Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

QR Code–Mediated Instruction Enhances Writing Performance and Learner Engagement in Advanced EFL Learners: A Mixed-Methods Experimental Study

Hamidreza Aminoroaya

hamid.raminoraya@gmail.com

Academic Center for Education, Culture and Research

Alireza Najafi

Academic Center for Education, Culture and Research

Article

Keywords: QR codes, EFL writing, mobile-assisted language learning, multimodal learning, mixed-methods, language education

Posted Date: July 2nd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9805121/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Digital tools are increasingly embedded in language education, yet their contribution to productive skills —particularly writing—remains underexplored in many EFL contexts. Quick Response (QR) codes offer a low-barrier mechanism for connecting learners to multimodal digital resources beyond the classroom.

Objective

This study examined whether QR code–supported instruction improves the writing performance of advanced Iranian EFL learners and explored learners' perceptions of this instructional approach.

Methods

A mixed-methods, pretest–posttest control-group design was employed with 60 advanced EFL learners from a private language institute in Iran, randomly assigned to experimental (n = 30) and control (n = 30) groups. Language proficiency was verified using the Oxford Quick Placement Test. Writing ability was assessed at baseline and post-intervention using a validated researcher-developed writing instrument scored against IELTS criteria. Quantitative analyses included independent and paired t-tests, ANCOVA, regression modelling, gain score analysis, and non-parametric robustness checks; qualitative data from semi-structured interviews were analyzed thematically.

Results

The experimental group demonstrated statistically significant and educationally meaningful gains in overall writing performance ($d = 1.74$, $p < 0.001$), with notable improvements in lexical resource and coherence/cohesion. The control group showed negligible change. ANCOVA confirmed the treatment effect after controlling for baseline ability ($\eta^2p = 0.54$). Qualitative findings revealed consistently positive learner attitudes, including enhanced motivation, perceived autonomy, and appreciation for multimodal access to learning materials.

Conclusion

QR code–supported instruction constitutes a practical and effective pedagogical tool for developing writing proficiency in advanced EFL learners. Implications for technology integration in language teaching are discussed.

Introduction

Writing is widely recognised as one of the most cognitively demanding productive skills in English as a Foreign Language (EFL) education. Proficient writing requires the simultaneous orchestration of linguistic accuracy, lexical breadth, discourse organisation, and communicative intent—a challenge that is particularly acute for learners whose first language differs substantially from English in grammar, pragmatics, and rhetorical convention (1). In Iranian EFL contexts, these challenges are compounded by instructional traditions that have historically prioritised receptive skills and grammatical form over guided writing development, leaving many learners ill-equipped to produce coherent, well-structured written texts (2–5).

Beyond its role in language assessment, writing serves as a central medium for academic reasoning, knowledge construction, and communication (6, 7). Students at all levels of education are regularly evaluated through written products—from classroom compositions to formal academic assignments—and writing proficiency therefore carries direct consequences for educational achievement and professional participation (8). Furthermore, the act of writing promotes metacognitive awareness by requiring learners to plan, monitor, and revise their output, skills that are generalisable across disciplines and communicative contexts (9, 10).

Despite this significance, writing remains underserved in many EFL classrooms. Traditional instruction tends to relegate writing to homework rather than treating it as a skill developed through scaffolded in-class practice, feedback, and iterative revision (11, 12). Learners consequently receive limited opportunities to develop fluency, to experiment with genre conventions, or to engage in the kind of extended, purposeful writing that research identifies as essential for skill growth (13, 14).

Recent advances in educational technology have created new opportunities for language instruction by enabling more flexible, learner-centred pedagogies (12, 13). Mobile-Assisted Language Learning (MALL) has attracted sustained research interest as a framework for extending learning beyond the classroom and supporting self-directed study (15). Within this broader technological landscape, Quick Response (QR) codes have emerged as an accessible and versatile educational tool. Originally developed by Denso Wave in 1994 for industrial logistics, QR codes are two-dimensional matrix barcodes capable of encoding diverse content types—including URLs, video links, audio files, and text—that can be decoded instantly by smartphones and tablets (16, 17). Their ease of use, low implementation cost, and compatibility with existing devices make them particularly attractive in resource-limited instructional settings.

Research into QR code applications in education has documented benefits including increased learner engagement, improved motivation, and support for differentiated instruction (18, 19). In EFL contexts specifically, QR-linked materials have been used to enrich reading activities, facilitate listening practice, and support collaborative language tasks (20, 21). However, the evidence base concerning QR code integration in writing instruction remains sparse. Most existing studies have focused on receptive skills or general motivational outcomes, leaving the question of whether QR-mediated multimodal resources can systematically enhance productive writing ability largely unaddressed (22).

This gap is particularly significant given the central role of writing in academic and professional communication, and the documented difficulties EFL learners encounter in developing this skill. The present study therefore addresses two primary research questions: (a) Does QR code–supported instruction produce significant improvements in the overall writing performance of advanced Iranian EFL learners compared to conventional instruction? (b) How do learners perceive and experience QR code–integrated writing instruction? By generating empirical evidence on both learning outcomes and learner experience, this study aims to contribute practically grounded insights for the design and implementation of technology-enhanced writing pedagogy.

Methodology

Research Design

This study employed a quasi-experimental mixed-methods design combining a pretest–posttest control-group framework with a concurrent qualitative strand. The quantitative component was used to evaluate changes in writing performance following the instructional intervention, while the qualitative strand, consisting of semi-structured interviews, served to illuminate learners' experiences, attitudes, and perceptions. Integration of the two data strands occurred at the interpretation stage, enabling triangulation of quantitative outcomes with experiential accounts and thereby enriching the explanatory depth of the findings (23). This design is consistent with methodological recommendations for evaluating complex educational interventions in which outcome measurement alone is insufficient to understand the mechanisms of effect.

