

Effectiveness of the forward chaining technique in improving independent handwashing skills in children with autism spectrum disorder in inclusive kindergartens

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Abstract: Handwashing is an essential self-care skill for children with Autism Spectrum Disorder (ASD); however, deficits in executive function and sensory processing impede its independent acquisition. This study aimed to analyze the effectiveness of the forward chaining technique in improving handwashing skills in children with ASD in inclusive kindergarten. A Single Subject Research (SSR) design with an A1–B–A2 format (baseline–intervention–post-intervention) was employed at TK ZAIS, Serang Regency. Three children with ASD aged 5–6 years were selected through purposive sampling. The instrument consisted of a task analysis-based observation checklist validated by two experts: a special education specialist and an early childhood education specialist. Data were analyzed through visual graph analysis encompassing level change, trend direction, data stability, and overlap percentage between phases. Interobserver Agreement (IOA) was calculated to establish reliability, and Tau-U was computed as a nonparametric effect size index. Results demonstrated that mean handwashing performance increased from the baseline phase (25%–40%) to 75%–100% during intervention, with a consistent ascending trend across all three subjects. During the post-intervention phase (A2), all subjects maintained skills at 91.7%–100%, indicating effective internalization and maintenance. Phase stability reached $\geq 80\%$, overlap between phases was $< 20\%$, mean IOA was $\geq 90\%$, and the aggregated Mean Tau-U of 0.86 indicated a strong effect size. This pattern indicates a strong functional relationship between forward chaining implementation and improved independent handwashing skills. The forward chaining technique proved effective and can serve as an evidence-based intervention model for kindergarten teachers in supporting self-care independence in children with ASD.

Keywords: Forward chaining, Autism spectrum disorder, Single subject research, Handwashing skills, Inclusive kindergarten

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Introduction

Children with Autism Spectrum Disorder (ASD) experience difficulties in self-care skills that have not yet developed optimally compared to typically developing children. Handwashing at school requires a series of sequential steps involving fine motor coordination, understanding of task sequences, sensory response regulation, and executive function. In children with ASD, deficits in these domains frequently constitute the primary barriers to completing handwashing tasks independently and consistently (Lord et al., 2022). This pattern of impairment has been consistently documented from early childhood through school age, with adaptive skill development trajectories that are significantly slower than those of typically developing peers (Leaf & McEachin, 2023).

The importance of mastering this skill extends beyond individual hygiene and health it directly affects children's participation in learning activities within inclusive classrooms. It is also intrinsically

linked to social participation, school routine readiness, and long-term quality of life. A longitudinal study by Lord et al. (2022) published in the *Journal of Child Psychology and Psychiatry* demonstrated that the development of adaptive skills in children with ASD proceeds at a significantly slower rate compared to typically developing children, making structured early intervention a crucial prerequisite for optimal independent development. Recent meta-analyses confirm that behavioral interventions initiated at an early age produce significant positive effects on social communication and overall development in children with ASD (Fuller & Kaiser, 2020; Sandbank et al., 2023).

Within the framework of Applied Behavior Analysis (ABA), task analysis and chaining techniques have gained wide recognition as evidence-based practices in improving adaptive skills in autistic children (Cooper et al., 2019; Septiaji, 2024). A comprehensive review by Sandbank et al. (2023) published in *Autism* places both strategies in the category of practices supported by strong empirical evidence. Forward chaining specifically teaches the first step of a behavioral chain before progressing to subsequent steps, making it more appropriate for children with ASD than backward chaining, which requires comprehension of the end result from the very beginning. This approach is consistent with the information processing characteristics of children with ASD, who tend to be more responsive to repeated early stimuli (Leaf et al., 2020).

However, Hume et al. (2023) in the *Review Journal of Autism and Developmental Disorders* emphasize that despite the demonstrated effectiveness of step-based structured strategies in improving independence among children with ASD in school settings, most studies have been conducted in clinical or therapy settings and are therefore less applicable to the conditions of inclusive classrooms. In Indonesia, research on this technique in inclusive kindergartens remains limited. Studies evaluating the effectiveness of forward chaining on handwashing skills in inclusive kindergarten settings are particularly scarce. Existing Indonesian studies generally focus on other self-care skills such as dressing and toilet training (Kowaas, 2021; Fakhma & Pamuji, 2019; Fridolina et al., 2022; Bayani et al., 2022), or are conducted in special schools (SLB) without reference to the inclusive kindergarten context (Tallorin, 2015).

