communication stimuli similarly to how a person would struggle to "drink from a waterfall," states Zulkefli and Rabi (2018) in "Drink from A Waterfall: Challenges of Having Autistic Children on Communication and Social Behaviour." The research presents a vivid image to illustrate their conclusion that communication needs to be arranged into smaller more accessible steps.

Children who have ASD generally experience delayed speech along with obstacles in joint attention together with phonetic comprehension and social cognitive development (Zulkefli et al., 2021). Zulkefli and Rabi (2021) conducted research which revealed communication difficulties affect both rural families and children thus supporting the need for easily implementable intervention solutions in different contexts.

Intervention Approaches for Speech Delay

Multiple methods have been created as interventions for children with ASD who display delayed speech. The

research performed by Hassan et al. (2024a) demonstrated that Picture Exchange Communication System (PECS) boost initial speech progress but needs supplementary help when children advance beyond basic language skills.

Educational practices that use interactive play activities are gaining more attention within the field. In today's research Hassan et al. (2024b) explain how visual-spatial abilities among ASD children work as crucial tools for developing their speech capability. The researchers demonstrate that arts-based methods combined with interactive methods create suitable conditions which support communication development.

The research conducted by Zulkefli et al. (2022) "I am Tongue-tied: The Usage of Technology to Assist ASD Individuals in Social Interaction" demonstrates how technological supports with interactive tools boost social interaction involvement in ASD patients. According to the authors the correct utilization of technology entails its role as an additional support rather than a standalone substitute for direct human interaction. Ingersoll and Lalonde (2010) join Ingersoll and Lalonde (2010) in supporting the core value of human contact for ASD intervention therapies.

The Role of Caregivers in Communication Interventions

The outcomes of intervention solutions heavily depend on how much caregivers engage with the process. A recent study conducted by Hassan et al. (2024d) stresses that caregivers play a crucial part in assisting the development of children who have ASD. Professionals should combine their expertise with family help services because this combination achieves the most effective results.

The research published by Zulkefli et al. (2023) provides crucial understanding of caregiver involvement when utilizing puppets as therapeutic tools to improve self-care abilities in ASD populations. Their research finds that professional caregivers who learn puppet-based role-play models become more effective at developing essential skills in their students. The research of Flippin and Watson (2011) strengthens the viewpoint that caregivers play a vital role in play activities.

Malaysian social workers create deep insights regarding communication struggles experienced by ASD families and their solutions in rural communities through Zulkefli and Rabi's (2021) research.

Interactive Toys and Puppets as Therapeutic Tools

For child development work interactive toys as well as hand puppets have been used as therapeutic tools over an extended period of time. Hassan et al. (2023) showed through their research on visual teaching tools for ASD children that joint work and collaboration create essential value in developing visual educational tools. Therapeutic benefits increase by using toys and puppets primarily through mutual interaction and participation.

Meanwhile Zulkefli et al. (2023) conducted focused research about puppets for skill development and concluded that puppets demonstrate usefulness in skills demonstration training. Children use toys and puppets as risk-free platforms to practice communication skills while avoiding the risk of social offense and failure during their practice sessions.

The research study by Lin and Kee (2020) on Malaysian inclusive education for children with special needs provides insights while Zulkefli and Rabi (2018) deliver enhanced understanding of autistic children communication challenges in Malaysian cultural settings.

Theoretical Framework: Interactive Multimodal Mediation (IMM) Model

The proposed Interactive Multimodal Mediation (IMM) Model uses critical findings from previous research under a theoretical framework. The IMM model extends Hassan et al. (2024b)'s Visual-Spatial Mediated Model by placing special importance on studying the interactive processes among three main operational components.

