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An Action Research to Explore the Crucial Role of Executive Functioning in the Development of Children with Neurodevelopmental Disorders

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Abstract

Children with neurodevelopmental disorders encounter a distinctive cluster of challenges in academic and social development, a substantial proportion of which stem from difficulties in executive functioning (EF). This action research investigated whether a structured, activity-centred training programme targeting EF skills could generate measurable developmental progress in school-going children diagnosed with Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), and learning disabilities. Grounding the intervention in a well-established conceptual framework that foregrounds cognitive flexibility, working memory, and inhibitory control as core neurocognitive processes, the study administered a ten-month programme to 27 students between the ages of 8 and 13 enrolled in the special education department of a mainstream CBSE school. Data collection combined pre- and post-intervention checklist assessments with qualitative observation, classroom tracking, and structured interviews with teachers and parents. Results showed a mean improvement of 10.76% in elementary-level participants and 6.23% in middle-school students, with 11 of 27 children transitioning from a deficit range to functional performance. These findings support the conclusion that regular, practice-oriented engagement with EF tasks can produce tangible gains even in children with significant neurodevelopmental constraints, and that initiating intervention at an earlier developmental stage is associated with more pronounced improvement.

Keywords: executive functioning, neurodevelopmental disorders, action research, ADHD, autism spectrum

What Is Executive Functioning?

Executive functions (EF) refer to a cluster of attention-regulation capacities that allow individuals to maintain focus, hold goals in working memory, manage impulsive responses, tolerate frustration, weigh the consequences of behaviour, draw on prior experience, and plan for the future. Over the past two decades, EF has attracted significant research attention across psychology, neuroscience, and education. Growing empirical consensus holds that these capacities form a critical foundation for learning, with evidence linking strong EF to school readiness and early academic achievement (Blair, 2002; Blair & Raver, 2015). Longitudinal findings further associate childhood EF with outcomes as varied as successful transition to kindergarten (Blair & Razza, 2007), academic and social competence during adolescence (Mischel, Shoda, & Rodriguez, 1989), improved physical health, higher socioeconomic attainment, and lower rates of drug use and criminal conviction in adulthood (Moffitt et al., 2011).

Three interrelated reasons explain the current prominence of EF in educational discourse. First, EF skills serve as a broad scaffold for learning and adaptive behaviour across multiple contexts, including the classroom. Second, deficits in these capacities are reliably associated with learning difficulties, behavioural problems, and several emotional and neurodevelopmental conditions, including ADHD, ASD, and specific learning disabilities. Third, EF is developmentally malleable: environmental stressors such as poverty and chronic disadvantage are known to impair EF, while responsive caregiving, quality early education, and deliberate practice can strengthen it. The extent to which schooling promotes or inhibits EF development therefore represents a meaningful question for researchers and practitioners alike (Zelazo, Blair, & Willoughby, 2017).

Researchers generally characterise EF as a set of attention-regulation processes involved in conscious, goal-directed problem solving, comprising three core components: cognitive flexibility, working memory, and inhibitory control (Blair & Diamond, 2008; Carlson, Zelazo, & Faja, 2013; Diamond, 2013; Garon, Bryson, & Smith, 2008; Meuwissen & Zelazo, 2014). *Cognitive flexibility* involves reconsidering a problem from alternative angles or adopting another person's perspective. *Working memory* involves holding and integrating information simultaneously, as a reader might do when constructing meaning from multiple ideas across a text. *Inhibitory control* involves deliberately overriding a dominant response, whether suppressing distraction,

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withholding an impulsive remark, or resisting a well-practiced but inappropriate reaction.

These processes rely on neural circuitry anchored in the prefrontal cortex and its subcortical connections. Like most cognitive capacities, EF develops through experience and practice: sustained engagement with goal-directed tasks consolidates the underlying neural pathways and increases the likelihood that these skills will be reliably recruited in future situations (Miyake et al., 2000).

efficiently than peers with weaker EF (Benson et al., 2013).

Who Are Neurodiverse Children?

