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Original Research

Peer-Group Assertive Communication and Verbal Bullying Scores Among High-School Students: A Quasi-Experimental Study

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ABSTRACT

Introduction: Peer-assisted assertive communication education may support adolescents' interpersonal skills, but changes in bullying questionnaire responses do not necessarily indicate fewer bullying incidents.

Objective: To describe pretest–posttest verbal-bullying questionnaire scores and unadjusted posttest differences following ASERTIF-S education in high-school students.

Method: This two-group quasi-experimental study included 79 Grade 11 students (intervention, n = 40; comparison, n = 39). A 22-item questionnaire was administered before and after the educational activity. Wilcoxon signed-rank and Mann–Whitney U tests were reported.

Result: The intervention group had 37 negative signed ranks ($Z = -5.305$; $p < 0.001$) and the comparison group had 10 ($Z = -2.970$; $p = 0.003$). Posttest ranks differed ($U = 107$; $p < 0.001$). Baseline very-frequent response categories differed considerably (35.0% vs 79.5%).

Conclusion: Questionnaire scores differed within and between groups, but substantial baseline imbalance and absent baseline-adjusted analysis prevent a causal conclusion that the activity reduced or prevented bullying.

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INTRODUCTION

Bullying is a repeated, intentional form of aggression involving a power imbalance, and its effects extend beyond interpersonal misunderstanding to psychological well-being, peer norms, and the school environment. Perpetration and victimization are distinct constructs that must be measured separately. A systematic review of school-based anti-bullying programmes found modest average reductions in perpetration and victimization but substantial variation between interventions and settings (2). This indicates that a promising training activity cannot automatically be considered an effective prevention programme without a clearly defined behavioural outcome and adequate follow-up.

Bullying remains a relevant school-health issue in Indonesia. The PISA 2018 report documents substantial exposure to bullying among Indonesian students (10). However, estimates from different surveillance systems should not be combined as if they measure the same population or incident definition. Locally appropriate strategies need to consider not only students' responses but also school climate, reporting systems, supervision, and peer-group norms. The Roots Indonesia programme illustrates a broader, adolescent-engaged approach to changing school climate (21); its design differs fundamentally from a brief communication-learning session.

Bullying reflects interacting individual, peer, family, and institutional influences. In particular, aggressive peer norms, unequal social power, and insufficient adult response may sustain bullying even when targeted students communicate assertively. A communication-skills module should therefore be viewed as one potentially supportive element of a whole-school response, rather than a substitute for safeguarding, school policies, and trusted reporting pathways (2),(21).

In this setting, developing respectful refusal, boundary-setting, and help-seeking skills could be relevant to adolescents' response options. These skills may support protective coping, but it would be inappropriate to infer that low assertiveness causes victimization or that responsibility for stopping aggression rests with the targeted student.

Verbal bullying may include insults, threatening language, teasing, or humiliating remarks; whether individual questionnaire items capture actual perpetration, victimization, or exposure determines the meaning of the measured construct. This distinction is especially important when outcomes are obtained from students shortly after anti-bullying education, because changed awareness and socially desirable responding may affect scores independently of real-world incident frequency.

Assertive communication refers to the respectful expression of needs, feelings, disagreements, and interpersonal boundaries. A social-cognitive interpretation suggests that observing and rehearsing such responses with peers could support skill acquisition through modelling and feedback; this is a proposed mechanism rather than a pathway demonstrated by the present data. Peer-group practice may create opportunities for rehearsal, whereas preventing bullying also requires changes in perpetrator behaviour, bystander responses, and school norms (9),(2).

The present intervention is best situated within a multilevel school-health framework. Assertive practice might help participants respond to pressure, decline harmful requests, or seek adult help without escalation. It cannot by itself remove the power imbalance central to bullying, and it should not be interpreted as a victim-responsibility intervention. The effect of

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communication training may depend on whether students are targets, perpetrators, bystanders, or have overlapping roles; these roles were not stratified in the available data.

Peer influence can be beneficial or harmful depending on group norms and the influence of particular students. In a school-network experiment, Paluck et al. (9) demonstrated the importance of social referents for conflict-related behaviour, while the Roots Indonesia model incorporated student-led activities within a wider school-climate strategy (21). These examples justify examining peer processes but do not establish that the peer-group activities used here were peer-led: selection, training, and supervision of peer leaders are not sufficiently specified in the source manuscript.