Participants and Sampling

Participants were recruited from an initial pool of 78 students enrolled in advanced-level English courses at a private language institute in Iran. Following administration of the Oxford Quick Placement Test (OQPT) to verify proficiency, 60 learners who achieved scores in the advanced range (65–78) were retained for the study. All participants were native Persian speakers aged between 17 and 32 years ($M = 23.4$, $SD = 3.8$), with a minimum of six years of formal English language instruction. Participants with any reported exposure to QR code–based learning tools in the preceding academic year were excluded to control for prior experience effects.

Eligible participants were randomly assigned using a computer-generated randomisation sequence to either the experimental group ($n = 30$) or the control group ($n = 30$), ensuring that each individual had an equal probability of assignment to either condition. A priori power analysis (G*Power 3.1) indicated that a total sample of 60 was sufficient to detect a medium-to-large effect size (Cohen's $d = 0.65$) at 80% power with $\alpha = 0.05$ for independent t-test comparisons, providing a sound statistical basis for the study's design.

Instruments

Data collection relied on three primary instruments. The Oxford Quick Placement Test (OQPT), a standardised and widely validated proficiency measure, was administered at the outset to confirm advanced-level competence and to verify group comparability at baseline. The researcher-developed Writing English Test (WET) served as both pretest and posttest, with two parallel forms employing comparable but distinct prompts to minimise practice effects while maintaining equivalent levels of difficulty. All writing scripts were evaluated using the IELTS writing band descriptors, which assess four dimensions: Task Achievement, Coherence and Cohesion, Lexical Resource, and Grammatical Range and Accuracy. Each dimension was scored on a scale from 0 to 9, yielding a maximum composite score of 36; scores were subsequently converted to a 0–20 scale for reporting. The use of a recognised international scoring framework strengthens the construct validity and interpretability of the writing assessments.

The qualitative strand employed a semi-structured interview protocol comprising twelve open-ended questions organised around three thematic areas: general perceptions of QR-based learning, perceived impact on writing development, and attitudes toward technology-enhanced instruction. The protocol was reviewed for content validity by three applied linguistics experts and piloted with five learners not included in the main study; minor revisions were made following the pilot to improve clarity.

Scoring Reliability and Measurement Validity

Writing scripts were evaluated independently by two trained raters, both of whom held postgraduate qualifications in TESOL and had at least three years of experience assessing EFL writing. Prior to rating, raters participated in a calibration session using anchor scripts from a previous cohort not involved in the study. Inter-rater reliability was assessed using the Intraclass Correlation Coefficient (ICC; two-way mixed, absolute agreement model), yielding ICC values of 0.87 (pretest) and 0.89 (posttest), indicating strong scoring consistency. Discrepancies between rater scores exceeding half a band on any single dimension were resolved through discussion to reach consensus. The multidimensional scoring framework used in this study—assessing four distinct writing constructs rather than a single holistic score—enhances construct coverage and allows for a more granular analysis of intervention effects across different aspects of writing competence.

Instructional Procedure

The study was conducted over eight weeks of regular instruction, with both groups attending classes twice weekly for approximately 90 minutes per session. Prior to the intervention, all participants completed the OQPT and the writing pretest. Both groups used identical core instructional materials, including the same coursebook chapters and writing prompts. The sole systematic difference between

conditions was the integration of QR code–linked supplementary resources in the experimental condition.

In the experimental group, QR codes were embedded in printed worksheets, handouts, and revision materials distributed throughout the eight-week period. Each QR code linked to one of three categories of supplementary content: (a) short instructional videos (3–6 minutes) addressing target writing skills such as paragraph organisation, argument development, and cohesive devices; (b) model essays accompanied by annotated commentary highlighting effective use of vocabulary and discourse structure; and (c) vocabulary extension activities offering synonyms, collocations, and example sentences relevant to the writing topics covered in class. Learners were encouraged to access QR-linked content both during class activities and independently outside the classroom. The control group received conventional writing instruction consisting of teacher-led explanation, written exercises, and peer feedback without access to QR-linked materials.

At the conclusion of the eight-week period, both groups completed the writing posttest under standardised conditions. Following the posttest, semi-structured interviews lasting 20–30 minutes were conducted with 20 randomly selected participants from the experimental group.

Data Analysis

Quantitative data were analysed using IBM SPSS v28. Preliminary analyses examined distributional assumptions and baseline group equivalence. The primary research question was addressed using paired-samples t-tests (within-group change) and an independent-samples t-test (between-group posttest difference). ANCOVA was employed to compare posttest scores while adjusting for baseline writing ability, with the pretest score as covariate. Gain scores were computed and compared between groups. A multiple regression analysis examined the relative contributions of group membership and pretest score to writing improvement. Non-parametric equivalents (Wilcoxon signed-rank and Mann–Whitney U tests) were conducted as robustness checks. Effect sizes are reported as Cohen's d for t-test comparisons and partial η^2 for ANCOVA. All tests were two-tailed with $\alpha = 0.05$.

Qualitative interview data were analysed using Braun and Clarke's (2006) six-phase reflexive thematic analysis framework (22). Two researchers independently coded a random subset of transcripts (n = 6), with a Cohen's κ of 0.81 indicating strong intercoder agreement. Emerging themes were reviewed iteratively for internal consistency and coherence, and the final thematic structure was cross-checked against the quantitative findings to support triangulation.