Neurodivergence is best understood as a dimension of human neurological variation rather than a categorical departure from a fixed norm. Just as there is no hierarchically superior racial, gender, or cultural identity, there is no single standard brain type. The term *neurotypical* broadly denotes individuals whose cognitive and behavioural profiles align with the assumptions

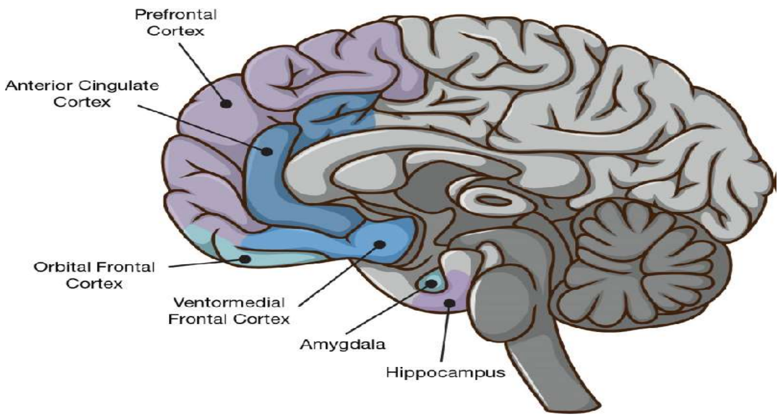

Fig 1: Medial view of select brain regions relevant to executive function

Development of EF During Early Childhood

The relationship between EF and early academic functioning is well documented and statistically robust, with a mean effect size of r = .27 across relevant studies (Allan et al., 2014). EF measured at the preschool and kindergarten stages has been found to predict school readiness in both literacy and numeracy (Espy et al., 2004; McClelland et al., 2007; Morrison, Ponitz, & McClelland, 2010; St. Clair-Thompson & Gathercole, 2006), as well as broader indices of academic achievement (Bull & Scerif, 2001; Clark, Pritchard, & Woodward, 2010; Mazzocco & Kover, 2007), grade attainment (Duckworth & Seligman, 2005), high school completion (Vitaro et al., 2005), and college graduation (McClelland et al., 2013). Notably, EF has demonstrated stronger predictive validity for academic outcomes than IQ in several studies. Kindergarteners with weaker EF and poorer social competence showed greater difficulties in reading and mathematics, and performance gaps not only persisted but widened between the second and sixth grades (McClelland, Acock, & Morrison, 2006). Children with stronger EF also appear to derive more benefit from equivalent amounts of instruction, retaining and applying learning more

embedded in most social institutions, including schools. The neurodiversity movement has sought to reframe conditions historically described as deficits or dysfunctions, instead emphasising the unique strengths and adaptive strategies of neurodiverse individuals. Practical accommodations, such as extended assessment time or access to sensory regulation tools, are often what enable these students to perform at their potential.

Neurodiversity is not a clinical diagnosis but an umbrella concept. Individuals who identify as neurodiverse may live with one or more of the following:

- Autism spectrum disorder
- Attention deficit/hyperactivity disorder
- Learning disabilities, such as dyslexia, dyscalculia, dysgraphia, and dyspraxia
- Tourette syndrome and other tic disorders
- Sensory processing issues

Certain mental health conditions such as bipolar disorder, obsessive-compulsive disorder, or anxiety disorders, as well as intellectual disabilities such as Down syndrome, are also sometimes grouped under this framework.

Neurodevelopmental Disorders and Executive Functioning

EF deficits appear with notable regularity in neurodevelopmental conditions, most prominently in ASD and ADHD.

Autism Spectrum Disorder (ASD) is characterised by impairments in communication, reciprocal social interaction, and a restricted or repetitive repertoire of activities and interests (APA, 2000). The spectrum encompasses what was previously described as autistic disorder, Asperger syndrome, and pervasive developmental disorder not otherwise specified (PDD-NOS), and may present in individuals with or without intellectual disability. EF difficulties in autism have been widely documented, particularly in the domains of planning, cognitive flexibility, and working memory, though the degree to which these deficits are primary versus secondary to other features of the condition remains an open question (Geurts et al., 2004; Goldberg et al., 2005; Hughes, 1994; Ozonoff et al., 1991; Pennington & Ozonoff, 1996; Hill, 2004).

