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Fuzzy Delphi Method Identifies Key Training Approaches in the Parent-Implemented Intervention Model for Autism

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Abstract

Early, family-centred support is crucial for children diagnosed with Autism Spectrum Disorder, as social communication and behaviour challenges could last forever. Although structured training is still scarce, the Parent-Implemented Interventions approach presents a promising means of empowering parents. This study applied the Fuzzy Delphi Method to get the expert agreement consensus on nine core training approach elements. Family Capacity-Building and Integrated Coaching are emerging as top priorities from all elements. These insights set the baseline for an evidence-based parent training model. Its long-term effects and adaptability to families with multicultural and multilingual backgrounds should be investigated in future studies.

Keywords: Autism Spectrum Disorder; Parent-Implemented Interventions; Fuzzy Delphi Method; Parent Training

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1.0 Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder that impacts an individual with persistent deficits in social communication and interaction, as well as limited and repetitive patterns of activities and interests (American Psychiatric Association [APA], 2013). People with ASD traits may have a hard time with everyday tasks, which may influence their quality of life. Hence, it is important to initiate early intervention at the earliest, as it has been proven to maximise the developmental growth and outcomes of young children with ASD (Zhou, 2024).

The Parent-Implemented Interventions (PIIs) approach is receiving a lot of attention because it can help parents use evidence-based strategies and techniques in their children's daily activities, which could lead to long-term positive effects (Meadan et al., 2023). However, many available PIIs programs are missing a structured methodology in their PIIs development, such as relying on informal information, which makes them lack applicability and consistency (Liu et al., 2020; Stahmer & Pellecchia, 2015). These limitations show that parents

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of children with ASD need a systematic and culturally sensitive training program or model that meets their needs and abilities, simultaneously able to achieve targeted educational goals (Duggal et al., 2020; Morsa et al., 2022).

The Fuzzy Delphi Method (FDM) is an organised and systematic way to rank the most crucial elements designed in a complex intervention model or program (Mustapha & Darusalam, 2018). The FDM is employed in this current study to address the gaps in ASD intervention practice and methodology. FDM is becoming increasingly popular in healthcare and educational research due to its efficiency and reliable results (Basri et al., 2024; Hsu & Sandford, 2007, 2018; Som et al., 2023), including the ability to determine expert agreement in a single round.

This study aims to develop a structured and practical PIIs model for parents of children with ASD using the FDM. The study objective is to identify core training approaches in delivering PIIs based on expert consensus. By identifying and evaluating nine core training approach elements, this information is beneficial to researchers, practitioners and policymakers in developing a training framework that engages parents by ensuring their active participation in the early intervention of their children with ASD.

2.0 Literature Review

The Parent-Implemented Interventions (PIIs) approach identifies parents as the main facilitators of an intervention, offering a paradigm shift in Autism intervention. PII's approach is centralised in family-capacity building practice and has received more empirical support, as evidenced by models such as the Early Start Denver Model (ESDM; Rogers & Dawson, 2010) and Enhanced Milieu Teaching (EMT; Kaiser & Roberts, 2013). These models have been shown to significantly improve the cognitive, language, and social skills of children with ASD (Shire et al., 2020), even when delivered by trained paraprofessionals, such as parents (Li et al., 2022). On top of that, for example, ESDM is able to aid language and cognitive development of children through play-based activities embedded in their daily routines (Wang et al., 2022).

Despite this knowledge, there are still barriers to the actual implementation of PIIs. These include high parental stress, inconsistent home delivery of the learned intervention, and difficulties in understanding how the treatment works and troubleshooting related issues (Amsbary et al., 2020; Jurek et al., 2022). Furthermore, accessibility is limited by the reliance on an in-person training approach, particularly for working parents or those with 24-hour caregiving responsibilities, which hinders their ability to receive optimal interventions.

Numerous recommendations have been proposed to develop a flexible and inclusive training framework aimed at addressing existing barriers. One of these is the implementation of asynchronous online training programs, which have been found effective in overcoming challenges related to service accessibility and time constraints, thereby enabling more participation from families with diverse backgrounds and characteristics (Meadan et al., 2023). On top of that, it has been suggested that intervention models should involve both parents, fostering inclusive parental involvement (De Santis et al., 2020). This inclusive approach potentially increases the intervention's overall reach and relevance, underscoring the need for an adaptable and culturally sensitive training framework. The benefits are not only towards parents but also able to promote family well-being and children's development.