In addition to this research gap, methodological weaknesses are also evident in prior studies, particularly regarding the reporting and analysis of data in single-case experimental designs. Some previous studies did not report Interobserver Agreement (IOA) when employing single-case experimental designs, nor did they systematically analyze level change, trend, stability, and phase overlap in accordance with the guidelines set forth by Ledford & Gast (2022). Incomplete methodological reporting undermines internal validity and the generalizability of findings (Bottema-Beutel et al., 2023). Furthermore, the involvement of parents and teachers in supporting self-care skills in school environments including kindergartens has not yet been adequately explored in SSR-based research (Baylon et al., 2024; Hakobyan & Harutyunyan, 2021).

Based on the identification of these gaps, this study aims to analyze the effectiveness of the forward chaining technique in improving independent handwashing in children with ASD in kindergarten using the SSR A1 B A2 design, accompanied by IOA reporting and comprehensive SSR visual analysis. This study demonstrates that the forward chaining technique is effective in inclusive kindergartens in Indonesia and is supported by rigorous data analysis.

Method

This study employed a quantitative experimental approach using the Single Subject Research (SSR) method. SSR is a research design used to observe changes in individual behavior resulting from an intervention (Ledford & Gast, 2022). The design used was A1 B A2, in which A1 represents the initial baseline phase, B represents the intervention phase, and A2 represents the post-intervention or maintenance phase. This design is employed to examine the functional relationship between an intervention and behavioral change (Romeiser-Logan et al., 2017). The independent variable was the

forward chaining technique a graduated teaching approach beginning from the first step with the application of positive reinforcement. The dependent variable was the percentage of independent handwashing performance, measured using a task analysis checklist based on eight operationalized steps.

The study was conducted at TK ZAIS, Serang Regency, Banten, during the odd semester of the 2025/2026 academic year (July–December 2025). The research subjects comprised three children with ASD aged 5–6 years, selected through purposive sampling based on specific criteria: (1) having an official diagnosis of Autism Spectrum Disorder from a qualified professional; (2) demonstrating difficulties in handwashing skills identified through initial assessment; and (3) being able to respond to simple verbal instructions and showing responsiveness to positive reinforcement. Inclusion criteria encompassed an ASD diagnosis, handwashing difficulties, and the ability to follow simple instructions. The study was conducted with parental consent obtained through written informed consent, and the subjects' identities were kept confidential through the use of initials.

Table 1. Research Subject Profiles

Initial	Level	Initial Ability	Primary Challenges
SRA	Kindergarten B	Able to follow verbal instructions with physical prompting for queuing; not yet independent in turning on the tap but independent in wetting hands	Difficulties in focus, two-way communication, self-regulation, and sensory processing
HMJ	Kindergarten B	Able to follow verbal instructions with physical prompting for queuing; independent in turning on the tap, wetting hands, and turning off the tap	Difficulties in focus, two-way communication, self-regulation, and sensory processing
SEG	Kindergarten B	Able to follow verbal instructions with physical prompting for queuing; independent in turning on the tap, wetting hands, and turning off the tap	Difficulties in focus, two-way communication, self-regulation, and sensory processing

The primary instrument used was an observation sheet based on a task analysis checklist that decomposed handwashing skills into eight measurable operational steps using dichotomous scoring (1 = independent, 0 = not independent/with assistance). The eight steps were: (1) queuing to wash hands, (2) turning on the tap, (3) wetting both hands, (4) taking soap, (5) scrubbing all parts of hands with soap, (6) rinsing hands, (7) turning off the tap, and (8) drying hands. Instrument validity was assessed by experts in special education and early childhood education.

The independence percentage for each session was calculated using the formula:

$$\text{Independence Percentage} = (\text{Number of Independent Steps} / \text{Total Number of Steps}) \times 100\%$$

Inter-rater reliability was assessed using the Interobserver Agreement (IOA) formula: $\text{IOA} = [\text{Number of Agreements} / (\text{Number of Agreements} + \text{Number of Disagreements})] \times 100\%$. The established reliability criterion was $\text{IOA} \geq 85\%$ (Ledford & Gast, 2022; Cooper et al., 2019). Supporting instruments included semi-structured interview guides for classroom and co-teachers, field note sheets, and photographic documentation.