ADHD is a neurologically mediated condition characterised by varying degrees of inattention, impulsivity, and hyperactivity (APA, 2000), and presents across three subtypes: combined, predominantly inattentive, and predominantly hyperactive-impulsive. A comprehensive meta-analysis by Willcutt et al. (2005) identified response inhibition and vigilance as the most consistently impaired EF domains in ADHD, with additional deficits in working memory (Kempton et al., 1999; Rhodes et al., 2005), planning, and cognitive flexibility (Vance et al., 2003).

Comparative studies of EF across ADHD and ASD have produced mixed findings, with some researchers proposing condition-specific EF profiles (Pennington & Ozonoff, 1996). Behavioural disinhibition and vigilance deficits appear more prominent in ADHD, while planning difficulties, set-shifting impairments, and spatial working memory deficits may be more pronounced in high-functioning autism (Geurts et al., 2004; Goldberg et al., 2005; Landa & Goldberg, 2005). Goldberg et al. (2005) examined inhibition, planning, set-shifting, and working memory in a sample of 8 to 12-year-olds with high-functioning autism (HFA), ADHD, and typical development using the CANTAB battery, finding that response inhibition, planning, and set-shifting did not significantly differ across groups, though spatial working memory was impaired in both the ADHD and HFA groups.

While a considerable body of research has examined EF deficits in neurodevelopmental populations, far less attention has been directed toward structured intervention approaches for building these capacities, particularly within the Indian educational context. The growing inclusion of neurodiverse learners in mainstream classrooms makes this gap increasingly consequential. The present study was therefore designed to investigate whether systematic, play-based EF training delivered in a mainstream school setting would produce measurable improvement in the classroom functioning of neurodiverse children. Specifically, the aim was to administer a structured ten-month EF intervention to students with neurodevelopmental conditions and track changes in their daily functioning using pre- and post-intervention checklists.

Method

The study adopted the action research framework described by Hopkins (1993), which is most suitable for practitioners who have identified a gap in their educational practice and wish to formulate, implement, evaluate, and iteratively refine an intervention. The process involves a spiral of cycles comprising four phases: *planning, acting, observing, and reflecting* (Zuber-Skerrit, 1991). Each cycle informs the design of the next, with critical reflection alternating with action to build progressively deeper understanding of the intervention's effects (Dick, 2002).

A Rationale for Using a Mixed Methodology That Is Both Qualitative and Quantitative in Approach

A mixed methodological design was chosen because executive functioning, as an object of inquiry in educational research, lends itself to both quantitative measurement and qualitative description (Strauss & Corbin, 1990; Patton, 2002; Libarkin & Kurdziel, 2002). Quantitative data, collected through pre- and post-intervention checklists administered at the ten-month mark, enabled the study to assess the magnitude of change in EF-related behaviours across individuals. Qualitative data, gathered through structured observations, interviews with teachers and parents, and analysis of regular interactions with students, allowed for a more nuanced understanding of the subtle shifts that the checklist alone could not capture. All quantitative data were analysed using basic descriptive statistics to ensure accessibility across audiences.

Sample

Participants were 27 students aged 8 to 13 years, drawn from a single mainstream CBSE school and enrolled in its special education department. All participants had average-range intellectual functioning (IQ above 75). The diagnostic composition of the sample included 8 children with ADHD, 3 with ASD, and 16 with a primary diagnosis of a learning disability. Each student had been attending special education sessions at the school for a minimum of one year before the study commenced. For analytical purposes, the sample was divided into two groups: Grades 3 to 5 (elementary level, n = 11) and Grades 6 to 8 (middle school level, n = 16). Sampling was based on availability and diagnostic eligibility.

Duration and Frequency of Training

Each participant engaged in structured EF training for 80 minutes per week across a ten-month period. Tasks were individually calibrated to each student's grade level and ability profile.

Tasks Used in Training

The students were given a plethora of tasks designed to enhance their executive skills. The worksheets and play activities were designed keeping in mind the individual ability of the students. Training covered the following areas of executive functioning:

- Sustained attention
- Working memory
- Flexibility and inhibition
- Organization, planning and time management
- Emotional control and self-monitoring
- Abstract reasoning

Activities included multi-step puzzle solving, maze navigation, colour-by-code tasks, word searches, digit coding, structured planning exercises broken into sequential steps, social problem-solving through role-play, and guided conversation tasks using provided starters.

