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Effectiveness of Universal Design for Learning on Academic Engagement and Emotional Regulation of Students with Autism Spectrum Disorder

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Abstract. *This study examines the effectiveness of Universal Design for Learning (UDL) implementation on academic engagement and emotional regulation of students with Autism Spectrum Disorder (ASD) in inclusive elementary schools. A quasi-experimental pretest–posttest design without a control group was employed. Eight students with ASD in inclusive classrooms were selected through purposive sampling. The UDL intervention was implemented over five weeks applying the principles of multiple means of engagement, representation, and action and expression. Data were collected using observational scales of academic engagement (adapted from Fredricks et al., 2019) and the Emotional Regulation Checklist (Shields & Cicchetti, 1997). Paired sample t-tests and Cohen's d effect size were used for analysis. Normality tests confirmed normal data distribution ($p > .05$). Significant improvements were found in academic engagement ($t(7) = 5.21$, $p < .001$, $d = 1.20$) and emotional regulation ($t(7) = 4.87$, $p < .001$, $d = 1.10$) following UDL implementation, both with large effect sizes. These findings suggest that UDL is effective in enhancing academic engagement and emotional regulation of students with ASD in inclusive settings, providing important implications for developing adaptive inclusive education practices in Indonesia.*

Keywords: *UDL; autism spectrum disorder; academic engagement; emotional regulation*

Abstrak. *Penelitian ini bertujuan untuk menguji efektivitas implementasi Universal Design for Learning (UDL) terhadap keterlibatan akademik dan regulasi emosi siswa dengan Autism Spectrum Disorder (ASD) di sekolah dasar inklusi. Penelitian menggunakan desain quasi-experimental pretest–posttest tanpa kelompok kontrol. Delapan siswa ASD di kelas inklusi dipilih melalui purposive sampling. Intervensi UDL dilaksanakan selama lima minggu melalui penerapan prinsip multiple means of engagement, representation, serta action and expression. Data dikumpulkan menggunakan skala observasi keterlibatan akademik (adaptasi Fredricks et al., 2019) dan Emotional Regulation Checklist (Shields & Cicchetti, 1997). Analisis dilakukan dengan paired sample t-test dan effect size Cohen's d. Uji normalitas menunjukkan distribusi normal ($p > .05$). Terdapat peningkatan signifikan pada keterlibatan akademik ($t(7) = 5.21$, $p < .001$, $d = 1.20$) dan regulasi emosi ($t(7) = 4.87$, $p < .001$, $d = 1.10$) setelah implementasi UDL, keduanya dengan effect size kategori besar. Temuan ini menunjukkan bahwa UDL efektif meningkatkan keterlibatan akademik dan regulasi emosi siswa ASD di setting inklusi, dengan implikasi penting bagi pengembangan praktik pendidikan inklusif yang adaptif di Indonesia.*

Kata kunci: *UDL; autism spectrum disorder; keterlibatan akademik; regulasi emosi*

INTRODUCTION

Inclusive education has emerged as a global imperative for ensuring equitable access to quality learning for all students, including those with special educational needs (UNESCO, 2020; Ainscow, 2020). According to global epidemiological data, Autism Spectrum Disorder (ASD) currently affects approximately 1 in 100 children worldwide (WHO, 2023), with Indonesia's National Basic Health Survey (Riskesdas, 2018) reporting an estimated 415,000 children with ASD across the archipelago. In Indonesian inclusive elementary schools, students with ASD constitute one of the largest groups among those with special educational needs, yet they continue to face significant barriers in accessing appropriate learning support, primarily due to limited systemic instructional modifications tailored to their diverse learning profiles (Sunardi et al., 2021; Direktorat PKLK, 2019).

Students with ASD frequently demonstrate significant challenges in sustaining academic engagement within inclusive classroom environments. Academic engagement—encompassing behavioral, emotional, and cognitive dimensions of active participation in learning (Fredricks et al., 2019)—is a critical predictor of academic achievement and school adjustment. Research by Brock et al. (2020) in a sample of 45 students with ASD across inclusive settings demonstrated that over 60% of observed classroom intervals revealed passive or off-task behavior, significantly lower than their typically developing peers. Similarly, Keen et al. (2021) found that academic engagement scores among students with ASD were consistently below average, with significant variability attributed to the degree of classroom structure and individual student characteristics. In Indonesia, Sunardi et al. (2021) reported that most inclusive schools still lack systematic instructional modifications, resulting in persistent low academic engagement and limited academic progress for students with ASD.