Earlier Indonesian work has examined assertiveness-oriented training for students experiencing bullying (1),(16), while wider evaluations have examined multifaceted anti-bullying programmes (2). These studies assess different populations, intervention doses, and outcomes. Consequently, their findings should not be treated as direct evidence that a brief ASERTIF-S learning activity prevents future verbal bullying.

The research gap concerns the limited clarity about how a brief, peer-assisted assertive-communication activity relates to self-reported verbal bullying scores in Indonesian upper-secondary students, particularly when comparable baseline measures and implementation fidelity are insufficiently documented. The study's bounded contribution is to report a two-group, pretest-posttest examination of the ASERTIF-S educational approach in one school. Its novelty is contextual and intervention-specific, not proof of a new behavioural mechanism or long-term bullying prevention; this distinction is necessary given existing peer-based and assertiveness literature (9),(21),(2).

This study aimed to describe within-group changes in the reported verbal-bullying questionnaire outcome and compare posttest score distributions between students receiving ASERTIF-S peer-group education and students continuing routine school activities. A directional expectation was that intervention participants would report lower frequency-category scores after the activity. Because allocation was nonrandomized, baseline equivalence was not established, and no delayed bullying-incident follow-up was reported, this analysis was considered exploratory rather than a confirmatory test of prevention effectiveness. An improvement in observed communication skills was a possible process mechanism but no corresponding inferential process-outcome results were provided.

METHOD

Type of Research

A quantitative quasi-experimental, two-group pretest-posttest design was used at SMAN 1 Jonggat, Central Lombok, Indonesia. This design permits descriptive within-group and unadjusted between-group comparisons but does not ensure exchangeability between groups. The source dataset supplied in the manuscript does not provide individual baseline and posttest scores, so a baseline-adjusted intervention effect or its 95% confidence interval cannot be reconstructed from the published summary tables.

Population and Sample

The study population comprised Grade 11 students at SMAN 1 Jonggat. The manuscript reports cluster sampling with 79 participants (intervention group, n = 40; control group, n = 39).

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The original report does not specify the number or selection of classes, whether assignment occurred at class or individual level, or the procedures used to allocate participants. Therefore, random allocation must not be inferred, and possible intraclass correlation and baseline selection differences remain unresolved.

The original study reports school permission and written student consent following explanations of the study objectives, confidentiality, and questionnaire procedures. The available manuscript does not specify whether parent/guardian permission and age-appropriate adolescent assent were obtained, or whether participation affected school relationships. These protections require confirmation against original study records, especially because school participants may be minors.

Intervention and Comparison Conditions

The intervention group received education using the ASERTIF-S (Assertiveness as an Anti-Bullying Strategy in Schools) module, with an educational component reported as approximately 10-15 minutes. The source manuscript additionally describes peer-group discussion, role-play, simulations, and guided practice in expressing opinions, feelings, refusals, and interpersonal boundaries. However, it does not establish which of these activities occurred within the 10-15-minute interval, which were planned teaching ingredients, and which formed part of formative assessment. The total number and duration of sessions, peer-group sizes, leader recruitment and training, scripts, attendance, adherence, and intervention deviations must be confirmed from primary study materials before reproducibility can be claimed.

The original manuscript states that the researcher was assisted by a sixth-semester student and that peer groups were used for formative evaluation. This describes a peer-assisted activity but does not document a trained peer-led intervention. The comparison group continued routine school activities without the ASERTIF-S programme; concurrent counselling, school-wide anti-bullying activities, and interaction between study groups were not reported. Therefore, contamination and co-intervention exposure cannot be excluded. The intervention is reported here using the principles of the TIDieR framework, with unreported components identified rather than invented (7).

Instruments

The manuscript identifies a 22-item, four-option verbal-bullying questionnaire with response labels 'never', 'sometimes', 'often', and 'very often', as well as a yes/no observation sheet for assertive communication. The available descriptions suggest increasing categorical frequency from 'never' to 'very often'; however, the original item wording, respondent role (perpetration, victimization, or exposure), score coding, possible score range, recall period, aggregation method, validated category thresholds, and anonymity procedures were not supplied. Consequently, the reported categories are described as questionnaire-response categories, not a validated measure of prevented bullying incidents.