Ethical Issues in Data Collection

Ethical considerations were integral to the study's design from the outset. All activities were grounded in sound educational practice and calibrated to individual students' developmental level and grade placement. Participation at no point placed students at psychological or physical risk. Teachers were regularly briefed about students' progress and encouraged to contribute their observations. Parents were informed of the study's purpose, the significance of EF for children's overall development, and the procedures in place to protect confidentiality and preserve participant anonymity. Written informed consent was obtained from all parents prior to data collection.

Data Collection

The following steps were followed to gather data:

1. Students were selected based on age-appropriate diagnosis, with inclusion and exclusion criteria applied consistently.
2. Parental consent and study debriefing were conducted in a group meeting.
3. A pre-assessment was administered using a standardised EF checklist to establish baseline functioning.
4. Training sessions of 80 minutes per week were scheduled over ten months, with activities matched to individual ability.
5. Sessions were documented through still photography.
6. Classroom performance was observed and recorded on an ongoing basis.
7. Teachers and parents were interviewed twice during the study period to capture reported progress.
8. On completion of training, the same EF checklist was re-administered as a post-assessment.

Data Analysis

Percentage improvement was calculated at both aggregate and domain-specific levels to determine whether structured EF practice produced observable gains in neurodiverse children. Qualitative data from interviews, observations, and informal interactions with students and parents were analysed thematically to surface changes that the checklist could not quantify.

Results and Discussion

When executive functioning is adequately developed, it allows children to organise themselves, regulate their attention, manage frustration, and engage productively with both academic work and social relationships. These capacities have downstream effects on how children perform in school, how they relate to peers and teachers, and ultimately on the kind of adults they become. The central aim of this study was to find out whether regular, structured practice targeting these skills would produce measurable change in a group of 27 students with neurodevelopmental disabilities. The EF domains targeted across the ten-month intervention were:

- Sustained attention
- Working memory
- Flexibility and inhibition

- Organization, planning and time management
- Emotional control and self-monitoring
- Abstract reasoning

The checklist used for pre- and post-assessment measured the proportion of EF deficit markers present for each student. A lower score indicates fewer deficits and better functioning, so improvement is represented by a decrease in the percentage from pre- to post-test. Following convention for this instrument, scores above 50% fall in the red zone, indicating clinically meaningful deficit, while scores below 50% indicate the green zone, reflecting functional-level performance.

Tables 1 and 2 display the full domain-by-domain breakdown for each student. Table 1 covers the elementary group (Grades 3 to 5, n = 11) and Table 2 covers the middle school group (Grades 6 to 8, n = 16).

Table 1: Comparative Growth Rate in Students of Grades 3 to 5

Elementary Level (Grades 3 to 5)																	
Students	**Class**	**Sustained Attention**		**Working Memory**		**Flexibility**		**Inhibition**		**Organizing/Planning**		**Emotional Control**		**Self-Monitoring**		**Abstract Reasoning**	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
P. B	3	100	44	100	43	88	44	100	69	100	69	97	92	96	87	94	83
A. B	4	100	88	100	71	47	42	79	38	83	42	72	36	82	69	92	90
A. I	4	100	86	100	89	41	38	56	37	88	44	42	38	33	32	76	62
M.G	4	72	66	73	60	48	36	68	48	72	50	36	28	32	28	52	48
R. P	4	86	53	92	89	100	98	88	79	89	81	100	98	98	97	100	98
S.M	4	100	96	50	48	20	20	50	48	50	47	27	25	83	79	24	24
A.M	5	87	80	55	49	67	62	60	55	63	56	95	92	66	60	56	48
A. B	5	98	96	96	94	92	90	89	80	100	98	82	80	92	90	98	92
A. D	5	95	90	100	97	82	77	76	64	96	88	62	50	92	84	100	98
B. R	5	85	72	92	90	42	38	36	27	25	23	25	24	37	32	96	89
S.M	5	67	50	45	38	65	52	64	50	30	22	25	24	25	25	39	35

*The quantifications make the percentage of features, the lower the numbers, the better is the student's progress. Features above 50% is marked as red zone and below 50% is marked as green zone.