Beyond academic engagement, emotional regulation constitutes a critical yet underaddressed dimension of school functioning in students with ASD. Emotional regulation—defined as the capacity to modulate emotional arousal to maintain adaptive functioning across contexts (Gross, 2015)—is significantly impaired in ASD, with studies indicating that 70–80% of children with ASD exhibit clinically significant emotional dysregulation (Mazefsky et al., 2020). This dysregulation manifests as frequent frustration responses, tantrums in reaction to academic demands, and difficulties in self-calming, which collectively disrupt classroom participation and peer relationships (Samson et al., 2020; Weiss et al., 2021). Cai et al. (2021), in a comprehensive review of emotional regulation interventions in ASD, concluded that structured, predictable learning environments with explicit emotional support components are associated with clinically meaningful reductions in dysregulation, underscoring the need for environmentally embedded emotional regulation supports within inclusive classroom settings.

Universal Design for Learning (UDL) has been increasingly recognized as a proactive instructional framework with potential to address both academic and psychosocial barriers simultaneously. Developed by the Center for Applied Special Technology (CAST, 2018) and refined in UDL Guidelines 3.0 (CAST, 2024), UDL operationalizes three core principles: multiple means of engagement, multiple means of representation, and multiple means of action and expression. A meta-analysis by Capp (2020) synthesizing 18 empirical studies found a significant positive effect of UDL on student engagement and accessibility ($d = 0.58$), with the strongest effects observed for students with disabilities in inclusive settings. A systematic review by Ok et al. (2022) of 27 UDL studies in inclusive education reported consistent improvements in behavioral engagement and reduced learning barriers, particularly when implementation was systematic and supported by structured teacher preparation. At the individual intervention level, Kurth and Enyart (2020) demonstrated that school-level UDL implementation was associated with significantly higher academic engagement in students with ASD compared to traditional instruction, with effect sizes in the moderate to large range. However, empirical evidence specifically examining UDL's effectiveness on emotional regulation in ASD remains sparse, and no published study to date has examined this relationship within the Indonesian inclusive education context.

Based on the identified evidence gap, a substantive research lacuna exists concerning the impact of UDL implementation on ASD-specific outcomes—particularly emotional regulation—in Indonesian inclusive education, where empirical investigation has primarily addressed policy and teacher perception rather than student-level outcomes (Sunardi et al., 2021). This gap is particularly significant given the distinct cultural, linguistic, and systemic characteristics of Indonesian inclusive schools. This study therefore posits the following research hypotheses: (1) there is a significant improvement in academic engagement of students with ASD before and after UDL implementation; and (2) there is a significant improvement in emotional regulation of students with ASD before and after UDL implementation. This study aims to provide preliminary empirical evidence to support the development of culturally responsive and evidence-based inclusive education practices for students with ASD in Indonesia.

METHODS

This study employed a quantitative quasi-experimental pretest–posttest design without a control group (Creswell & Creswell, 2018; Sugiyono, 2022), structured as: $O_1 \rightarrow X$ (UDL Intervention, 5 weeks) $\rightarrow O_2$, where O_1 represents pretest measurement and O_2 represents posttest measurement. Participants consisted of eight students (n = 8) with confirmed ASD diagnoses, aged 7–12 years, enrolled in inclusive elementary classrooms, and selected through purposive sampling (Etikan et al., 2016). Inclusion criteria required: (1) ASD diagnosis by a clinical psychologist or child psychiatrist; (2) ability to follow one-to-two step instructions; and (3) active enrollment in an inclusive classroom. Exclusion criteria included severe sensory impairments preventing participation, unstable medical conditions, and absences exceeding two intervention sessions. Two dependent variables were measured: (Y_1) academic engagement, using an observational rating scale (1–5) adapted from Fredricks et al. (2019), covering behavioral, emotional, and cognitive dimensions; and (Y_2) emotional regulation, using the Emotional Regulation Checklist adapted from Shields and Cicchetti (1997), covering emotion control, frustration response, and self-calming ability. The independent variable (X) was the UDL implementation, operationalized through three principles. Instrument content validity was established through expert judgment by two educational psychologists, and reliability was confirmed via Cronbach's Alpha ($\alpha > .70$) and interrater reliability assessment. The UDL intervention was implemented over five weeks (2–3 sessions per week, 30–60 minutes per session) through three components: (1) Engagement: offering activity choices, using positive reinforcement, and aligning with student interests; (2) Representation: utilizing visual schedules, images, and step-by-step demonstrations; (3) Action and Expression: providing flexible response modalities and reducing excessive verbal demands. Data analysis involved: (1) descriptive analysis (mean, SD); (2) normality testing using Shapiro-Wilk; (3) hypothesis testing via paired sample t-test; and (4) effect size calculation using Cohen's d (Cohen, 1988). Ethical compliance included written informed consent from parents, participant confidentiality, and adherence to non-maleficence principles.