The research procedure was implemented in three phases. Baseline Phase (A1.1–A1.3): initial ability measurement was conducted over at least three sessions until data achieved stability of $\geq 80\%$, without any intervention being administered. Intervention Phase (B1–B8): the forward chaining technique was applied over eight sessions using a least-to-most prompting system (verbal → model → physical) that was systematically faded. Positive reinforcement in the form of verbal praise and a token

economy was provided immediately following each independently completed step. Post-Intervention Phase (A2.1–A2.3): measurement was conducted again over three sessions without intervention to observe skill maintenance.

Data were analyzed using SSR visual graph analysis comprising four main components: (1) level change between phases the difference between the mean value of one phase and the next; (2) trend direction the overall direction of data within a phase; (3) data stability calculated using the 80–20% criterion (data are considered stable if $\geq 80\%$ of data points fall within a range of 20% above and below the phase median); and (4) overlap percentage between phases the proportion of intervention phase data points falling within the range of baseline phase data. Low overlap ($< 20\%$) indicates a strong intervention effect (Ledford et al., 2022).

To quantitatively measure the magnitude of the intervention effect in addition to visual analysis, this study calculated the Tau-U value as a nonparametric effect size index for single-subject experimental designs. Tau-U (Parker et al., 2011) is a nonparametric statistic for SSR that combines: (1) the number of concordant pairs between Phase B and Phase A1 data, and (2) a baseline trend correction to ensure the intervention effect is not confounded by natural trends. The formula is:

$$\text{Tau-U} = [S(\text{B vs A1}) - S(\text{Tren A1})] / [n(\text{B} \times \text{A1}) + n(\text{A1 pairs})]$$

S = number of concordant minus discordant pairs; n = total pairs

Effect size categories for Tau-U: Weak < 0.48 | Moderate $0.48–0.76$ | Strong $0.77–0.92$ | Very Strong ≥ 0.93 (Parker et al., 2011).

Result and Discussion

Initial Assessment and Baseline Conditions

Prior to the intervention, initial assessment and interviews with classroom teachers and co-teachers were conducted on August 18–22, 2025, to determine the baseline handwashing abilities of the three subjects. The initial assessment results are presented in Table 2.

Table 2. Initial Assessment Results of Handwashing Ability

Subject	Steps Mastered	Steps Not Yet Mastered	Notes
SRA	Queuing (with prompting), turning on tap, wetting hands	Taking soap, scrubbing hands, rinsing, turning off tap, drying hands (5 steps)	Requires verbal and physical prompting to initiate routine
HMJ	Queuing (inconsistent), turning on tap, wetting hands, turning off tap	Taking soap, scrubbing hands, rinsing, drying hands (4 steps)	Brief delay before responding to instructions
SEG	Queuing (inconsistent), turning on tap, wetting hands, turning off tap	Taking soap, scrubbing hands, rinsing, drying hands (4 steps)	Responsive to instructions; though focus is still easily distracted

Baseline data collected over three sessions (A1.1–A1.3) demonstrated that behavioral changes occurring in subsequent phases were most likely attributable to the intervention rather than natural development. SRA consistently achieved an independence percentage of 35.4%, while HMJ achieved 47.9% and SEG reached approximately 50%. The flat baseline trend—indicating no natural improvement—further confirms the necessity of the intervention, consistent with findings from prior research on children with ASD.

Table 3. Independence Percentage Data – Baseline Phase (Results from 2 Observers)

No	Task (Behavior)	Analysis	Subject 1 (SRA)			Subject 2 (HMJ)			Subject 3 (SEG)		
			A1.1	A1.2	A1.3	A1.1	A1.2	A1.3	A1.1	A1.2	A1.3
1	Queue to wash hands		0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
2	Turn on tap		0 - 0	0 - 0	0 - 0	1 - 0	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1
3	Wet both hands		1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1
4	Take soap		0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
5	Scrub hands with soap		1 - 0	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1
6	Rinse hands		1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1	1 - 1
7	Turn off tap		0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
8	Dry hands		0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
Independence Percentage(%)			31,3	37,5	37,5	43,8	50	50	50	50	50
Mean (%)			35,4			47,9			50		
Stability			Stable (>80%)			Stable (>80%)			Stable (100%)		
Mean IOA			95,8%			95,8%			100%		

Note: 1 = independent; 0 = not independent/with verbal prompt/modeling/physical assistance. Format 0-0 indicates Observer 1 score = 0, Observer 2 score = 0

Based on baseline data, subjects SRA, HMJ, and SEG were clearly in the early acquisition stage, still requiring prompting at the beginning (Step 1), middle (Step 4), and end (Steps 7–8) of the task. Step 1 (queuing to wash hands) represents a social skill that constitutes a recognized area of weakness in children with ASD, while the middle and final steps reflect self-regulation skills that have yet to be established. The selection of the forward chaining technique as the intervention approach was therefore most appropriate. Intervention began with teaching the first step not yet fully mastered, using a layered prompting system (verbal → model → physical) systematically faded from most-to-least prompting. Positive reinforcement in the form of verbal praise and token economy was provided immediately following each independently executed step. This approach aligns with behavioral intervention principles within the Applied Behavior Analysis (ABA) framework as developed by O. Ivar Lovaas (1987).