This evidence makes the FDM a valuable approach to achieving the study objective. By incorporating the concept of Fuzzy logic into the classic Delphi technique, FDM enables a more accurate analysis of experts' opinions in situations where subjectivity and uncertainty prevail. Furthermore, FDM is grounded in expert consensus; hence, it is particularly useful in contexts where evaluating specific components or elements in intervention models or programs requires a variety of viewpoints and subjective opinions from experienced individual professionals.

Based on prior studies, FDM has been proven effective in identifying key elements and components for ASD intervention tools or resources, especially those that prioritise the development of behavioural and communication skills (Basri et al., 2024; Som et al., 2023). As a result, there are many opportunities to create contextually relevant, useful, and adaptable intervention models or programs by utilising FDM in the research.

3.0 Methodology

This study adopted the Design and Development Research (DDR) approach (Richey & Klein, 2007). DDR is a multi-method design with a focus on quantitative aspects. The key training approaches required to implement the PII model for parents of children with ASD were validated by a group of experts, who subsequently reached a consensus agreement through the Fuzzy Delphi Method (FDM).

The FDM is designed to manage the ambiguity and subjectivity often present in complex, human-based research, particularly within the health and education fields. It accomplishes this by combining the principles of Fuzzy Logic with the conventional Delphi technique, thereby enhancing the precision and dependability of subjective experts' responses.

3.1 Sampling

A purposive sample technique was used to select 15 local and international experts. These experts were chosen based on their academic qualifications and professional experience in Autism intervention. This sampling technique is excellent for obtaining experts' viewpoints on the research objectives. Adler and Ziglio (1996) suggest a group of expert panels comprising 10 to 15 members to ensure the diversity and credibility of the consensus results. The details of the expert panel participants and their institutional affiliations are listed in Table 1.

Table 1. Composition of the Expert Panel in FDM

Expert	Institution	Total Experts
Speech-Language Therapist	Public & Private Centre	5
Special Early Childhood Educator	University & Centre	4
Clinical Psychologist	University & Research Centre	2
Interventionist	College	1
Child and Adolescent Psychiatrist	University Hospital	1
Developmental Paediatrician	University Hospital	1
Family Medicine Specialist	Health Clinic	1

3.2 Expert Criteria

In research related to FDM, careful expert selection is crucial in sustaining the reliability and robustness of the findings (Mustapha & Darusalam, 2018). Berliner (2004) stated that experts were selected based on at least five years of relevant experience, formal educational credentials, specific training, and recognition from others (Perera et al., 2012). Their competence as experts might be acquired from either a theoretical aspect or practical experience (Cantrill et al., 1996; Mullen, 2003).

This study involved a group of experts, including physicians, therapists, educators and academic researchers who are actively involved in supporting individuals with ASD and their families. Their diverse disciplinary background enabled a comprehensive understanding of the ASD spectrum in nature, thus contributing directly to the development of a contextually relevant and holistic therapeutic model framework (Albawardi et al., 2022; Martsyniak et al., 2024). The integration of these varied viewpoints strengthens the model's practical relevance and potentially supports broader implementation (Nandi et al., 2024; Roberts et al., 2022).

3.3 Instrumentation

Following typical methods of FDM research, questionnaire items or elements could be designed utilising related literature reviews and professional perspectives (Skulmowski et al., 2007). Nine key training components were produced via data triangulation from three sources: therapist and parent survey responses, observational studies of mother-child interactions in a naturalistic setting, and a comprehensive literature review on PIIs key strategies (De La Roche & Im-Bolter, 2023; Roberts et al., 2022). The designed elements were organised into explicit statements expressing the key training approach necessary for the effective implementation of the PII model.