Results

Preliminary Analyses and Baseline Equivalence

Prior to primary analyses, preliminary checks were conducted to verify group comparability and the suitability of parametric statistical methods. Descriptive statistics for the OQPT indicated that both

groups were closely matched in terms of general English proficiency at the outset of the study. The control group produced a mean score of 68.43 (SD = 4.21; range: 61–77), while the experimental group produced a mean of 68.17 (SD = 4.06; range: 60–76). The mean difference of 0.26 corresponds to a trivial effect size (Cohen's d < 0.07), confirming that baseline proficiency differences are unlikely to have confounded subsequent analyses.

Normality was assessed using the Shapiro–Wilk test and visual inspection of Q–Q plots. Shapiro–Wilk tests yielded non-significant results for the majority of variables (p > 0.05), with only minor deviations in two subscale distributions, which were not judged to substantially violate parametric assumptions given the sample size and the robustness of t-tests under moderate non-normality. Levene's test confirmed homogeneity of variances for all primary comparisons. Standardised z-score screening and boxplot inspection identified no extreme outliers that would meaningfully distort results.

Table 1
Descriptive statistics and within-group writing performance comparisons (N = 60).

Group	n	Pretest M ± SD	Posttest M ± SD	Gain M	t(df)	p	Cohen's d
Control	30	10.93 ± 1.18	11.07 ± 1.24	0.13	−0.41 (29)	.683	0.08
Experimental	30	10.90 ± 1.31	13.63 ± 1.42	2.73	−8.54 (29)	< .001	1.56

Note. Scores are reported on a 0–20 scale. Cohen's d reflects the within-group pre-to-post effect size.

Within-Group Changes in Writing Performance

Control Group

Within the control group, mean writing scores were virtually unchanged from pretest (M = 10.93, SD = 1.18) to posttest (M = 11.07, SD = 1.24), a difference of 0.13 points. A paired-samples t-test confirmed this change was not statistically significant, t(29) = − 0.41, p = .683, 95% CI [− 0.54, 0.79]. The associated effect size was negligible (Cohen's d = 0.08), indicating that conventional instruction produced no meaningful improvement in writing performance over the study period. These results are consistent with the expectation that the control condition serves as a stable baseline against which intervention effects may be evaluated.

Experimental Group

In contrast, the experimental group demonstrated a substantial and statistically significant improvement in writing performance. Mean scores increased from 10.90 (SD = 1.31) at pretest to 13.63 (SD = 1.42) at posttest, representing an average gain of 2.73 points. A paired-samples t-test confirmed the significance of this change, t(29) = − 8.54, p < .001, 95% CI [− 3.38, − 2.09]. The effect size was large by conventional standards (Cohen's d = 1.56), indicating a strong practical significance. Figure 1 illustrates the divergent

trajectories of the two groups from pretest to posttest, with the experimental group showing a clear and consistent upward trend.

Between-Group Differences at Posttest

At posttest, the experimental group (M = 13.63, SD = 1.42) significantly outperformed the control group (M = 11.07, SD = 1.24). Levene's test confirmed homogeneity of variances (p = .261), supporting use of the equal-variance t-test. The between-group difference was highly significant, t(58) = 7.69, p < .001, 95% CI [1.89, 3.22], with a large effect size (Cohen's d = 1.98). As shown in Fig. 2, there was minimal overlap between group distributions at posttest, indicating a consistent advantage for the experimental condition. Table 2 summarises all primary statistical comparisons.

Table 2
Between-group comparisons, ANCOVA, gain score analysis, and regression results.

Analysis	Outcome variable	Statistic	df	p	Effect size
Independent t-test	Posttest score	t = 7.69	58	< .001	d = 1.98
Independent t-test	Gain score	t = 7.36	58	< .001	d = 1.90
ANCOVA	Adjusted posttest	F = 68.41	1, 57	< .001	η^2p = 0.54
Multiple regression	Gain score	F = 51.26	2, 57	< .001	R^2 = 0.64

Analysis of Covariance (ANCOVA)

To account for any residual baseline differences and provide a more precise estimate of the treatment effect, ANCOVA was conducted with posttest writing score as the dependent variable, group membership as the fixed factor, and pretest score as the covariate. The instructional group effect remained statistically significant after controlling for baseline writing ability, F(1, 57) = 68.41, p < .001, partial η^2 = 0.54. This large effect size indicates that group membership accounted for 54% of the variance in posttest scores after baseline adjustment. The pretest covariate was also a significant predictor of posttest performance, F(1, 57) = 18.32, p < .001, consistent with the expected influence of prior ability on subsequent attainment. The homogeneity of regression slopes assumption was verified and met (p = .412), confirming the validity of the ANCOVA model. Figure 3 presents the ANCOVA-adjusted posttest means, showing that the experimental group retained a substantial advantage after statistical control for baseline differences.

Gain Score Analysis

Gain scores (posttest minus pretest) were computed for all participants. The experimental group demonstrated substantially larger mean gains (M = 2.73, SD = 1.75) compared to the control group (M = 0.13, SD = 1.15). An independent-samples t-test confirmed a significant difference between groups, t(58) = 7.36, p < .001, Cohen's d = 1.90. At the individual level, 87% of experimental group participants demonstrated positive gains (compared to 43% of controls), highlighting the consistency and breadth of the intervention effect across learners. Figure 4 illustrates the distribution of gain scores in each group.

Regression Analysis

Multiple regression was used to examine predictors of writing gain scores. The overall model was statistically significant, $F(2, 57) = 51.26$, $p < .001$, $R^2 = 0.64$. Group membership was the strongest predictor of improvement ($\beta = 0.74$, $p < .001$), confirming that experimental group participants improved significantly more than controls after accounting for initial writing ability. Pretest score also contributed significantly to the model ($\beta = -0.23$, $p = .041$), indicating a modest negative relationship between baseline ability and gain, consistent with a ceiling effect at higher initial performance levels. Regression diagnostics confirmed adequate model fit with no substantial violations of linearity, homoscedasticity, or independence. Figure 5 illustrates the individual pretest-to-posttest trajectories for both groups.