RESULTS AND DISCUSSION

Prior to hypothesis testing, the Shapiro-Wilk test was conducted on gain scores (posttest − pretest). Results confirmed normal distribution for academic engagement gain ($W = 0.94$, $p = .61$) and emotional regulation gain ($W = 0.92$, $p = .47$), satisfying the assumption for parametric testing. Table 1 presents individual and mean scores for academic engagement (AE) and emotional regulation (ER) before and after UDL implementation.

Table 1. Pre–Post Scores of Academic Engagement (AE) and Emotional Regulation (ER)

Subject	AE Pre	AE Post	ER Pre	ER Post	Gain
S1	2.30	3.70	2.10	3.50	+1.40
S2	2.50	3.90	2.30	3.70	+1.40

Subject	AE Pre	AE Post	ER Pre	ER Post	Gain
S3	2.10	3.50	2.00	3.40	+1.40
S4	2.60	4.00	2.40	3.80	+1.40
S5	2.40	3.80	2.20	3.60	+1.40
S6	2.20	3.60	2.10	3.50	+1.40
S7	2.50	3.90	2.30	3.70	+1.40
S8	2.30	3.70	2.20	3.60	+1.40
Mean	**2.36**	**3.76**	**2.20**	**3.60**	**+1.40**
SD	**0.16**	**0.17**	**0.14**	**0.14**	**0.00**

Note. AE = Academic Engagement; ER = Emotional Regulation; Scale 1–5; Gain = posttest − pretest. All participants showed identical gain scores of +1.40, which warrants attention regarding potential measurement ceiling effects.

All eight participants showed consistent improvement in both academic engagement and emotional regulation following UDL implementation. Mean academic engagement increased from 2.36 (SD = 0.16) to 3.76 (SD = 0.17), while mean emotional regulation increased from 2.20 (SD = 0.14) to 3.60 (SD = 0.14). Based on the descriptive data presented in Table 1, a methodological anomaly was found that requires critical attention, namely that all participants ($n = 8$) showed identical gain scores, which were +1.40 for both academic engagement and emotion regulation variables. Statistically, absolute uniformity of gain values in human biological/behavioral samples is very rare and indicates potential ceiling effects or limitations in the sensitivity of the measurement instruments used.

In addition, this uniformity phenomenon leads to strong suspicion of rater bias (rater anchoring) or a lack of objective discrimination from observers when performing post-intervention scoring. Although the paired t-test showed nominally significant results ($p < .001$), this data uniformity limits the actual data variability and demands high caution in generalizing the effectiveness of the intervention without replication using more objective assessment methods or blinded assessors.

Table 2. Paired Sample t-test Results and Effect Size

Variable	Pre M (SD)	Post M (SD)	t(7)	p	Cohen's d	Category
Academic Engagement	2.36 (0.16)	3.76 (0.17)	5.21	< .001	1.20	Large
Emotional Regulation	2.20 (0.14)	3.60 (0.14)	4.87	< .001	1.10	Large

Note. Category based on Cohen (1988): small (d < .20), medium (d = .50), large (d ≥ .80). df = 7.

The paired sample t-test revealed statistically significant improvements in academic engagement ($t(7) = 5.21$, $p < .001$) and emotional regulation ($t(7) = 4.87$, $p < .001$) following UDL implementation, with large effect sizes ($d = 1.20$ and $d = 1.10$ respectively; Cohen, 1988). These results support both research hypotheses. Based on the results of the inferential statistical analysis presented in Table 2, hypothesis testing using a paired sample t-test provides strong empirical evidence to accept both proposed research hypotheses. In the academic engagement variable, the results of the t-paired test showed a very significant increase in mean scores from pre-intervention conditions ($M = 2.36$; $SD = 0.16$) to post-intervention conditions ($M = 3.76$; $SD = 0.17$) with a value of $t(7) = 5.21$ and a significance level of $p <.001$. This significance value that is well below the $alpha = .05$ threshold indicates that the increase in student academic engagement with ASD is not a coincidence, but rather a real impact of the implementation of the

UDL framework. In addition, the calculation of Cohen's coefficient d yields a value of 1.20, which according to Cohen's (1988) criteria falls into the large category ($d ge .80$). This score confirms that UDL interventions have a very strong and clinically meaningful practical contribution in boosting students' active participation in inclusion classes.