Each item was assessed on a 7-point Likert scale, ranging from 1 (extremely disagree) to 7 (extremely agree), providing a detailed rating of the relevance and significance of each element. Experts were asked to assess the suitability of each item for inclusion in the proposed training model. Evidence demonstrating that wider answer choices may improve the accuracy and reliability of experts' opinions drives the adoption of a 7-point scale (Chen et al., 2011) in this research. To support ease of interpretation from experts' respondents, the researcher adapted the Fuzzy scale values presented in Table 2 to correspond with a simplified 1-to-7 scale format.

Table 2. Triangular Fuzzy Scale

7-Likert Scale	Fuzzy Number
Extremely Disagree	(0.0, 0.0, 0.1)
Very Disagree	(0.0, 0.1, 0.3)
Disagree	(0.1, 0.3, 0.5)
Moderately Agree	(0,3, 0.5, 0.7)
Agree	(0.5, 0.7, 0.9)
Very Agree	(0.7, 0.9, 1.0)
Extremely Agree	(0.9, 1.0, 1.0)

3.4 Fuzzy Delphi Procedure

The seven steps followed in the FDM process are outlined in Table 3.

Table 3: Fuzzy Delphi Method Steps

Step	Description	References
1. Identification of the Problem and Expert Panel Selection	Define research objectives and select qualified experts, typically with 5 years of relevant experience, a minimum of 10 experts. This study chooses 15 experts to cover a range of related experts in Autism management.	Adler & Ziglio (1996); Jones & Twiss (1978); Mustapha & Darusalam (2018)
2. Development of Questionnaire Items	Develop questionnaire items through multi-methods such as surveys, systematic reviews, and observational studies.	Habibi et al. (2014); Murry & Hammons (1995)
3. Design of the Fuzzy Scale	Create a linguistic 7-point Likert scale with corresponding Triangular Fuzzy Numbers (TFNs). All linguistic variables (Likert-scale) will be converted into TFNs, displayed as m1 (minimum value), m2 (rational value), and m3 (maximum value).	Hsieh et al. (2004)
4. Distribution of Questionnaire to Experts	Disseminate the questionnaire to experts by email. Experts were given two weeks to complete the form.	Murry & Hammons (1995)
5. Conversion to TFNs and Aggregation of Fuzzy Data	Convert expert responses into TFNs and compute the average Fuzzy scores. The purpose of aggregating the Fuzzy score is to compute the group consensus for each element by calculating the average of m1, m2, and m3 of all TFN across all responses.	Hsieh et al. (2004); Ishikawa et al. (1993); Murray et al. (1985)

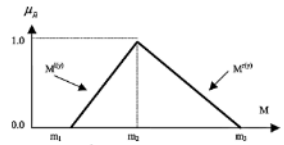

Fig. 1: TFNs Illustration

	As illustrated in Figure 1, TFNs represent expert responses using three parameters: m1, m2, and m3, enabling the transformation of linguistic data into quantifiable fuzzy scores.	
6. Defuzzification Process (d ≤ 0.2; A ≥ 0.5; ≥75% agreement)	Defuzzify involves computing the threshold (d-cut≦0.2), determining the percentage of consensus (≥75%) of each element, and calculating the average Fuzzy scores (A). First, the value of *d* is calculated using the following formula: $d(\tilde{m},\tilde{n}) = \sqrt{\frac{1}{3}\left[(m_1-n_1)^2+(m_2-n_2)^2+(m_3-n_3)^2\right]}$ d = threshold value, m1 = average of minimum, m2 = average of plausible value, m3 = average of maximum, n1 = minimum value, n2 = plausible value, n3 = maximum value Second, a minimum agreement of 75% among experts was required for final inclusion. The percentage of each element with d ≤ 0.2 is calculated. Third, the Fuzzy score (A) must exceed or equal the median value (α-cut value), which is 0.5. Additionally, based on expert consensus, the Fuzzy score (A) value can determine the element's position and priority. Three formulas can be used to determine the ranking/score of each element. The formulas are as follows, whereby Amax = maximum amplitude. i.Amax=1/3×(m1+m2+m3) ii.Amax=1/4×(m1+m2+m3) iii.Amax=1/6×(m1+m2+m3) Hence, elements with a threshold value of d ≤ 0.2, defuzzification score of A ≥ 0.5, and 75% and above were considered to have reached experts' consensus as accepted elements.	Kuo & Chen (2008); Murray et al. (1985); Tang & Wu, 2010
7. Final Selection and Ranking Analysis	Retain items that meet threshold criteria (d≦0.2), Fuzzy Score (A) ≥ α-cut = 0.5, percentage of consensus ≥75%. Finalise the validated (accepted) elements, then determine the elements' priority ranking based on expert opinions. Elements not meeting the criteria were excluded from the final model.	Habibi et al. (2014); Mustapha & Darusalam (2018)