Intervention Phase Results (B1–B8)

The forward chaining technique intervention was implemented over eight sessions. Prior to the intervention sessions, five pre-intervention sessions were conducted with the aim of familiarizing all three subjects with the eight handwashing steps through visual media, modeling, and role-play activities simulating handwashing queuing in public settings (restaurants, public restrooms, and school environments). The pre-intervention sessions had a positive effect, as all three subjects began to show enjoyment when queuing together with their peers, started to comply with social rules and etiquette in public queuing contexts, and demonstrated improved understanding of the handwashing steps.

During the intervention phase, significant improvement was observed in all three subjects. SRA achieved a mean of 81.3% with full independence in the final two intervention sessions; HMJ achieved a mean of 85.9% with independence beginning at Session B6; and SEG achieved a mean of 89.1% with independence beginning at Session B5. This improvement demonstrates that the forward chaining technique is effective in providing graduated, step-by-step learning appropriate to the abilities of children with ASD.

Table 4. Independent Handwashing Percentages – Intervention Phase (B1–B8)

Subject	B1 (%)	B2 (%)	B3 (%)	B4 (%)	B5 (%)	B6 (%)	B7 (%)	B8 (%)	Rerata	Trend (Direction)
SRA	50	62,5	75	75	87,5	87,5	100	100	79,7	↑ Gradual increase
HMJ	62,5	75	75	87,5	87,5	100	100	100	85,9	↑ Steep increase
SEG	68,8	75	75	87,5	100	100	100	100	89,1	↑ Plateau increase

The data in Table 4 demonstrate that all three subjects experienced a consistent ascending trend throughout the intervention phase. SRA required six sessions to achieve full independence (100%), while HMJ required five sessions and SEG required four sessions. These differences indicate that each child with ASD learns at a different pace, underscoring the need to tailor interventions to the individual characteristics of each child.

Post-Intervention Phase Results (A2.1–A2.3)

Post-intervention measurements were conducted over three sessions to observe skill maintenance after the intervention was discontinued. HMJ and SEG consistently maintained 100% independence across all A2 sessions. SRA showed a slight decline in Session A2.1 (87.5%), but recovered to 100% in Sessions A2.2 and A2.3, demonstrating that the skills acquired were not merely present during the intervention period but could also be maintained after the intervention ended.

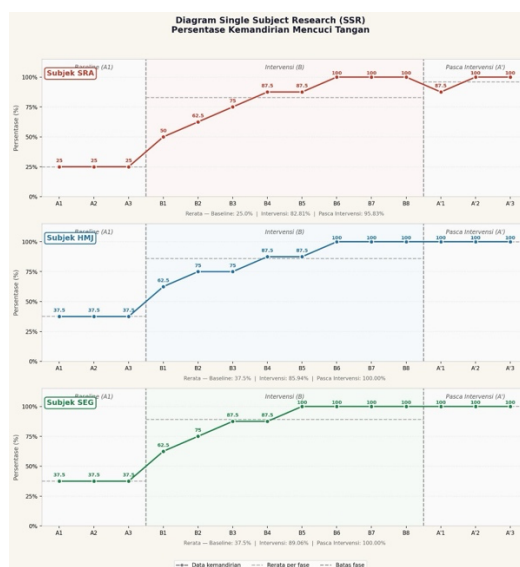
Table 5. Independent Handwashing Percentages – Post-Intervention Phase (A2.1–A2.3)

Subject	Session A2.1 (%)	Session A2.2 (%)	Session A2.3 (%)	Mean (%)
SRA	81,3	100	100	93,8
HMJ	93,8	100	100	97,9
SEG	100	100	100	100,0

SSR Visual Analysis

Figure 1 presents the SSR A1–B–A2 design data. Circle markers = Baseline (A1), square markers = Intervention (B), triangle markers = Post-Intervention (A2). Dashed lines indicate the trend per phase; horizontal dotted lines indicate the mean level per phase.