Looking across the two tables, most students were showing quite marked deficits at baseline, particularly in sustained attention and working memory. After ten months of training, every student showed some reduction in deficit scores, though the magnitude varied considerably. Of the 27 students, 11 crossed from the red zone into the green zone on their composite score, which is meaningful given that these children were working against real neurodevelopmental constraints. The progress may appear modest in percentage terms but given the nature of the conditions involved and the relatively short intervention period, it is genuinely encouraging. As is widely recognised in developmental science, genes set certain parameters for EF development, but the trajectory is substantially shaped by experience and practice (Centre on the Developing Child, Harvard University). The neurodevelopmental profiles of these students may slow the rate of acquisition (Khan & Lal, 2023), but the data show clearly that progress is achievable.

Table 2: Comparative Growth Rate in Students of Grades 6 to 8

Middle School Level (Grades 6 to 8)																	
Students	**Class**	**Sustained Attention**		**Working Memory**		**Flexibility**		**Inhibition**		**Organizing/ Planning**		**Emotional Control**		**Self-Monitoring**		**Abstract Reasoning**	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
A.J	6	88	82	100	97	95	92	85	82	75	72	48	40	56	48	100	99
D.S	6	95	92	80	72	100	96	98	90	100	94	100	98	100	97	79	75
I.B	6	98	95	100	98	100	96	95	90	90	86	98	90	98	96	100	98
A.G	7	56	50	78	70	45	36	54	48	32	28	25	24	35	30	98	84
A.S	7	98	89	84	76	35	32	45	42	65	57	36	34	45	42	78	68
G.N	7	65	50	57	52	32	28	48	45	49	45	35	28	35	28	62	54
K.R	7	56	48	48	40	43	42	35	32	62	56	55	50	48	46	36	30
P.C	7	89	82	78	76	75	68	67	63	92	86	98	87	96	87	64	62
S.R	7	82	78	85	76	56	49	72	65	64	52	48	40	57	50	98	92

Tables 3 and 4 present aggregate pre- and post-scores for each student, along with the size of the individual difference, enabling a clearer picture of who gained most and how the two groups compared overall.

Based on the above tables it can be stated that students of the elementary level have shown a progress of 10.76% while those in middle school show an average difference of 6.23%. A steady progress can be seen in all students and considering the span of training (10months) it is quite a significant progress. Furthermore, the t-test findings suggest a significant improvement in pre and post performance of the students from both the groups. The average percentage of students in the elementary level (10.76%) is more than that of the average progress percentage of the middle school students (6.23%). This can be because the earlier we begin the developmental training, the better is the learning rate in children (Centre on the Developing Child, Harvard University) and therefore we see more progress in the elementary school students in comparison to the middle school students. However, a large significant difference (p<0.001) suggest that late childhood

Middle School Level (Grades 6 to 8)																		
Students	**Class**	**Sustained Attention**		**Working Memory**		**Flexibility**		**Inhibition**		**Organizing/ Planning**		**Emotional Control**		**Self-Monitoring**		**Abstract Reasoning**	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
S.G	7	56	48	63	55	45	40	23	20	34	28	25	23	25	23	48	44
S.S	7	97	90	100	98	90	87	92	88	86	80	87	85	89	86	100	98
A.A	8	100	98	100	96	90	87	96	90	85	82	76	72	67	62	100	98
D.A	8	85	80	96	78	72	69	78	72	67	59	57	50	64	59	97	87
R.S	8	98	85	79	71	56	48	67	56	77	63	48	43	45	40	84	79
R.T	8	78	70	65	56	72	67	64	56	56	50	54	48	54	48	57	53
S.G	8	76	70	68	60	58	50	56	54	54	48	48	42	45	38	65	59

*the quantifications make the percentage of features, the lower the numbers, the better is the student's progress. Features above 50% is marked as red zone and below 50% is marked as green zone.

Table 3: Elementary Students

NAME	PRE	POST	DIFFERENCE
PB	96.87	66.37	30.5
AB	81.87	59.50	22.37
AI	67.75	53.25	14.5
MG	57.25	45.50	11.75
RP	94.12	86.62	7.5
SM	51	48.37	2.63
AM	68.62	62.75	5.87
AB	93.37	90	3.37
AD	87.87	81	6.87
BR	54.75	49.75	5
SM	45	37	8

Average progress percentage: 10.76%

Results of the paired-t test indicated that there is a significant large difference between Before (M = 72.6 ,SD = 19) and After (M = 61.8 ,SD = 17.6), t(10) = 4.1, p = .002.