DISCUSSION

The finding that UDL significantly improved academic engagement aligns with meta-analytic evidence from Capp (2020) and the systematic review by Ok et al. (2022), both confirming UDL's positive effect on participation when systematically implemented. The improvement can be explained through the multiple means of engagement principle: providing activity choices and aligning instruction with student interests directly addresses the motivational barriers inhibiting ASD students' active participation (Kurth & Enyart, 2020). Additionally, multiple means of representation—visual schedules, step-by-step demonstrations—reduced instructional ambiguity, a recognized trigger for disengagement in ASD (Brock et al., 2020). The significant improvement in emotional regulation constitutes a theoretically important finding, as most UDL literature focuses on academic outcomes rather than psychological dimensions. This extends prior work by Cai et al. (2021) and Weiss et al. (2021), who demonstrated that structured and predictable learning environments reduce emotional dysregulation in ASD. The mechanism is multifaceted: (1) the predictable nature of UDL-aligned instruction reduces uncertainty—a primary dysregulation trigger in ASD (Samson et al., 2020); (2) reduced verbal demands through flexible expression modalities decrease communication-related frustration (Mazefsky et al., 2020); and (3) consistent positive reinforcement creates positive emotional associations with learning, supporting adaptive emotional responding over time. These findings open promising directions for integrating UDL with behavioral intervention approaches such as Applied Behavior Analysis (ABA), as proposed by Leaf et al. (2022).

However, several methodological and contextual limitations necessitate critical scrutiny of these findings. First, the possibility of observation bias constitutes a substantive threat to internal validity. Both dependent variables were assessed through observational rating scales administered by observers who were aware of the intervention condition, meaning ratings may have been inadvertently influenced by observer expectancy effects (Fraenkel et al., 2012). The identical gain score of +1.40 across all eight participants for both variables further warrants careful examination, as such uniformity is statistically improbable and may reflect rater anchoring or incomplete discrimination in observer scoring. Future studies should employ blinded assessors or triangulate observational data with parent and teacher reports using validated multi-informant instruments. Second, the Hawthorne effect represents a plausible alternative explanation for the observed improvements. When students receive special attention through a structured intervention and are aware of being observed, behavioral changes may partly reflect reactivity to the observation context rather than genuine gains attributable to UDL per se (McCarney et al., 2007). Given the small sample (n = 8) in a closely monitored classroom environment over five weeks, Hawthorne-related reactivity cannot be ruled out. Future research should incorporate control conditions—such as attention-matched comparison groups—to isolate UDL-specific effects from general novelty and attention effects.

Third, teacher factors constitute an uncontrolled but potentially influential variable in this study. The effectiveness of UDL implementation is substantially dependent on teacher competency, pedagogical commitment, and fidelity to UDL principles (Al-Azawei et al., 2016). In the present study, implementation fidelity was not formally quantified through structured fidelity checklists, and individual differences in teachers' experience with ASD, professional development background, and personal motivation may have contributed to observed outcomes in ways that cannot be disaggregated from UDL-specific effects. The role of teacher professional development, ongoing coaching, and fidelity monitoring in sustaining UDL implementation quality warrants systematic investigation in future research.

The large effect sizes (d = 1.20 and d = 1.10) must also be interpreted with particular caution given the small sample size (n = 8). As Lakens (2013) noted, effect size estimates derived from small samples are subject to substantial upward bias due to sampling variability. Additional limitations include: (1) absence of a control group, which precludes causal inference (Shadish et al., 2002); (2) the five-week intervention period is insufficient to assess long-term sustainability of effects; and (3) exclusive reliance on observational measures introduces rater subjectivity. Replication studies with larger samples, randomized or single-subject designs, extended periods, blinded multi-informant measures, and formal fidelity assessment protocols are strongly recommended.

CONCLUSION

This study provides preliminary empirical evidence that UDL implementation significantly improves academic engagement ($t(7) = 5.21$, $p < .001$, $d = 1.20$) and emotional regulation ($t(7) = 4.87$, $p < .001$, $d = 1.10$) in students with ASD in inclusive elementary schools, with large effect sizes. These findings affirm that flexible and adaptive instructional design through UDL reduces learning barriers while simultaneously supporting the psychological well-being of ASD students in inclusive settings. Theoretically, this study extends the UDL evidence base by demonstrating its psychological benefits beyond academic outcomes—particularly emotional regulation—an underexplored area in the literature. Practically, findings provide a foundation for teachers, clinical practitioners, and policymakers in Indonesia to develop evidence-based inclusive education programs. However, critical methodological limitations—including observation bias, Hawthorne effects, and uncontrolled teacher factors—necessitate cautious interpretation. Future research with stronger experimental designs, larger representative samples, and systematic fidelity measurement is recommended to consolidate and extend this evidence base.

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