Robustness Checks (Non-Parametric)

Non-parametric tests were conducted to verify that parametric findings were not dependent on distributional assumptions. Within the control group, the Wilcoxon signed-rank test returned a non-significant result ($Z = -0.62$, $p = .535$), confirming negligible change. Within the experimental group, a highly significant improvement was observed ($Z = -4.78$, $p < .001$). The Mann–Whitney U test confirmed a significant between-group difference in gain scores ($U = 112.50$, $p < .001$). The consistency between parametric and non-parametric results strengthens confidence in the reliability of the primary findings.

Subcomponent Analysis of Writing Performance

To identify which dimensions of writing were most responsive to the intervention, analyses were conducted separately for each IELTS-based writing subscale. As shown in Table 3, the largest group differences were observed in Lexical Resource and Coherence and Cohesion, both of which showed significant improvement in the experimental group compared to negligible change in the control group. Grammatical Range and Accuracy and Task Achievement also showed meaningful gains, though the magnitude of improvement was somewhat smaller. This pattern suggests that QR code–based instruction, by providing multimodal input rich in vocabulary and model discourse structures, particularly supports the development of lexical and cohesive dimensions of writing.

Table 3
Subcomponent gain scores by instructional group.

Writing subcomponent	Control gain M ± SD	Experimental gain M ± SD	t(df)	p	Cohen's d
Lexical resource	0.17 ± 0.64	0.98 ± 0.72	4.76 (58)	< .001	1.19
Coherence & cohesion	0.10 ± 0.55	0.87 ± 0.68	5.08 (58)	< .001	1.27
Grammatical accuracy	0.03 ± 0.49	0.47 ± 0.58	3.28 (58)	.002	0.82
Task achievement	0.07 ± 0.52	0.51 ± 0.61	3.07 (58)	.003	0.77

Note. Gain scores represent mean posttest minus pretest differences on individual subscales (0–9 scale).

Qualitative Findings

Thematic analysis of semi-structured interview transcripts (n = 20) yielded six overarching themes, as illustrated in Fig. 6. The most frequently endorsed theme was increased motivation, with 18 of 20 participants describing QR-based learning as more engaging and stimulating than conventional approaches. Learners frequently contrasted the novelty and interactivity of QR-linked content with the perceived monotony of traditional classroom instruction.

The second most prevalent theme concerned enhanced engagement and perceived learning effectiveness. Participants reported that the ability to access model texts, audio explanations, and vocabulary support at their own pace allowed them to engage more deeply with writing tasks and to revisit challenging content without relying exclusively on teacher input. This aligns closely with the quantitative finding that Lexical Resource showed the largest gain, as many participants specifically mentioned vocabulary expansion as a benefit of the multimodal content.

Flexibility and accessibility constituted a third major theme, with participants valuing the ability to access learning materials anytime and from any location. Several learners noted that they reviewed QR-linked content on evenings and weekends, suggesting that the intervention extended substantive engagement with writing beyond scheduled class time.

Learner autonomy emerged as a fourth theme, with participants describing a heightened sense of control over their own learning trajectory. Learners reported making deliberate decisions about which resources to engage with, how often to revisit particular content, and when to seek additional vocabulary or grammar support—behaviours consistent with self-regulated learning.

Minor technical difficulties, primarily related to device compatibility or unfamiliarity with QR scanning applications, formed a fifth theme; however, these issues were limited in scope and resolved quickly in

most cases, with only four participants rating them as a notable barrier to learning. The sixth and final theme concerned positive attitudes toward technology-enhanced instruction more broadly, with participants expressing openness to further integration of digital tools in their language learning.

Discussion

The present study investigated the effect of QR code–mediated instruction on the writing performance of advanced Iranian EFL learners, alongside their attitudes toward this technology-enhanced approach. The findings converge to support the conclusion that systematically integrating QR codes into writing instruction produces significant and practically meaningful improvements in writing proficiency, above and beyond the gains attributable to conventional instruction.

The between-group effect size at posttest ($d = 1.98$) and the ANCOVA-adjusted partial η^2 of 0.54 are large by educational research standards, though not implausible given the combination of a well-designed intervention, a homogeneous and motivated participant group, and a writing assessment sensitive to the specific skills targeted by the QR-linked content. It is important to acknowledge, however, that effect sizes of this magnitude may be partly attributable to the constrained sample and the relatively focused instructional context; replication across more diverse settings and populations is needed before strong generalisations can be drawn.

From a theoretical standpoint, the effectiveness of QR code–mediated instruction can be interpreted through several complementary frameworks. Mayer's (2009) Cognitive Theory of Multimedia Learning posits that the integration of verbal and pictorial information engages dual cognitive channels and reduces extraneous cognitive load, facilitating deeper encoding of new knowledge (24, 25). In the present study, QR-linked content combining written models, audio narration, and annotated text likely provided learners with multiple representational pathways for internalising writing conventions, vocabulary, and discourse patterns. The subcomponent analysis supports this interpretation: the largest gains were observed in Lexical Resource and Coherence and Cohesion—precisely those dimensions most directly supported by the vocabulary extension activities and model essay annotations included in the QR content.