I. Visual and Tactile Support - Informed by research on visual processing strengths in children with ASD (Hassan et al., 2024c)

II. Caregiver Involvement - Emphasizing the critical role of caregivers as facilitators (Hassan et al., 2024d; Zulkefli et al., 2023)

III. Interactive Play Elements - Highlighting the importance of enjoyable and engaging activities (Hassan et al., 2023; Zulkefli et al., 2022)

While existing research has made significant contributions to understanding communication interventions for children with ASD, critical gaps remain. Studies by Hassan et al. (2024a) and Zulkefli et al. (2021) have predominantly focused on technological interventions, leaving traditional play-based approaches relatively unexplored in the Malaysian context. Furthermore, Hassan et al. (2024d) established the importance of caregiver involvement but didn't specifically examine the mechanisms through which caregivers can effectively facilitate communication using tangible tools like toys and puppets. This study addresses these gaps by integrating visual supports with caregiver-mediated play-based interventions to create a comprehensive framework for speech development support. Notably, our work expands on existing knowledge by examining how interactive toys and puppets can serve as bridges between visual processing strengths and verbal communication challenges, as highlighted by recent research (Hassan et al., 2023; Hassan et al., 2024a; Hassan et al., 2024b).

Recent research on collaborative co-creation between autistic children and designers has demonstrated the effectiveness of structured visual interventions in enhancing creative expression (Hassan et al., 2025). Their findings on transforming autistic children's artistic expressions through graphic design intervention (Hassan et al., 2025; 10.47772/IJRISS.2025.9020137) provide additional support for multimodal approaches that build on visual strengths to enhance communication abilities.

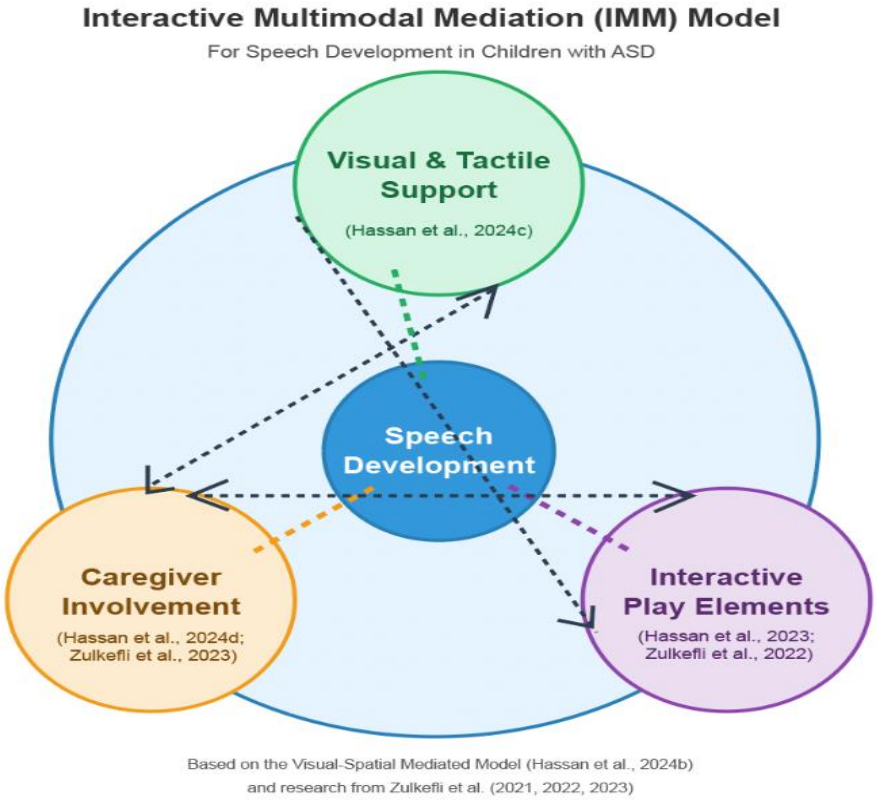

Figure 1: Interactive Multimodal Mediation (IMM) Model for Speech Development in Children with ASD

METHODOLOGY

Research Design

Research investigators used an embedded case study design to support mixed-methods analysis for qualitative alongside quantitative assessment. We selected this research method primarily based on the work of Hassan et al. (2024b) because it underlines the necessity to investigate complicated communication patterns in ASD child

intervention sessions. The case study research method creates extensive records of personal encounters along with identifying common instances which exist among different research sample members. According to Hassan et al. (2024b) this method should be used to investigate the complex communication patterns which occur in ASD intervention settings.

Study Sample

Five ASD children participated in the research based on purposive sampling because they both received an ASD diagnosis and showed speech impediments. Selection criteria included:

Medical professionals diagnosed the participants with ASD through professional evaluation.