The manuscript attributes the communication observation sheet to Takahashi et al. (2023; reported validity coefficients 0.852-0.956 and Cronbach's alpha 0.993) and the verbal-bullying questionnaire to Anatasya Febriani (2025; reported validity coefficients 0.817-0.935 and alpha 0.991). Full primary instrument citations, adaptation/translation procedures, validity samples, and local reliability estimates require verification. The very high alpha values could reflect item redundancy and cannot replace content or construct validation. Observer training, blinding, and

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inter-rater agreement were not reported, and numerical observation results were unavailable for analysis.

Data Collection Procedure

Both groups completed pretest questionnaires. The intervention group then received the ASERTIF-S educational activity with peer-group formative assessment, while the comparison group continued routine school activities. Both groups were assessed again after the intervention period; the exact pretest-to-posttest interval is not documented. Responses were coded and tabulated for analysis. Because timing and concealment of responses were not established, measurement reactivity, desirability bias, and short-term priming remain plausible.

Statistical Analysis

Within-group changes in verbal-bullying questionnaire scores were examined using the Wilcoxon signed-rank test. Differences in posttest score distributions between groups were evaluated using the Mann–Whitney U test. Because baseline distributions differed substantially between groups, the unadjusted posttest comparison was interpreted cautiously and was not considered a baseline-adjusted intervention effect.

Data Analysis

The reported analysis used Wilcoxon signed-rank tests for within-group pretest-posttest comparisons and a Mann-Whitney U test for unadjusted between-group posttest distributions. Two separate within-group p-values do not test whether the groups changed differently. The posttest Mann-Whitney estimate is descriptive and cannot be interpreted as a baseline-adjusted treatment effect. A more appropriate comparative estimate would use individual-level baseline-adjusted modelling or a change-score analysis with effect estimates and 95% confidence intervals, accounting for clustering if participants were allocated by class. Such modelling cannot be performed using the supplied aggregate tables alone. Reported p-values of '0.000' are presented as $p < 0.001$.

Ethical Approval

The source manuscript reports ethical approval number 073/F.Kes/YP2QHX/X/2025 and written student consent. The approving committee's full institutional name, guardian permission/assent procedures, privacy measures for sensitive disclosures, and referral safeguards for ongoing bullying or distress were not documented in the supplied report and require verification by the investigators.

RESULTS

The intervention group demonstrated a statistically significant change in verbal-bullying questionnaire scores (Wilcoxon $Z = -5.305$; $p < 0.001$). A statistically significant within-group change was also observed in the comparison group ($Z = -2.970$; $p = 0.003$). The posttest distributions differed between groups (Mann–Whitney $U = 107$; $p < 0.001$). However, substantial baseline differences prevent attributing the observed posttest contrast specifically to the intervention.

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Table 1. Verbal-Bullying Questionnaire Frequency Categories at Pretest and Posttest: Intervention Group (n = 40)

Category	Pretest n	Pretest %	Posttest n	Posttest %
Never	2	5.0	2	5.0
Sometimes	2	5.0	10	25.0
Often	22	55.0	28	70.0
Very frequent	14	35.0	0	0.0
Total	40	100.0	40	100.0

Source: Primary Data (2026)

In the intervention group, the 'very frequent' category decreased from 14/40 (35.0%) at pretest to 0/40 (0%) at posttest, whereas the 'often' category rose from 22/40 (55.0%) to 28/40 (70.0%) and the 'sometimes' category from 2/40 (5.0%) to 10/40 (25.0%). These shifts describe reported categories only; raw total-score summaries were not available. The posttest percentages of 10/40 and 28/40 have been corrected mathematically from 25.5% and 70.5%, respectively.

Table 2. Verbal-Bullying Questionnaire Frequency Categories at Pretest and Posttest: Comparison Group (n = 39)

Category	Pretest n	Pretest %	Posttest n	Posttest %
Never	1	2.6	1	2.6
Sometimes	1	2.6	1	2.6
Often	6	15.4	8	20.5
Very frequent	31	79.5	29	74.4
Total	39	100.0	39	100.0

Source: Primary Data (2026)

The comparison group reported the 'very frequent' category in 31/39 (79.5%) at baseline and 29/39 (74.4%) at posttest. The baseline proportion was markedly higher than in the intervention group (79.5% versus 35.0%), indicating substantial pre-intervention imbalance; this precludes treating the posttest contrast as an unbiased intervention effect without adjustment.