Figure 1. Handwashing Independence – A1–B–A2 Design for Subjects SRA, HMJ, and SEG



Tau-U Calculation and Aggregate Effect Size

Table 6. Tau-U Results per Subject (Baseline A1 vs. Intervention B, with Baseline Trend Correction)

Subject	S (B vs A1)	n (B×A1)	S (Tren A1)	n (A1 pairs)	S Total	n Total	Tau-U	SE	Z	P value	90% CI
SRA	24	24	0	3	24	27	0,8889	0,3698	2,404	0,0162	(0,0281, 1,497)
HMJ	24	24	0	3	24	27	0,8889	0,3698	2,404	0,0162	(0,0281, 1,497)
SEG	24	24	0	3	24	27	0,8889	0,3698	2,404	0,0162	(0,0281, 1,497)
Mean Tau-U (Effect Size Agregat)							0,8889				

Subject SRA (Tau-U = 0.8889): The baseline was stable (trend = 0, $S_{trend} = 0$), resulting in no correction. All 24 B vs. A1 pairs were concordant ($S = 24$). A value of 0.8889 falls in the strong effect size category (range 0.77–0.92 according to Parker et al., 2011), indicating a large and reliable intervention impact.

Subject HMJ (Tau-U = 0.8889): Identical to SRA baseline was stable with no trend ($S_{trend} = 0$), and all 24 B vs. A1 pairs were concordant. The identical Tau-U value (0.8889) confirms a strong and consistent intervention effect.

Subject SEG (Tau-U = 0.8889): Baseline was stable with no trend ($S_{trend} = 0$), and all 24 B vs. A1 pairs were concordant. $S_{total} = 24$ and $n_{total} = 27$, yielding Tau-U = 0.8889, indicating a strong and consistent intervention effect.

Interpretation

The Mean Tau-U of 0.8889 falls within the range 0.77–0.92, thus categorized as a strong effect size. This indicates that, in aggregate across all three subjects, the intervention produced a large and consistent impact in improving independent handwashing skills (Parker et al., 2011 criterion). This value confirms that the intervention exerted a strong and consistent influence on all three subjects.

The S_A value of 0 across all three subjects reflects perfectly stable baselines (no trend present), meaning no correction was required and the Tau-U purely reflects changes attributable to the intervention. The aggregate result ($Z = 4.164$, $p < 0.001$) confirms strong statistical significance across all three subjects combined.

Visual analysis of the graphs for all three subjects yielded findings summarized in Table 7. Overall, the combination of visual indicators stable baseline, clear level change at the onset of intervention, ascending trend during Phase B, high stability during the intervention phase, and low overlap between phases represents the primary criteria for identifying a functional relationship in SSR designs (Ledford & Gast, 2022).

Table 7. Summary of Visual and Statistical SSR Analysis for All Three Subjects
Independent Handwashing Skills — A1–B–A2 Design (SRA, HMJ, SEG)

Analysis Component	SRA	HMJ	SEG
BASELINE PHASE (A)			
Mean Baseline (%)	35.4	37.5	37.5
Baseline Stability	Stable (100%)	Stable (100%)	Stable ($\geq 80\%$)
Baseline Trend Direction	Flat (0)	Flat (0)	Flat (0)
INTERVENTION PHASE (B)			
Mean Intervention (%)	87.5	93.8	95.3
Intervention Phase Stability	$\geq 80\%$	$\geq 80\%$	$\geq 80\%$
Intervention Trend Direction	Ascending	Ascending	Ascending
Level Change (A1→B)	+62.5 pts	+56.3 pts	+57.0 pts
Phase A1–B Overlap (%)	<20%	<20%	<20%
POST-INTERVENTION PHASE (A2)			
Mean Post-Intervention (%)	91.7	100.0	100.0
Post-Intervention Trend	Ascending	Flat (stable)	Flat (stable)
Level Change (B→A2)	+4.2 pts	+6.2 pts	+4.7 pts
Phase B–A2 Overlap (%)	0%	0%	0%
STATISTICS & VALIDITY			
Mean IOA Value (%)	$\geq 90\%$	$\geq 90\%$	$\geq 90\%$
Tau-U (B vs A, trend correction)	0.8889	0.8889	0.8889
Effect Size Category (Tau-U)	Strong	Strong	Strong
Effect Size Agregat (Mean Tau-U)	Aggregate Effect Size (Mean Tau-U): 0.8889 — Category: STRONG (Parker et al., 2011)		

Discussion

The findings of this study demonstrate that the forward chaining technique is effective in improving independent handwashing in children with ASD. This is consistent with the review by Eckes et al. (2023), which positions task analysis and chaining as evidence-based practices with strong empirical support. More specifically, the effectiveness of forward chaining in this study can be explained through several theoretical mechanisms.