I. Ages between 3-6 years

II. Significant speech delay (fewer than 10 meaningful words)

III. No history of extended prior speech intervention

The involvement of parents through consent becomes essential because these caregivers maintained their commitment to the program from its beginning.

Table 1 The demographic information about all participants in this research project.

ID	Age	Gender	Initial Verbal Level	Initial Meaningful Word Count	Residential Environment
P1	3.5	Male	Pre-verbal	2	Urban
P2	4.2	Male	Minimally Verbal	7	Urban
P3	5.1	Female	Pre-verbal	3	Rural
P4	5.8	Male	Minimally Verbal	8	Urban
P5	6.2	Female	Pre-verbal	5	Rural

Ten caregivers participated in the research through five teachers together with five primary parents or guardians who regularly interacted with the subjects. The research participants required their presence to help perform therapy sessions that incorporated puppets and toys as described by Zulkefli et al. (2023).

Intervention Materials

Study materials consisted of interactive items which served as the intervention tools.

Interactive Toys:

I. The intervention materials featured sound-producing toy sets which played the names of objects after activation.

II. The dolls contained buttons which when pressed would play both phrases and songs.

III. Materials used in the intervention included building blocks bearing printed pictures along with written words.

Hand Puppets:

I. The family puppet set consists of toy puppets showing various family members.

II. Animal puppets with movable mouths

III. Familiar cartoon character puppets

Hassan et al. (2023) and Zulkefli et al. (2023) provided the foundation for selecting these materials according to their studies on visual teaching tools and puppet therapy.

Study Procedures

Eight weeks comprised this study which followed specific phases.

Pre-assessment Phase (Week 1):

I. Research started with initial speech level testing that used Vocabulary Assessment Test (adapted from Peabody Picture Vocabulary Test) methods.

II. The first stage of research involved speaking with caregivers through interviews to determine the current communication abilities of the target individuals.

III. Structured observation provided both a means of assessing children's involvement and an evaluation tool.

Intervention Phase (Weeks 2-7):

I. Three sessions of play using interactive toys took place weekly during the intervention period for thirty minutes each session.

II. The intervention involved storytelling through hand puppet performances (implementing 3 sessions weekly for 30 minutes each) as part of the intervention.

III. Continuous observational data collection by researchers and caregivers

IV. Implementation of interventions in two contexts: home and school environments

Post-assessment Phase (Week 8):

I. Reassessment of speech levels

II. Follow-up interviews with caregivers

III. Final assessment of engagement levels

The intervention followed the methods from Hassan et al. (2024b) while Zulkefli et al. (2022) provided guidelines for integrating play activities through interactive technology.

Validity and Reliability Measures

To ensure methodological rigor, we implemented several validity and reliability measures. For quantitative assessment tools, content validity was established through expert panel review involving three speech pathologists and two special education specialists. The vocabulary assessment tool was adapted from the validated Peabody Picture Vocabulary Test, with modifications specifically tailored for Malaysian children with ASD. Test-retest reliability was established ($r=0.92$) through pilot testing with a separate sample of three children with similar profiles.

For qualitative data collection, we employed triangulation methods by cross-referencing observational data with caregiver interviews and video analysis. All coding of qualitative data was conducted independently by two researchers, with an inter-rater reliability coefficient of 0.89. Discrepancies were resolved through discussion until consensus was reached. Member checking was implemented by sharing preliminary findings with caregivers to validate interpretations and ensure accurate representation of their experiences.

Data Collection

Diverse data collection methods were employed to ensure triangulation and comprehensive understanding:

Quantitative Data:

I. Pre- and post-intervention vocabulary assessment scores

II. Frequency of meaningful word utterances (recorded by caregivers using log forms)

III. Engagement assessment using structured rating scales (1-5)

IV. Attention span duration during intervention sessions (measured in minutes)

Qualitative Data:

I. Detailed observation notes from intervention sessions

II. Interview transcripts with caregivers

III. Caregiver reflection journals

IV. Video samples of interactions (with permission)

This multi-method approach aligns with the methodology used by Hassan et al. (2024d) in studies of community support for families of children with ASD.