Table 3.1 stating the essentials of T-test finding, pointing out the significant difference between the pre and post performance of the elementary school students.

Parameter	**Value**
P-value	0.00208
T	-4.1191
Sample size (n)	11
Average of differences ($\bar{x}_d$)	-10.76
SD of differences (S_d)	8.6637
Normality p-value	0.02861
A priori power	0.3232
Post hoc power	0.959
Skewness	-1.4936
Excess kurtosis	1.6785

is a significant large difference between Before (M = 72.6 ,SD = 19) and After (M = 61.8 ,SD = 17.6), t(10) = 4.1, p = .002.

years can also mark significant improvement in performance.

Qualitative Analysis

Table 4: Middle School Students

NAME	PRE	POST	DIFFERENCE
AJ	81	76.50	4.5
DS	94	80.75	13.25
IB	97.37	93.62	3.75
AG	52.87	46.25	6.62
AS	60.75	55	5.75
GN	47.87	41.25	6.62
KR	47.87	43	4.87
PC	82.37	76.37	6
SR	70.25	62.75	7.5
SG	39.87	35.12	4.75
SS	92.62	89	3.62
AA	89.25	85.75	3.5
DA	77	69.25	7.75
RS	69.25	60.62	8.63
RT	62.50	56	6.5
SG	58.75	52.62	6.13

Average progress percentage: 6.23%

Results of the paired-t test indicated that there is a significant large difference between Before ($M = 70.2$,$SD = 18.2$) and After ($M = 64$,$SD = 18.2$), $t(15) = 10.3$, $p < .001$.

Table 4.1 stating the essentials of T-test finding, pointing out the significant difference between the pre and post performance of the middle school students.

Parameter	**Value**
P-value	3.177e-8
T	-10.3488
Sample size (n)	16
Average of differences ($\bar{x}_d$)	-6.2338
SD of differences (S_d)	2.4095
Normality p-value	0.02021
A priori power	0.4649
Post hoc power	1
Skewness	-1.6343
Excess kurtosis	4.043

OBSERVATION OF RESEARCHERS: No meaningful change was detectable in the first three months of training. By the midpoint of the intervention, however, steady improvement had become visible across most participants. Students began demonstrating more careful note-taking, fewer careless errors, and greater punctuality in submitting work. Their capacity to follow multi-step instructions improved, as did sustained attention and the ability to comprehend and reason through problems. Several students showed progress in abstract reasoning and self-regulation, and behavioural outbursts became less frequent. Among the ADHD cohort, improved peer interaction was among the most notably observed changes.

OBSERVATION OF TEACHERS IN CLASSROOM: Teacher reports corroborated the researcher observations. Across the group, students were described as showing incremental progress in academic task completion and presentation quality. Some students demonstrated improved compliance with classroom routines. A subset of participants became noticeably more involved in class discussions and more communicative with peers and teachers. Teachers consistently noted that progress became more perceptible during the second term of the academic session.

Conclusion

The findings of this study support the conclusion that structured, practice-based EF training can generate measurable gains in academic and social functioning among neurodiverse school-going children, even within a relatively constrained ten-month window. The data suggest that more extended training would likely yield more substantial improvements. It is reasonable to anticipate that sustained intervention over multiple years would produce gains of greater magnitude in both academic performance and social integration.

The study encountered several practical constraints. The students' fixed school timetables limited available training time, and vacation periods disrupted continuity, with some younger participants showing signs of skill regression

following extended breaks, though recovery was typically rapid once sessions resumed. Medical absenteeism interrupted the training of a number of students, and three participants were ultimately unable to complete the programme due to a transition from mainstream to specialist schooling. These challenges are worth noting for future researchers planning similar interventions.
Despite these limitations, the most consistent and perhaps most significant finding was affective: across the group, children gained confidence in their capacity to perform. Each participant showed progress in at least one domain over the course of the study.

Scope for Further Research:

- Longitudinal tracking of EF development in neurodiverse students through continuous training and assessment over a five-year period.
- Disaggregated analysis of EF gains by gender.
- Cross-stage comparison of training outcomes across elementary, middle, and secondary school levels.
- Condition-specific analysis comparing outcomes for students with ADHD, ASD, and learning disabilities.

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