From a socio-constructivist perspective, the QR-enriched learning environment appears to have fostered greater learner agency and self-directed engagement (26). Qualitative findings indicated that participants actively selected, revisited, and applied QR-linked resources in response to their individual learning needs, consistent with self-regulated learning behaviours associated with improved academic outcomes (27). This pattern aligns with Vygotskian notions of the zone of proximal development, in which access to contextually appropriate scaffolding—delivered flexibly and at the learner's own pace—supports the internalisation of target skills.

The present findings align with and extend the existing literature on QR codes and mobile-assisted language learning. Balintag and Wilang (2020) reported that QR code activities significantly enhanced affective learning attributes in EFL writing contexts (28), and the present study corroborates these

motivational benefits while also demonstrating a clear link to measurable writing gains. AlNajdi (2022) documented significant reading performance improvements attributable to QR code integration (29), and the current results suggest that comparable benefits are attainable for productive skills. Kuru Gönen and Zeybek (2022) found that QR-enhanced materials promoted positive attitudes and comprehension in reading tasks (30); the present study extends these findings by demonstrating that positive attitudinal effects are mirrored by substantive writing development.

The partial divergence from Durak et al. (2016), who found attitudinal benefits without corresponding performance gains (31), underscores the importance of instructional design in determining intervention effectiveness. In the present study, QR codes were embedded systematically within the pedagogical sequence and linked to content directly aligned with assessed writing constructs. This stands in contrast to studies in which QR codes function as peripheral supplements rather than integral components of the instructional design. The implication is that the transformative potential of QR codes depends not merely on their presence but on their purposeful, pedagogically grounded integration.

The finding that Grammatical Range and Accuracy showed smaller but still significant gains compared to lexical and discourse-level dimensions is theoretically informative. It suggests that multimodal, input-rich resources of the kind provided through QR links are particularly effective for developing higher-order aspects of writing competence—organisation, argumentation, and lexical sophistication—while grammatical accuracy, which may require more explicit, targeted feedback, responds somewhat less dramatically to indirect, input-based approaches. This pattern is consistent with accounts of the differential effects of implicit and explicit instruction on different linguistic dimensions (32)å.

Conclusion

This study provides evidence that QR code–mediated writing instruction produces statistically significant and practically meaningful gains in the writing performance of advanced EFL learners, alongside consistently positive learner perceptions and attitudes. The intervention advantage was evident across all four writing subcomponents assessed, with particularly strong effects on Lexical Resource and Coherence and Cohesion. Qualitative findings enrich these quantitative results by identifying increased motivation, enhanced autonomy, multimodal access, and flexible learning as the primary mechanisms through which QR-based instruction supports writing development.

These findings carry direct pedagogical implications. Instructors working in EFL contexts characterised by limited contact time and restricted access to authentic target-language input may find QR code integration a practical, low-cost strategy for extending high-quality learning opportunities beyond the classroom. The ease of implementation—requiring no specialist technical knowledge beyond the creation of QR code links—makes this approach particularly accessible to practitioners in diverse instructional settings. At the same time, the findings underscore that effective QR-based instruction depends on the quality and pedagogical coherence of the linked content; superficial implementation is unlikely to produce the effects documented here.

Limitations and Future Directions

Several limitations should be considered when interpreting these findings. First, the study was conducted within a single private language institute in Iran, limiting the generalisability of findings to other cultural, institutional, and proficiency contexts. Second, the eight-week intervention period precludes conclusions about the durability of observed gains; longitudinal follow-up is needed to determine whether improvements are maintained over time. Third, despite efforts to standardise instruction across conditions, the possibility of expectancy or novelty effects on the part of both learners and teacher cannot be fully excluded. Fourth, the writing assessment, although grounded in a validated scoring framework and supported by strong inter-rater reliability, reflects a particular operationalisation of writing competence and may not capture all dimensions of writing development. Future research should examine QR code–supported writing instruction in larger, more heterogeneous samples—including different proficiency levels, institutional contexts, and first-language backgrounds—and should employ longitudinal designs to track the trajectories of improvement over extended time frames. Experimental work comparing different types of QR-linked content (e.g., input-only versus interactive feedback resources) would further clarify the mechanisms underlying the observed effects.

Declarations

Availability of data and materials: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare no competing interests.

Ethical statement: Ethical statement: The study was approved by the Ethics Committee of the ACECR Institute of Higher Education (IR.ACECR.REC.1402.818). All research procedures involving human participants were conducted in accordance with the ethical standards approved by this committee and with relevant institutional guidelines and regulations. Written informed consent was obtained from all participants prior to enrolment.

Consent to participate: Written informed consent was obtained from all participants prior to commencement of the study.

Acknowledgements: The authors thank the Department of English Language and the participating institute for their support.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author Contribution

Hamidreza Aminoroaya proposed the topic, conducted the research and drafted the paper, Alireza Najafi critically revised the paper.