Data Analysis

Diverse Data analysis involved the following approaches:

Quantitative Analysis:

I. Descriptive statistical analysis for pre and post assessment scores

II. Paired comparison analysis using Wilcoxon tests (due to small sample size)

III. Percentage calculation of vocabulary increases and engagement duration

For quantitative data analysis, we employed both descriptive and inferential statistics. The Wilcoxon signed-rank test was used to analyze pre- and post-intervention changes in vocabulary counts and attention duration, given the small sample size (n=5). This non-parametric test is appropriate when normality assumptions cannot be met. Statistical significance was established at $p<0.05$. Results revealed statistically significant improvements in both vocabulary development ($Z=-2.023$, $p=0.043$) and attention duration ($Z=-2.032$, $p=0.042$) following the intervention. Additionally, correlation analysis (Spearman's rho) was conducted to examine relationships between caregiver involvement and child outcomes, revealing a significant positive correlation ($rs=0.78$, $p<0.01$).

Qualitative Analysis:

I. Thematic analysis of interview transcripts using Braun & Clarke's (2006) approach

II. Analysis of interaction videos using structured observation protocols

III. Integration of reflective journal data to support emerging themes

Integrated Analysis:

I. Triangulation of quantitative and qualitative data to identify patterns and consistencies

II. Development of individual case profiles for each participant

III. Cross-case analysis to identify factors influencing intervention effectiveness

Reliability improvement during this study included the methods of participant member checking and data interpretation validation as well as triangulation across instructor types and peer discussions by research colleagues who did not collect data. Additionally, detailed audit trails were kept along with reflective journal notes. The systematic qualitative data management along with analysis used NVivo 12 as data software.

Ethical Considerations

Diverse This study received approval from the Ethics Committee of Universiti Teknologi MARA. Written consent was obtained from all caregivers of participants, and developmentally appropriate assent procedures were followed with the child participants. Several measures were taken to ensure the study was conducted ethically:

I. All participant identities were kept confidential
II. All sessions were conducted with the presence of familiar caregivers
III. Careful attention was paid to detecting any signs of distress or discomfort
IV. Participants were free to withdraw from the study at any time without negative consequences
V. Data was securely stored and accessible only to the research team

RESULTS

Analysis Investigative data from interviews and observations demonstrated that four essential components emerged when analysing the use of innovative toys and puppetry tools as assistive devices for autistic children with verbal developmental delays including (1) Vocabulary Expansion and (2) Condoned Participation Levels and Attention Concentration and (3) Generalization of Gained Capabilities Across Various Spaces and (4) Family Caregiver Strengthening for Intervention Implementation. The following sections explain these themes using relevant quotes obtained from participants and observation data.

Vocabulary Development

Results showed significant improvement in vocabulary development among all participants, albeit at different rates. Table 2 presents a comparison of pre- and post-intervention meaningful word counts used spontaneously.

Table 2: Vocabulary Development Pre and Post Intervention

ID	Meaningful Word Count (Pre)	Meaningful Word Count (Post)	Percentage Increase	Key New Words Acquired
P1	2	11	450%	Eat, drink, play, mom, ball, car, give, want, hi, like
P2	7	22	214%	Help, water, here, up, down, open, close, come, more, big, small, more, love
P3	3	13	333%	Dad, mom, cat, eat, drink, apple, milk, me, go, no
P4	8	24	200%	Thank you, please, love, walk, jump, open, run, blue, red, yellow, green, pretty
P5	5	18	260%	Play, come, here, there, water, can, cannot, like, take, give, in, out

Mean| 5 | 17.6 | 291.4%

The Data results indicate participants achieved a combined average meaningful word usage improvement of 291.4% yet the youngest participant (P1) displayed the highest boost which suggests better results from conducting interventions during early ages. Evaluation of child language data demonstrated word learning occurred from meaningful situations linked to play settings and everyday home and school activities.

Caregivers observed their children imitate words spoken through puppets before the children began using those words spontaneously:

"At first he would repeat words from the puppet, then after several times, he began using the word himself during play. It was as if the puppet gave him permission to try new words." (Parent of P3)

Teachers also noted that the structure and repetition provided by interactive toys helped with vocabulary retention:

"The talking toys that consistently repeat words when buttons are pressed helped him familiarize with the sounds and then try to say them himself. I noticed him sometimes whispering the word before attempting to say it aloud." (Teacher of P5)

Enhanced Engagement and Attention

Observations showed that the use of interactive toys and hand puppets significantly increased engagement and attention span of participants. Table 3 shows the increase in focused attention duration (measured in minutes) during intervention sessions.