Table 3. Results of Bivariate Analysis Using the Wilcoxon Test in the Intervention Group

Description		N	Mean Rank	Sum of Ranks	Z	Sig
Negative (Post<Pre)	Ranks	37	19,00	703,00	-5,305	<.001
Positive (Post>Pre)	Ranks	0	0,00	0,00		
Ties (Post=Pre)		3				
Total		40				

Source: Primary Data (2026)

In the intervention group, 37 students had lower posttest scores than pretest scores, none had higher scores, and three had unchanged scores (reported Wilcoxon Z = -5.305, p < 0.001). For 37 nonzero signed ranks all in the negative direction, the rank sum must equal 37 x 38 / 2 = 703, with a mean rank of 19; the original table entries 1.63 and 0.490 were arithmetically impossible and have been corrected from the rank counts. The source SPSS output and individual scores are nevertheless required to confirm the test statistic and any tie corrections.

Table 4. Bivariate Analysis Results Using the Wilcoxon Test in the Control Group

Descrription	N	Mean Rank	Sum of Ranks	Z	Sig
Negative Ranks (Post<Pre)	10	5,50	55,00	-2,970	0,003

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Descrription	N	Mean Rank	Sum of Ranks	Z	Sig
Positive Ranks (Post>Pre)	0	0,00	0,00		
Ties (Post=Pre)	29				
Total	39				

Source: Primary Data (2026)

In the comparison group, 10 students had lower posttest scores, none had higher scores, and 29 had unchanged scores (reported Wilcoxon Z = -2.970, p = 0.003). This is a statistically detectable within-group change rather than evidence of no change. Repeated measurement, contemporaneous school activities, and diffusion of information between students remain possible explanations.

Table 5. Comparative Analysis Between Groups Using the Mann–Whitney Test

Group	N	Mean Rank	Sum of ranks
Intervention	**40**	**23,18**	**927,00**
Control	**39**	**57,26**	**2233,00**
Total	**79**		

Source: Primary Data (2026)

At posttest the intervention group had a mean rank of 23.18 (n = 40) compared with 57.26 (n = 39) in the comparison group. The reported Mann-Whitney result was U = 107.000, Z = -6.614, p < 0.001. The raw direction of the rank difference suggests lower questionnaire scores in the intervention group, conditional on the original score coding. However, the baseline imbalance means this posttest difference is not a baseline-adjusted estimate of the effect of ASERTIF-S.

Table 6. Mann–Whitney Statistical Test Results

Statistics	Value
Mann-Whitney	107,000
Wilcoxon W	927,000
Z	-6,614
Asmp.Sig. (2-tailed)	<0,001

Source: Primary Data (2026)

The posttest-only Mann-Whitney contrast was statistically significant (U = 107.000; Z = -6.614; p < 0.001). The standardized statistic |Z|/sqrt(79) is approximately 0.74, a descriptive standardized rank contrast that must not be labelled as a causal intervention effect. Adjusted effect sizes and 95% confidence intervals cannot be calculated from the aggregate information provided.

DISCUSSION

The main finding was a statistically significant within-group change in the reported verbal-bullying questionnaire score among ASERTIF-S participants and a lower unadjusted posttest rank than in the comparison group. These findings are preliminary because the groups started with markedly unequal distributions: 35.0% versus 79.5% in the 'very frequent' baseline category. In addition, the comparison group also changed (p = 0.003). Consequently, neither the posttest rank contrast nor its derived |r| of approximately 0.74 demonstrates the independent causal effect of peer-group assertive communication. A baseline-adjusted between-group estimate is needed for that question.

One plausible, but untested, pathway is that practising respectful refusal, help-seeking, and boundary-setting may increase students' repertoire of nonaggressive responses. A second

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hypothetical pathway is social modelling through group discussion and rehearsal. Neither mediation through assertiveness nor changes in peer norms were measured and analysed in the submitted results. Furthermore, these pathways may apply differently to targets, bystanders, and perpetrators. Preventing perpetration or coercive social dynamics generally requires additional changes in group norms, adult response, and institutional safeguards (9),(2).

This study should be interpreted in the context of multicomponent school programmes rather than equated with them. The Roots Indonesia evaluation describes student activities aimed at the broader school climate (21), whereas the present manuscript documents a brief ASERTIF-S educational component and an incompletely specified peer-group process. The distinctive feature is the local combination of assertive-learning content with peer-assisted activities, but limited fidelity information prevents attributing any difference specifically to peer leadership or to role-play. Cultural norms surrounding public disagreement, teacher authority, and interpersonal harmony might also shape how assertive responses are understood and used; these potential moderators were not measured.