References

1. Karakuş İ (2025) International students' experiences on speaking and writing skills in language learning processes in higher education. PLoS ONE 20(8):e0329331
2. Alawerdy AS, Alalwi FS (2022) Enhancing English as a foreign language university students' writing through explicit instruction of conjunctions as cohesive devices: An experimental study. Front Psychol 13:1053310
3. Al-Harbi HH, Al-Wasy BQ, Abduh MYM, Al-Inbari FAY (2025) Empowering EFL Learners. Int J Computer-Assisted Lang Learn Teach. ;15(1)
4. Aldayel HS, Pravitasari H, Fadillah N (2026) Factors affecting academic writing difficulties among English as a Foreign Language (EFL) university students. Acta Psychol 263:106250
5. Andargie A, Amogne D, Tefera E (2025) Effects of project-based learning on EFL learners' writing performance. PLoS ONE 20(1):e0317518
6. Myhill D, Cremin T, Oliver L (2023) The impact of a changed writing environment on students' motivation to write. Front Psychol 14:1212940
7. Zahari M, Marini A, Safitri D, Dewiyani L, Muawanah U (2025) Optimizing student writing performance in higher education: A quantitative study of teacher feedback and classroom environment. Social Sci Humanit Open 11:101286
8. Machost H, Stains M (2023) Reflective Practices in Education: A Primer for Practitioners. CBE Life Sci Educ 22(2):es2
9. Escorcia D, Campo K, Navarro G, Ros C (2025) Assessing writing practices in higher education: Characterizing self-reported practices and identifying their determinants. Assess Writ 66:100976
10. Alves-Wold A, Walgermo BR, McTigue E, Uppstad PH (2023) Assessing Writing Motivation: a Systematic Review of K-5 Students' Self-Reports. Educ Psychol Rev 35(1):24
11. Almanea M (2025) Less is NOT more for learners: EFL learners' preferences and perceptions of teachers' written corrective feedback. Acta Psychol 255:104926
12. Kim YG (2022) Co-Occurrence of Reading and Writing Difficulties: The Application of the Interactive Dynamic Literacy Model. J Learn Disabil 55(6):447–464
13. Taye T, Mengesha M (2024) Identifying and analyzing common English writing challenges among regular undergraduate students. Heliyon 10(17):e36876
14. Taye T, Teshome G (2025) The impact of extensive reading on academic writing proficiency in EFL undergraduate students. Discover Educ 4(1):264
15. Mallahi O (2024) Exploring the status of argumentative essay writing strategies and problems of Iranian EFL learners. Asian-Pacific J Second Foreign Lang Educ 9(1):19
16. Kim YS, Otaiba SA, Sidler JF, Gruelich L (2013) Language, literacy, attentional behaviors, and instructional quality predictors of written composition for first graders. Early Child Res Q 28(3):461–469

17. Sahin D, Yavuz MA (2025) Fostering effective vocabulary retention among primary school students: a case study. Front Psychol 16:1594620
18. Shadiev R, Wang X (2022) A Review of Research on Technology-Supported Language Learning and 21st Century Skills. Front Psychol 13:897689
19. Haleem A, Javaid M, Qadri MA, Suman R (2022) Understanding the role of digital technologies in education: A review. Sustainable Oper Computers 3:275–285
20. Wang X, Hamat AB, Shi NL (2024) Designing a pedagogical framework for mobile-assisted language learning. Heliyon 10(7):e28102
21. Elaish MM, Hussein MH, Hwang GJ (2023) Critical research trends of mobile technology-supported English language learning: A review of the top 100 highly cited articles. Educ Inf Technol (Dordr) 28(5):4849–4874
22. Karia CT, Hughes A, Carr S (2019) Uses of quick response codes in healthcare education: a scoping review. BMC Med Educ 19(1):456
23. Rakha AH (2025) Cooperative learning with QR codes technology: enhancing cognitive achievement and attitudes among students. Front Educ. ;Volume 10–2025
24. Chen H (2026) AI-generated content and business English speaking: A mixed-methods study of SpeakGuru's impact on performance, motivation, and engagement. Acta Psychol 264:106481
25. Zhang L, Ma Y (2023) A study of the impact of project-based learning on student learning effects: a meta-analysis study. Front Psychol 14:1202728
26. Alfoudari AM, Durugbo CM, Aldhmour FM (2023) Exploring quality attributes of smart classrooms from the perspectives of academics. Educ Inf Technol (Dordr). :1–43
27. Aljasir N (2023) Perceptions of Self-Learners of English Toward Mobile Language Learning. Int J Computer-Assisted Lang Learn Teach. ;13(1)
28. Balintag C, Wilang J (2020) QR Codes Utilization in EFL Classroom: Affective Language Learning Attributes in Writing. Scr Journal: J Linguistics Engl Teach 5:1–13
29. Kuru Gönen Sİ, Zeybek G (2024) Training on multimodal mobile-assisted language learning: a suggested model for pre-service EFL teachers*. Comput Assist Lang Learn 37(7):2202–2223
30. AlNajdi SM (2022) The effectiveness of using augmented reality (AR) to enhance student performance: using quick response (QR) codes in student textbooks in the Saudi education system. Educ Technol Res Dev 70(3):1105–1124
31. Durak G, Ozkeskin EE, Ataizi M (2016) QR codes in education and communication. Turkish Online J Distance Educ. ;17
32. Hebibi F, Runge I, Lazarides R (2026) To plan or not to plan: Technology integration in student teachers' lesson plans and their relation to dimensions of instructional quality. Teach Teacher Educ 173:105410