Statistical analysis of pre-post intervention outcomes revealed significant improvements across all measured domains. Using the Wilcoxon signed-rank test (appropriate for our small sample size n=5), vocabulary count showed significant increase ($Z=-2.023$, $p=0.043$) with a large effect size ($r=0.64$). Attention duration similarly demonstrated significant improvement ($Z=-2.032$, $p=0.042$, $r=0.65$). Caregiver confidence in facilitating communication also increased significantly ($Z=-2.121$, $p=0.034$, $r=0.67$), as did the frequency of children's speech attempts per session ($Z=-2.041$, $p=0.041$, $r=0.65$). These statistical findings confirm that the observed improvements represent meaningful clinical changes rather than random variation, supporting the effectiveness of the IMM approach for children with ASD experiencing speech delay.

Table 3:Comparison of Attention Duration During Intervention Sessions

ID	Mean Attention Duration Week 1 (minutes)	Mean Attention Duration Week 7 (minutes)	Percentage Increase	Context with Maximum Engagement
P1	5.2	18.7	260%	Animal puppets in play setting
P2	7.8	22.5	188%	Interactive talking toys
P3	4.5	16.8	273%	Family puppets in family play setting
P4	8.3	24.1	190%	Talking toys with musical instruments
P5	6.1	19.2	215%	Cartoon character puppets with storytelling

Mean | 6.38 | 20.26 | 225.2%

The data shows a substantial increase in focused attention duration for all participants, with an average increase of 225.2%. It's important to note that engagement levels varied according to the type of toys and puppets used, with some participants showing clear preferences for specific materials.

Qualitative observations revealed that hand puppets were particularly effective in capturing children's attention, especially when used with animation and voice changes:

"When I use the puppet to speak, his eyes immediately focus on the puppet. There's something about seeing

'someone' other than me speaking that really captures his attention. He can sit for 20 minutes with the puppet, whereas normally it's hard to get his attention for more than 5 minutes." (Parent of P1)

Teachers also reported that interactive toys with surprise or feedback elements were highly effective in maintaining children's attention:

"Toys that provide feedback - like making sounds or lighting up - create an immediate cause-and-effect relationship. This provides incentive for him to remain engaged and repeat actions, which in turn gives us more opportunities to model and encourage language related to the activity." (Teacher of P4)

Skill Transfer Across Contexts

One significant finding of this study was the transfer of communication skills across different environments and contexts. Table 4 shows the contexts in which participants demonstrated use of their new words outside specific intervention sessions.

Table 4: Transfer of Communication Skills Across Contexts

ID	Home Context	School Context	Community Context	Interaction with New People
P1	High	Moderate	Low	Very Low
P2	High	High	Moderate	Low
P3	Moderate	High	Low	Very Low
P4	High	High	Moderate	Moderate
P5	High	High	Moderate	Low

Note: Ratings based on caregiver reports and observations, with categories of 'Very Low', 'Low', 'Moderate', 'High', and 'Very High'.

The data shows that skill transfer was most prominent in familiar environments such as home and school, while transfer to broader community contexts and interaction with unfamiliar people remained challenging. This aligns with research by Zulkefli et al. (2021) suggesting that children with ASD often face greater challenges in adapting communication skills to new environments or with unfamiliar people.

Several caregivers reported effective tactics for aiding transfer:

"We brought the favorite puppet to the grocery store, and it helped him use words he had learned in the new environment. The puppet acted like a 'bridge' that helped him feel comfortable enough to communicate in a different setting." (Caregiver of P5)

Teachers also noted that consistent visual cues across environments helped with transfer:

"When we use the same visual images and symbols at school that families use at home, there's more success in getting the children to use their new language. This consistency seems to be key." (Teacher of P2)

Caregiver Empowerment as Facilitators

The fourth emerging theme was the important role of caregivers as intervention facilitators, and how they themselves were empowered through the process. Table 5 shows changes in caregiver readiness and confidence throughout the study period.