3.5 List of Nine Training Approaches in Parent-Implemented Intervention Model

All the training approach component elements were designed using a multi-method approach. Experts validated the relevancy and importance of these elements to be accepted as part of the developed model (Table 4).

Table 4: List of Training Approach Elements for PIIs

Component	Elements	Early Item Rank
Training Approach	1.Family capacity-building practice	TTA1
	2.Integrated Coaching Model with Adult Learning Principle	TTA2
	3.Naturalistic Developmental Behavioural Interventions (NDBI) approach	TTA3
	4.Hybrid PII and therapist-delivered intervention to the child	TTA4
	5.Hybrid of child-led and parent-led intervention in home-based activities	TTA5
	6.Hybrid group and individualised coaching sessions	TTA6
	7.Personal coaching with the therapist, with elements of parent-child dyad interactions' video feedback	TTA7
	8.Hybrid of an online coaching approach	TTA8
	9.Hybrid PII and teacher-training approach	TTA9

4.0 Findings

This section presents the opinions of 15 local and international experts on the acceptable elements of the training approach for the PII's model. The results for each element are depicted in Table 5 below.

Table 5: Expert Consensus and FDM Analysis

No	Training Approach Elements	Fuzzy Score (A)	Threshold (d)	Percentage (%)	New Rank
1	**Family Capacity-Building Practice**	**0.960**	**0.019**	**100%**	**TTA1**
2	**Integrated Coaching Model with Adult Learning Principles**	**0.942**	**0.063**	**93%**	**TTA3**
3	Naturalistic Developmental Behavioural Interventions (NDBI)	0.936	0.074	93%	TTA6
4	Hybrid PII and Therapist-Delivered Intervention	0.893	0.159	80%	TTA7
5	**Hybrid Child-Led and Parent-Led Home-Based Activities**	**0.942**	**0.063**	**93%**	**TTA3**
6	**Hybrid Group and Individualised Coaching Sessions**	**0.942**	**0.063**	**93%**	**TTA3**
7	**Personal Coaching with Therapist & Video Feedback**	**0.953**	**0.035**	**100%**	**TTA2**
8	Hybrid Online Coaching Approach	0.891	0.138	87%	TTA8

9	Hybrid PII and Teacher-Training Approach	0.878	0.165	87%	TTA9

Table 5 presents the findings from FDM. These nine elements were assessed through triangulation of four primary indicators: the defuzzified score (A) derived from Triangular Fuzzy Numbers, the threshold value (d) as a measure of expert consensus, the percentage of expert agreement, and the resulting rank based on perceived importance and acceptance of the elements in the PIIs Model.

Elements were ranked (1–9) based on their defuzzified Fuzzy score (A), reflecting the central tendency of expert evaluations. The top-ranked element was Family Capacity-Building Practice (A = 0.960), followed by Personal Coaching with Therapist & Video Feedback (A = 0.953), and a three-way tie at A = 0.942 for Integrated Coaching with Adult Learning Principles, Hybrid Child-Led and Parent-Led Activities, and Hybrid Group and Individualised Coaching. The lowest-ranked was Hybrid PII and Teacher-Training Approach (A = 0.878).

All elements recorded threshold values below the accepted cut-off of $d \leq 0.2$ (Ishikawa et al., 1993), indicating strong consensus. The lowest threshold was for Family Capacity-Building Practice (d = 0.019), reflecting very high agreement. The highest thresholds were observed for Hybrid PII and Teacher-Training (d = 0.165) and Hybrid PII and Therapist-Delivered Intervention (d = 0.159), indicating a greater divergence in expert opinion.

Expert agreement ranged from 80% to 100%, with five elements exceeding 90%. Full consensus (100%) was achieved for Family Capacity-Building Practice and Personal Coaching with Video Feedback, which were top-ranked. The least expert agreement element was Hybrid PII and Therapist-Delivered Intervention (80%).