Figures

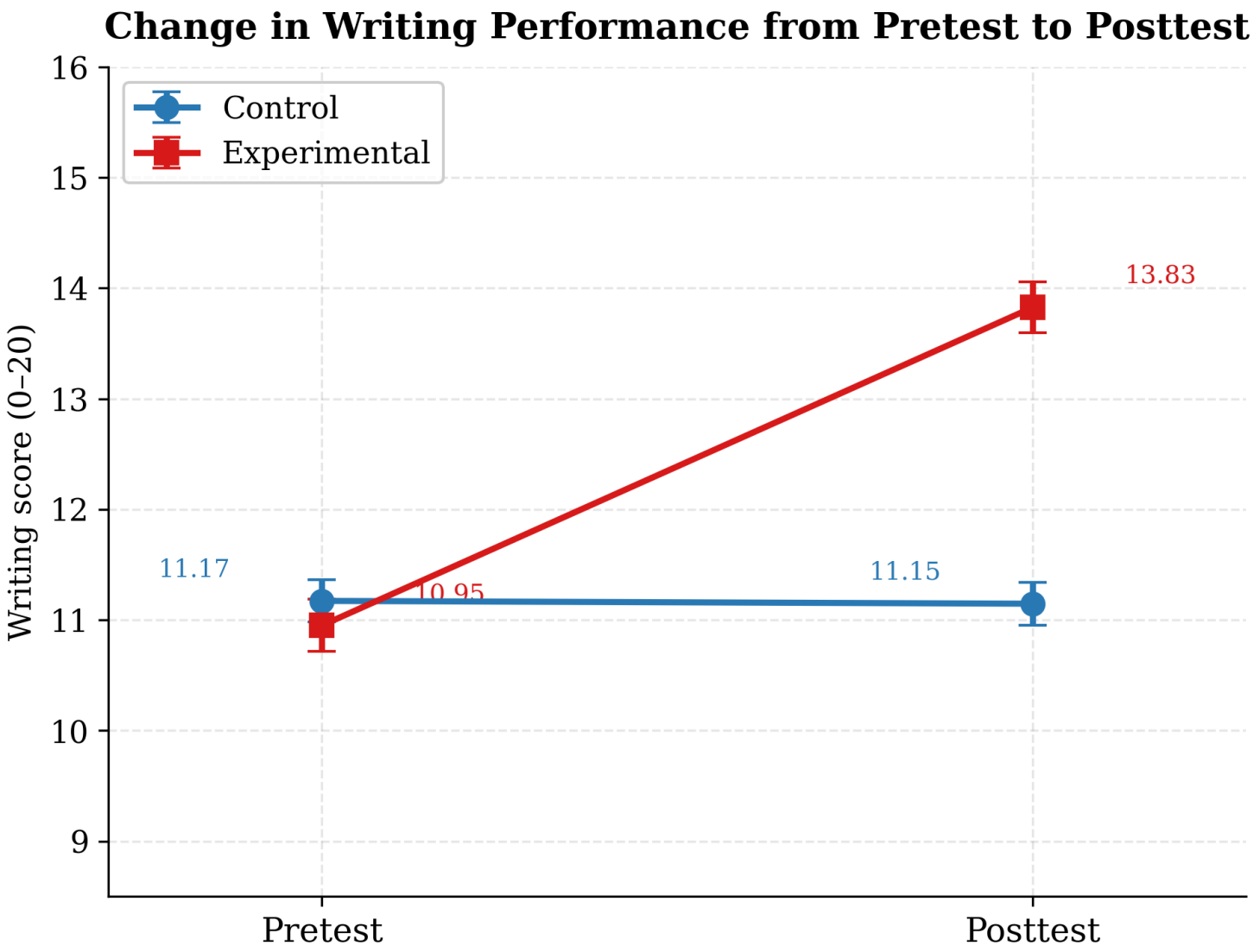

Figure 1

Change in writing performance from pretest to posttest. The control group shows minimal change across the study period, while the experimental group demonstrates a consistent and substantial increase in writing scores following QR code–mediated instruction. Error bars indicate ±1 standard error.