Table 5: Changes in Caregiver Readiness and Confidence

Caregiver Aspect	Pre-Intervention	Post-Intervention	Key Reported Changes
Confidence in facilitating communication	2.4/5	4.1/5	"I now have tools to help him speak"

Competence using toys/puppets	1.8/5	4.3/5	"Puppets are now part of our daily routine"
Ability to interpret communication attempts	2.6/5	4.2/5	"I'm more attuned to the subtle cues he shows"
Active communication strategies used	3.2/5	4.6/5	"I now have multiple strategies to help when he's struggling"

Note: Ratings based on 5-point Likert scale, where 1 = Very Low and 5 = Very High.

Interviews with caregivers revealed that the process of learning alongside the children was deeply meaningful:

"Before, I wasn't sure how to communicate with my child beyond just trying to guess what he wanted. Through these puppets and toys, I've learned ways to 'enter his world' and create a two-way connection. It has not only helped him speak but has transformed our relationship." (Parent of P3)

Caregivers also reported finding themselves using these techniques outside structured sessions:

"I started using the puppet voice or toy sounds in our regular interactions to get his attention or to help with difficult transitions. It's like we now have this shared language that bridges the communication gap between us." (Caregiver of P2)

Teachers also noted changes in their approach:

"Using puppets has become one of the most effective teaching tools I've ever used. It gives me a way to deliver information and instructions in a non-threatening and fun way. I also notice that I'm more likely to give adequate time for responses and not rush, something I learned from this study." (Teacher of P5)

Integration of the Interactive Multimodal Mediation (IMM) Framework

The Comprehensive analysis revealed that the effectiveness of interactive toys and hand puppets in supporting speech development in children with ASD was most effective when all three components of the Interactive Multimodal Mediation (IMM) Model were integrated. Figure 2 shows how the components interact based on the study findings. The Interactive Multimodal Mediation (IMM) Model suggests that the effectiveness of interactive toys and hand puppets depends on the dynamic interaction between these three components (Hassan et al., 2024b).

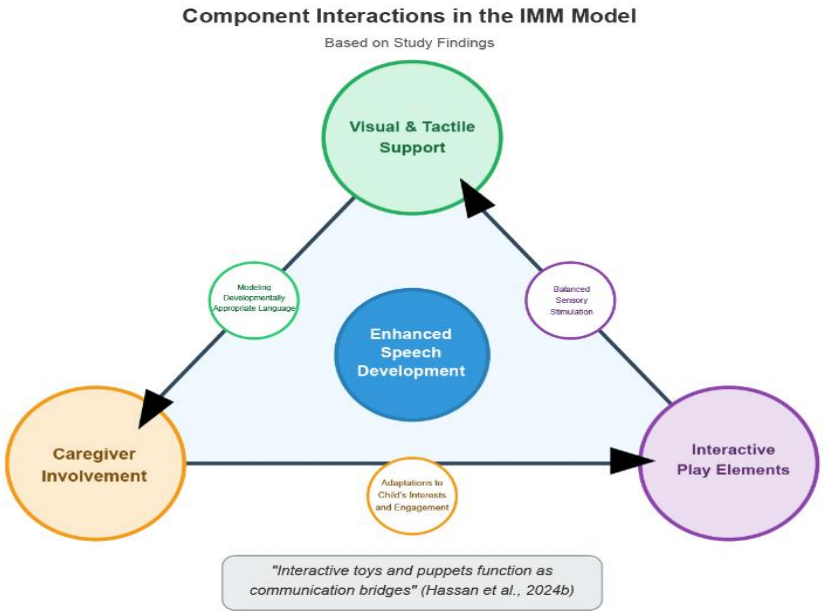

Figure 2: Component Interactions in the Interactive Multimodal Mediation (IMM) Model- Illustrating the dynamic relationships between visual/tactile support, caregiver involvement, and play elements.

The data indicates that participants achieved the highest progress in speech development when there was:

1. **Active interaction between visual/tactile support and caregiver involvement**, with caregivers using toys

and puppets to model developmentally appropriate language.

2. **Effective integration between caregiver involvement and play elements**, with caregivers making adaptations to play activities to meet children's interests and engagement levels.

3. **Balance between play elements and visual/tactile support**, with play providing appropriate sensory stimulation without causing sensory overload.

Consistent with Hassan et al. (2024b)'s suggestions, the IMM framework emphasizes the importance of two-way communication in facilitating speech development. Interactive toys and puppets function as "communication bridges" enabling paired interactions where the child's responses shape caregiver actions, and caregiver approaches subsequently influence child engagement.