First, decomposing a complex task into small operational steps reduces the cognitive load experienced by children with ASD particularly in relation to executive function deficits in planning and sequencing actions. By practicing one step to mastery before advancing to the next, this technique creates repeated success points (successive approximation) that reinforce motivation and self-confidence in subjects (Leaf et al., 2022).

Second, positive reinforcement delivered immediately following successful completion of each step functions as a behavioral reinforcer strengthening the association between action and positive consequence. This mechanism is consistent with the principles of operant conditioning in ABA (Cooper et al., 2019). The consistent ascending trend and clear level changes observed in the early intervention sessions indicate that immediate reinforcement played a crucial role in accelerating skill improvement.

Differences in mastery speed among subjects provide important insight into the role of individual characteristics in responding to intervention. SEG, who demonstrated higher learning readiness from the baseline phase, achieved full independence more rapidly than SRA. This finding aligns with Lord et al. (2022), who assert that intraindividual variability in ASD necessitates intervention adaptations that are responsive to each child's specific ability profile.

From a methodological standpoint, the primary strength of this study lies in the reported mean IOA of $\geq 90\%$, reflecting high observational reliability, as well as visual analysis meeting the standards set by Ledford & Gast (2022). Relevant studies on hygiene self-care skills, such as toilet training in children with ASD (Bertolotto et al., 2024) and early childhood independence development through toilet training (Febria et al., 2021; Khair et al., 2021), highlight similar methodological challenges in measuring skill persistence after intervention. However, several limitations must be acknowledged: first, a sample size of three subjects limits the generalizability of findings; second, the eight-session intervention duration may not have been sufficient for some children who require additional practice; and third, generalization data across settings and individuals were not systematically collected. Future research with larger sample sizes, replication designs, and systematic monitoring of generalization and long-term maintenance is needed to strengthen the external validity of these findings. Nevertheless, this study makes an important contribution to the development of evidence-based interventions in inclusive education.

The use of Tau-U in this study strengthens the internal validity of findings by providing a quantitative estimate of the intervention effect magnitude. Unlike visual analysis, which is primarily descriptive, Tau-U not only calculates the degree of non-overlap between phases, but also enables correction for baseline trends, thereby reducing the potential overestimation of effects when natural improvement tendencies exist prior to intervention (Parker et al., 2011).

Nonetheless, recent methodological reviews indicate that Tau-U, like other non-overlap indices, has limitations, including the possibility of ceiling effects or constrained data variability that may affect the interpretation of effect magnitudes. Accordingly, several researchers recommend the use of supplementary effect size measures as complements to enhance interpretive accuracy in replication studies and research syntheses (Landman et al., 2024; Tarlow, 2017).

Conclusion

This study confirms that the forward chaining technique is effective in improving handwashing skills in children with Autism Spectrum Disorder in kindergarten. All three subjects demonstrated significant and consistent improvements in mean independent handwashing percentages from the baseline phase (25%–38.3%) to the intervention phase (90.6%–98.4%), with a consistent ascending trend, data stability $\geq 80\%$, inter-phase overlap $< 20\%$, and IOA values $\geq 90\%$ confirming data reliability. The intervention effect was maintained during the post-intervention phase: SRA maintained a mean of 91.7%, while HMJ and SEG maintained 100%, indicating excellent behavioral generalization and

maintenance. The Tau-U values for all three subjects (SRA = 0.8889; HMJ = 0.8889; SEG = 0.8148) all fall within the strong effect size category, and the aggregate effect size Mean Tau-U = 0.8642 is also categorized as strong, confirming that the intervention as a whole is clinically and statistically meaningful and warranted for generalization to populations with similar characteristics.

These findings reinforce the position of forward chaining as an evidence-based intervention applicable in the early childhood education context. The practical implications of this research include: (1) this technique can be integrated into self-care learning programs in inclusive kindergartens as a component of an adaptive curriculum; (2) kindergarten teachers can be trained to systematically implement task analysis and chaining procedures; and (3) collaboration among classroom teachers, co-teachers, and parents should be optimized to support skill generalization across various contexts. Future research is recommended to expand sample sizes, explore the effectiveness of this approach for other self-care skills, and develop evidence-based teacher training models for implementing ABA techniques in early childhood education settings.

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