A second critical finding is that 10 of 39 comparison students had lower scores at posttest and the Wilcoxon test was significant ($p = 0.003$). The difference could be explained by assessment reactivity, regression to the mean, routine classroom and counselling activities, contamination through contact between groups, or broader school communication. These possibilities were not monitored, so causal interpretations based on within-group significance are particularly vulnerable. The large initial imbalance raises an additional concern: lower posttest ranks may partly reflect pre-existing differences rather than additional improvement attributable to the intervention.

The peer-group format may function as structured practice or social reinforcement, but peer support, peer-assisted learning, and peer-led intervention are not interchangeable. In the submitted records, formal selection, preparation, and supervision of student peer leaders were not established, and peer-support behaviour was not measured. Thus, it is not possible to isolate the incremental contribution of the peer-group format, although peer networks remain a theoretically relevant context for implementation (90,(21).

The intervention could potentially inform school-health education or counselling as an adjunct to established safeguarding systems, but implementation feasibility has not been demonstrated. Prior to wider adoption, schools would need a replicable teaching protocol, age-appropriate facilitators, adult supervision, confidential reporting and referral processes, and data on reach, fidelity, acceptability, cost, and maintenance. These considerations align with the RE-AIM implementation framework (24).

The study used pretest and posttest observations, included a contemporaneous comparison group, and reported nonparametric analyses. However, baseline nonequivalence, unclear cluster allocation, and lack of adjustment limit inference. Only one school and 79 participants were represented. The questionnaire construct, recall period, score coding, validation source, and observation outcome were incompletely reported. Intervention exposure, session dose, peer training, fidelity, blinding, contamination, and school context were also insufficiently documented. Student self-reports may be affected by social desirability or perceived researcher expectations, especially where follow-up is short or unspecified. No independently confirmed bullying incidents or later behavioural outcomes were available.

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Future evaluation should prespecify distinct outcomes for perpetration, victimization, help-seeking, and bystander behaviour; use validated and clearly scored instruments; and obtain student, teacher, or school-incident information when ethically feasible. Multi-school controlled designs with baseline-adjusted modelling, clustering corrections, transparent confidence intervals, and delayed follow-up are needed. Process evaluation should measure actual assertiveness performance, peer-group mechanisms, dose, fidelity, potential adverse effects, and school-level moderators.

Interpretation of the Observed Changes

The 37 negative signed ranks in the intervention group indicate downward shifts on the recorded questionnaire score for most participants. Nevertheless, without complete item coding and participant-role definitions, the change cannot be equated automatically with fewer observed incidents or improved protection from victimization. The comparison group also had 10 negative ranks and a significant result. The only between-group analysis reported was a posttest rank comparison, not a formal comparison of adjusted changes.

The study does not provide inferential results for the communication-skills observation sheet, nor does it present direct measures of emotional regulation, conflict avoidance, or peer norms. Therefore, statements that these specific abilities improved would be unsupported. The intervention's plausible psychological and social mechanisms should remain hypotheses to be tested in future research.

Distinguishing the observed outcome from the intended prevention mechanism is important for school-health interpretation. Increasing students' willingness to disclose bullying, for example, may alter questionnaire responses without an immediate change in events. Changes in reporting could also be affected by repeated questioning, pressure to provide socially approved responses, or information shared between students.

Overall, the data support reporting short-term or unspecified-interval differences in questionnaire scores and exploratory interpretation of the associated educational experience. They do not confirm that the programme prevents subsequent bullying or that the peer-group component independently caused the contrast.

Synthesis with Earlier Evidence

Ainiyah and Cahyanti (2020) examined assertiveness training in a bullying-related context, while Sari and Widyatmoko (2025) reported assertiveness changes in group counselling among students affected by bullying. Their intervention processes and outcomes differ from the verbal-bullying score used here. The present results therefore complement, rather than replicate, this work: the observed posttest contrast cannot determine whether improved assertiveness mediated any change in bullying-related self-report.

At a broader level, Gaffney et al. (2) synthesised school anti-bullying programmes and found modest average effects with substantial heterogeneity; the evidence base includes longer and more comprehensive programmes than the educational component described here. Guzman-Holst et al. (2022) further noted that reductions in bullying and improvements in mental-health symptoms are distinct outcomes. Accordingly, a statistically significant questionnaire change should not be extended to claims of improved mental health, emotional control, or long-term prevention without those measures.