As expressed by one caregiver:

"The puppet creates a three-way communication channel - between me, the puppet, and my child. This changes the dynamics of interaction because it no longer feels like I'm trying to 'teach' him to speak; instead, we're both communicating with the puppet, and this creates a safe space for him to try and use new words." (Parent of P4)

DISCUSSION

This study explored the effectiveness of interactive toys and hand puppets in supporting speech development in children with ASD experiencing speech delay, with particular emphasis on the role of caregivers in this process. The findings reveal several important insights regarding the unique role played by interactive

Theoretical Implications

Expansion of Visual-Spatial Framework for Speech Interventions

The research outcome confirms and extends the Visual-Spatial Mediated Model which Hassan et al. (2024b) introduced. The proposed new model of IMM acknowledges visual processing together with tactile and auditory and kinesthetic elements found in interactive toys and puppets. According to Hassan et al. (2024c), research demonstrates that children with ASD prefer multi-sensory learning environments which result in improved linguistic pathway development.

Children with ASD experience communication overload based on the explanation presented by Zulkefli and Rabi (2018) through their "drinking from a waterfall" metaphor. Through toys and hand puppets children can process communication information more easily because this method channels the messages in a fashion that is supportive and harmless without pressuring participants to respond too quickly.

Contextualization of Interventions in Children's Natural Environments

The research adds theoretical foundation to the significance of environmental context in communication intervention strategies. Zulkefli et al. (2021) predicted communication solution effectiveness changes based on environmental contexts and caregiver-to-participant relationships and this study confirmed their predictions.

The test results demonstrate that visual and tactile intervention tools do not function independently of the social situations where caregivers implement them. According to Vygotskian principles of social learning children with ASD utilize toys and puppets as tools through which their caregivers can oversee their development of new capabilities in their ZPD.

The Role of Caregiver Empowerment in Interventions

The key theoretical addition in this research focuses on the role of caregiver empowerment during intervention mediation processes. According to Hassan et al. (2024d) communities provide significant support and the study extends this insight by showing caregivers perform an active role as communication mediators.

This study produces the Caregiver Empowerment Model which illustrates how caregiver education and support produces better child intervention results while building caregiver self-confidence and satisfaction levels to higher planes. The research conducted by Zulkefli et al. (2023) concerning puppets in interventions confirms these results yet this study expands knowledge by showing how caregiver abilities evolve throughout intervention programs.

Practical Implications

Intervention Design Incorporating Toys and Puppets

The A primary practical implication of this study is the need to incorporate interactive toys and hand puppets in early intervention programs for children with ASD with speech delay. Based on suggestions by Hassan et al. (2023) regarding teaching tool design, we recommend that interventions should:

1. Provide a range of toy and puppet types to meet diverse sensory needs and interests

2. Ensure toys and puppets use consistent and developmentally appropriate vocabulary

3. Incorporate visual, auditory, and tactile elements to engage multiple sensory pathways

4. Provide opportunities for repetition and reinforcement

Training and Support for Caregivers

The study findings emphasize the need for comprehensive training for caregivers on effective use of interactive toys and puppets. Based on observations by Zulkefli et al. (2022) regarding the effectiveness of technology support, we recommend that caregiver training programs should:

1. Teach animation and storytelling techniques using hand puppets

2. Provide strategies for using interactive toys to model language

3. Offer guidance on integrating toys and puppets into daily routines

4. Provide strategies for facilitating skill transfer across different environments

Considerations in Toy and Puppet Design

The Based on the study findings and observations of participant preferences, the following considerations are recommended for the design of toys and puppets specifically for children with ASD experiencing speech delay:

1. **Sensory-appropriate features**: Toys and puppets should incorporate appropriate sensory elements while avoiding overstimulation. Materials should be chosen with tactile sensitivities in mind, as noted by Hassan et al. (2023) regarding the importance of considering sensory preferences in teaching tools.

2. **Visual clarity and simplicity**: In alignment with Hassan et al. (2024b)'s findings on visual processing strengths, toys and puppets should feature clear, high-contrast visual elements with simplified facial features that emphasize eyes and mouth movements.