5.0 Discussion

The data reveal a consistent trend; elements emphasising parental empowerment (formerly TTA1, TTA5), reflective learning (formerly TTA7, TTA2), and adult learning principle (formerly TTA2, TTA6) achieved higher rankings and lower threshold values, indicating strong relevance and consensus among expert panellists to accept the designed key training strategies. These findings align with theoretical constructs from Family Systems Theory (Bowen, 1978), Adult Learning Theory (Knowles, 1984), and Empowerment Theory (Zimmerman, 1995), which collectively advocate for approaches that enhance parental self-efficacy, build on family strengths, and support experiential and practical learning (De La Roche & Im-Bolter, 2023; Hudry et el., 2022). High expert consensus on these elements has shown that they play a foundational role in empowering families in ASD intervention through reflective (Roggman et al., 2025) and sustainable parental learning, with tailored guidance and preferences (Meadan et al., 2023; Otter et al., 2021).

In contrast, elements involving external agents (e.g., therapists, teachers) (formerly TTA4, TTA9) received comparatively lower endorsements, reflecting concerns about role clarity, feasibility, and implementation fidelity, despite literature acknowledging their effectiveness (Nandi et al., 2024; Som et al., 2023). Their moderate scores reflect the ongoing shift from therapist-led to parent-mediated interventions, promoting accessibility and scalability in the long run (Wang et al., 2022). Additionally, the element of hybrid online coaching (formerly TTA8) is known to offer a flexible and reachable intervention delivery format, yet concerns remain over technology barriers and intervention quality (Barro et al., 2022; Nascimento et al., 2023).

The triangulated analysis supported a parent-centred, self-directed, and coaching-based elements that is strongly approved, while hybrid or interprofessional delivery models are cautiously met. These findings underscore the critical elements in fostering parental empowerment through self-directed learning principles such as goal-setting, reflective practice and active decision-making, which are in line with the adult learning framework and essential for sustaining parental engagement in early Autism intervention (Knowles, 1984; Pellecchia et al., 2022). The insights provide a validated foundation for refining parent-implemented intervention models that align with expert consensus and evidence-based practices, bolstering both scalability and sustainability of early ASD interventions across diverse settings (Basri et al., 2024; Jurek et al., 2022; Meadan et al., 2023).

6.0 Conclusion and Recommendations

The study confirms strong expert consensus on the value of key training approach elements that centre on family-led practices, experiential learning, and context-sensitive delivery. Approaches that strengthen parental autonomy and embed reflective, adult-oriented strategies are perceived as most relevant and suitable. Conversely, integrating professional-led elements required careful consideration, as it may blur role boundaries and lead to a reduction in the sense of parental ownership in an intervention.

Although this study offers valuable views into the development of the PII's model for children with ASD, study limitations must be acknowledged. For example, the study relied exclusively on expert consensus obtained through FDM, which does not assess the real-world implementation or effectiveness of the proposed key training approaches. Moreover, though the sample size of experts is acceptable, it may not reflect the wider professionals' perspective or the cultural diversity embedded in the findings.

To improve future research, it is recommended to incorporate empirical validation with parent participants, conduct longitudinal follow-ups to measure sustained outcomes, and expand the diversity of experts' cultural backgrounds. Comparative studies between parent-led and therapist-led training approaches would also strengthen the evidence base for best practices.

Future research should explore implementation fidelity, digital adaptability, and cross-cultural tailoring to enhance sustainability across diverse family contexts (Martsyniak et al., 2024; Roberts et al., 2022). Future designs should build parent capacity, apply structured reflection, follow adult learning principles, adapt to local contexts, and be validated through ongoing, inclusive research (De La Roche & Im-Bolter, 2023; Hudry et al., 2022; Meadan et al., 2023; Otter et al., 2021; Pellecchia et al., 2022).

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Paper Contribution to Related Field of Study

The authors report no conflict of interest. Their study develops a prioritised, culturally responsive model for parent-implemented intervention using FDM, offering validated, practical guidance for early childhood ASD intervention, particularly in low-resource settings.

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