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The school-network intervention studied by Paluck et al. (9) operated through influential student peers and social norms, and Roots Indonesia addressed school climate through adolescent participation (21). In contrast, the current study lacks sufficient evidence that trained peer leaders implemented an intensive social-norm intervention. This comparison identifies an important conceptual gap: participation in peer groups during learning is not necessarily equivalent to a peer-led programme aimed at changing schoolwide behaviour.

Across studies, outcome construct, age, intervention intensity, facilitator selection, allocation method, and follow-up duration can alter interpretation. The present report contributes a locally situated preliminary observation but lacks sufficient detail for a robust head-to-head effectiveness claim. The synthesis therefore favors a cautious conclusion and prioritizes improved measurement and process documentation over overstating a novel mechanism.

Limitations and Cautions

The most serious methodological limitation is the baseline imbalance between groups, which could generate misleading posttest differences. Neither a baseline-adjusted group contrast nor individual-level change estimates with 95% confidence intervals can be produced from the supplied tables. Clustering was reported for sampling but not described well enough to evaluate intraclass correlation or adjustment. Therefore, the current analysis remains descriptive and exploratory.

Additional limitations include uncertain questionnaire scoring and roles, no documented recall period or validation of categorical thresholds, limited reporting of the observation measure, possible desirability and demand effects, and no delayed behavioural verification. The exact posttest timing, implementation dose, peer-leader preparation, intervention fidelity, concurrent school activities, group contamination, and safeguarding/referral pathways require confirmation. These gaps limit internal validity, generalizability, reproducibility, and claims of implementation readiness.

Recommendations for Future Research

Subsequent studies should prospectively register outcomes and hypotheses, test clearly defined verbal bullying perpetration and victimization separately, record baseline measures, and estimate adjusted between-group changes with 95% confidence intervals and cluster-appropriate models. Delayed follow-up and multiple informants or objective incident records are required to examine actual prevention rather than post-education questionnaire response.

Process evaluation should include observed assertive skills, help-seeking behaviour, peer norms, acceptability, facilitator competence, attendance, fidelity, school-climate conditions, cross-group contamination, and potential adverse consequences. Where appropriate, moderation by bullying role, baseline experience, and school context could help identify for whom the activity is useful.

The ASERTIF-S module may warrant refinement and a more rigorous trial, but should not yet be promoted as a proven stand-alone bullying-prevention strategy. Integration within established counselling, safeguarding, and whole-school anti-bullying systems should be evaluated, not assumed.

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CONCLUSION

Among 79 Grade 11 students at SMAN 1 Jonggat, the reported verbal-bullying questionnaire score decreased in 37/40 intervention participants and 10/39 comparison participants; both within-group Wilcoxon tests were statistically significant ($p < 0.001$ and $p = 0.003$, respectively). The unadjusted posttest rank distribution differed between groups ($U = 107$; $p < 0.001$). However, substantial baseline imbalance and the absence of a baseline-adjusted analysis prevent attributing the posttest contrast specifically to ASERTIF-S.

The findings provide preliminary, context-specific information about questionnaire responses after peer-group assertive-communication education, not evidence that future bullying events were prevented. Communication-skill changes, emotional regulation, and longer-term behaviour were not demonstrated by the reported analyses.

Larger controlled studies with clarified outcome scoring, fully documented intervention implementation, baseline adjustment, and delayed multi-informant follow-up are necessary before effectiveness or wider school implementation can be concluded.

AUTHOR CONTRIBUTION STATEMENT

Author-specific contributions must be confirmed by the four listed authors using the CRediT taxonomy before publication; the submitted manuscript provides a single-author narrative and does not establish individual roles. The roles of Noval Maulana, Maulin Halimatunnisa, Suswinda Yuli Sutomo, and D Mustamu Qamal Pa'ni in conceptualization, methodology, investigation, formal analysis, writing, review, and supervision require written confirmation from the author team. No individual CRediT roles have been assigned editorially because they cannot be determined from the supplied documents.

CONFLICT OF INTEREST

The authors declare no conflict of interest, according to the submitted manuscript. The author team should verify this declaration before publication.

DECLARATION OF GENERATIVE ARTIFICIAL INTELLIGENCE AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The submitted manuscript reported the use of ChatGPT and Grammarly for language assistance. During this editorial revision, AI-assisted drafting was also used to propose clearer scientific interpretation and reporting language; all changes, underlying data, and citations require independent verification and approval by the authors. The authors remain solely responsible for the scientific content, accuracy of data analysis, reference integrity, and final approved manuscript.

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