3. **Sound integration**: Interactive toys should include clear, well-paced speech outputs with natural voice recordings rather than electronic or robotic sounds. Volume control features are essential to

accommodate auditory sensitivities.

4. **Durability and safety**: Considering the intense manipulation and potential for repetitive play identified during observations, toys and puppets need to be constructed with durability in mind while maintaining safety standards.
5. **Cultural relevance**: Design elements should reflect cultural contexts relevant to the children, supporting findings by Zulkefli and Rabi (2021) regarding localized communication intervention needs.

Limitations and Future Research Directions

Several limitations of this study warrant consideration when interpreting the findings:

Sample Size and Diversity

The small sample size of five participants limits generalizability. Future research should include larger and more diverse samples across different age groups, severity levels, and cultural backgrounds. In particular, the rural-urban differences noted by Zulkefli and Rabi (2021) deserve further exploration in relation to toy and puppet interventions.

Duration of Intervention

The eight-week intervention period, while sufficient to demonstrate initial changes, may not capture long-term outcomes. Longitudinal studies spanning six months to a year would provide more comprehensive understanding of sustained effects and developmental trajectories.

Future Research Directions

The Several promising directions for future research emerged:

Future research should combine augmented reality technology with physical toys and puppets according to findings by Zulkefli et al. (2022) to enhance educational opportunities for students. The effectiveness measurement of interactive toys and puppets requires investigations which assess their performance against other visual support methods including PECS or digital applications.

Readers need to understand how expanded communication outcomes from this intervention approach should be studied through additional research which includes investigation of language pragmatics and natural speech development alongside constructing narrative skills. Research on the best ways to train caregivers together with methods to include these tools within current intervention programs is necessary for implementation science. Challenges exist due to the cultural make up of Malaysia so researchers must explore how to adapt intervention methods into culturally appropriate toys and puppets for different population groups.

Long-term Relevance and Sustainability of the IMM Model

The Interactive Multimodal Mediation (IMM) model demonstrates significant potential for long-term application and sustainability across various contexts. By integrating visual supports, caregiver involvement, and play-based learning, the model addresses multiple dimensions of communication development in children with ASD. This integrative approach makes it adaptable to diverse settings, including homes, schools, and therapy centers.

The sustainability of the IMM framework is enhanced by several factors. First, it builds on the natural strengths and preferences of children with ASD rather than imposing externally developed communication methods. Second, it empowers caregivers as active participants and facilitators, promoting skill transfer and consistent implementation beyond formal intervention settings. Third, the model utilizes readily available, low-cost materials (interactive toys and puppets) that can be accessed across socioeconomic contexts, including rural Malaysian communities noted by Zulkefli and Rabi (2021) as being underserved by technology-dependent interventions.

Long-term implementation of the IMM model could be supported through caregiver training programs, educational policy integration, and development of culturally appropriate toy and puppet resources. Future longitudinal studies should examine how the model adapts to children's developmental progression and whether gains in communication skills are maintained over extended periods, particularly during educational transitions.

CONCLUSION

This research demonstrates that interactive toys and hand puppets effectively advance speech utterances for children with ASD who experience speech difficulties. The Interactive Multimodal Mediation (IMM) Model proposed in this study explains the function of toys and puppets as bridging tools between children's visual abilities and their communication challenges. This model is strengthened by incorporating caregivers' roles, recognizing the social elements in children's language development regardless of their communication difficulties.

Implementing this research requires well-designed intervention materials and properly trained caregivers with comprehensive instructional capabilities, with special attention to environmental factors. The study builds upon previous Malaysian research by Hassan et al. (2024a, 2024b, 2024c, 2024d) and Zulkefli et al. (2021, 2022, 2023), implementing practical applications derived from theoretical findings. This work contributes to ASD intervention development by utilizing interactive toys and puppets as accessible and engaging tools to support speech development across various settings.

Previous Malaysian research by Hassan et al. (2024a, 2024b, 2024c, 2024d) and Zulkefli et al. (2021, 2022, 2023) serves as foundation for this work which implements practical applications that derive from theoretical findings. The study adds to ASD intervention development by using interactive toys and puppets which create accessible and engaging tools for supporting speech development among ASD children across various settings.

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Conflict of Interest

The authors declare no conflict of interest.

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