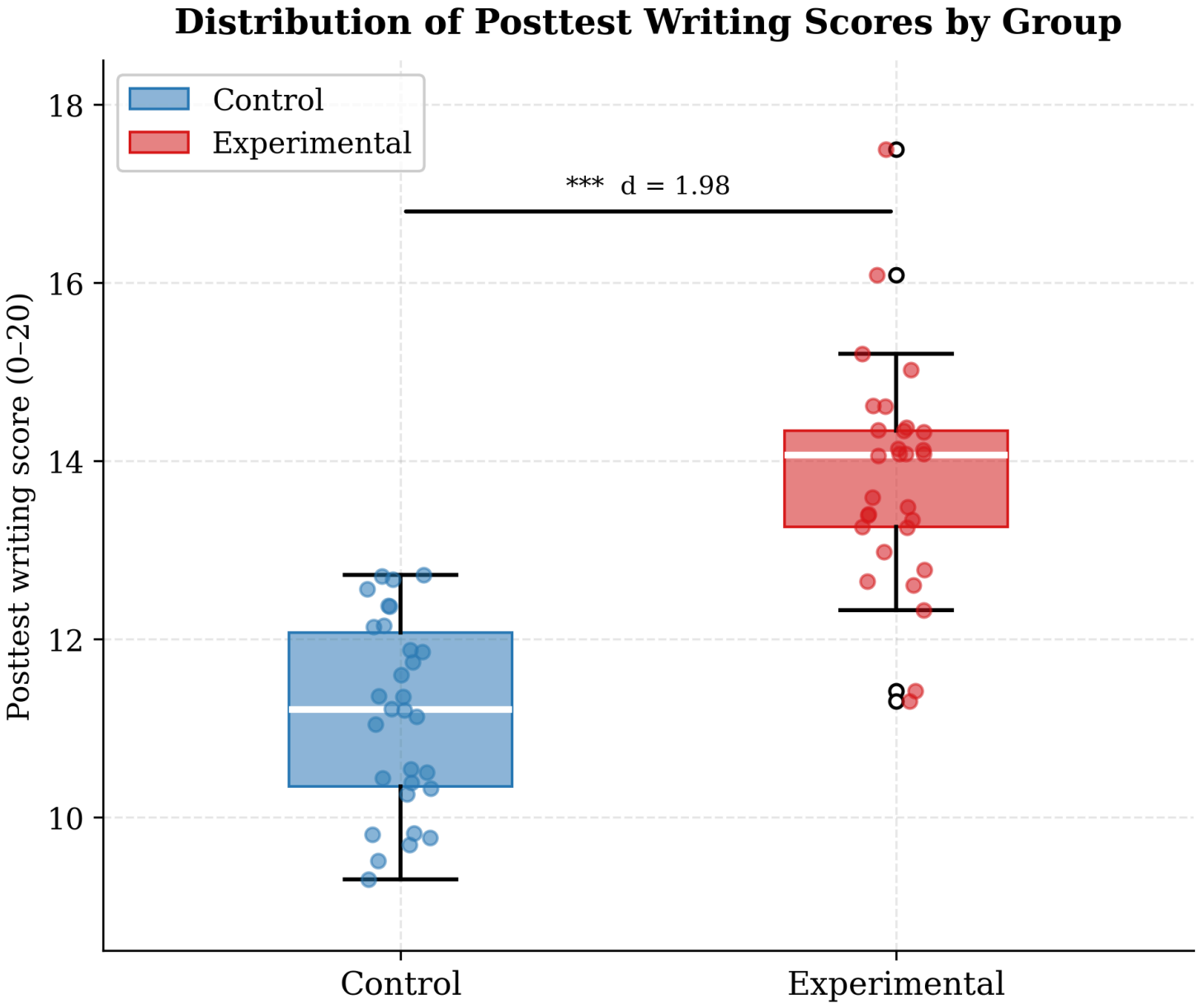

Figure 2

Distribution of posttest writing scores by group. Box plots with overlaid individual data points show that experimental group scores are consistently higher than control group scores, with minimal distributional overlap, consistent with the statistically significant between-group difference.

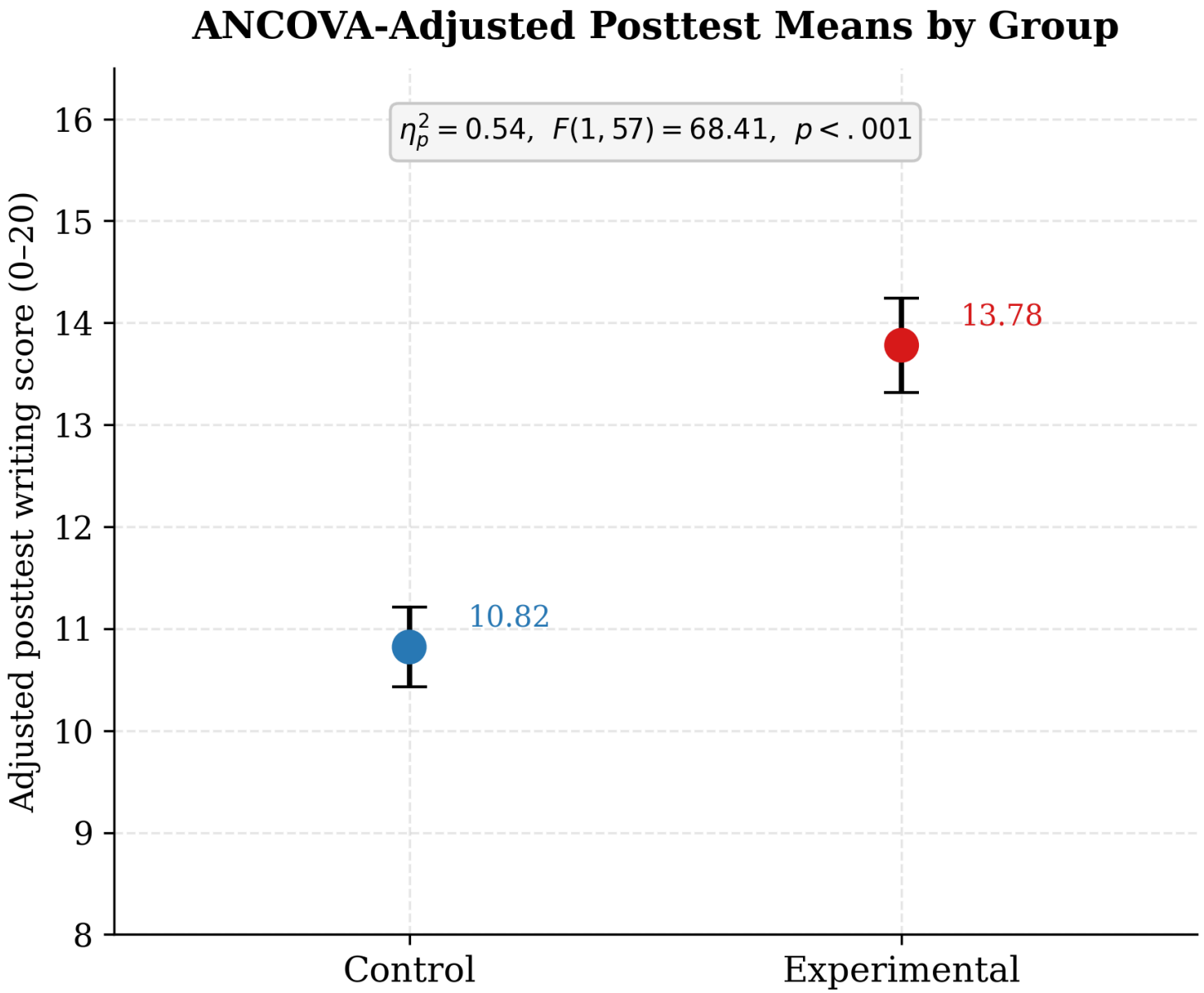

Figure 3

ANCOVA-adjusted posttest means by group. Estimated marginal means were derived after controlling for pretest writing scores. The experimental group retains a substantial advantage over the control group, confirming that the treatment effect was not attributable to baseline differences.

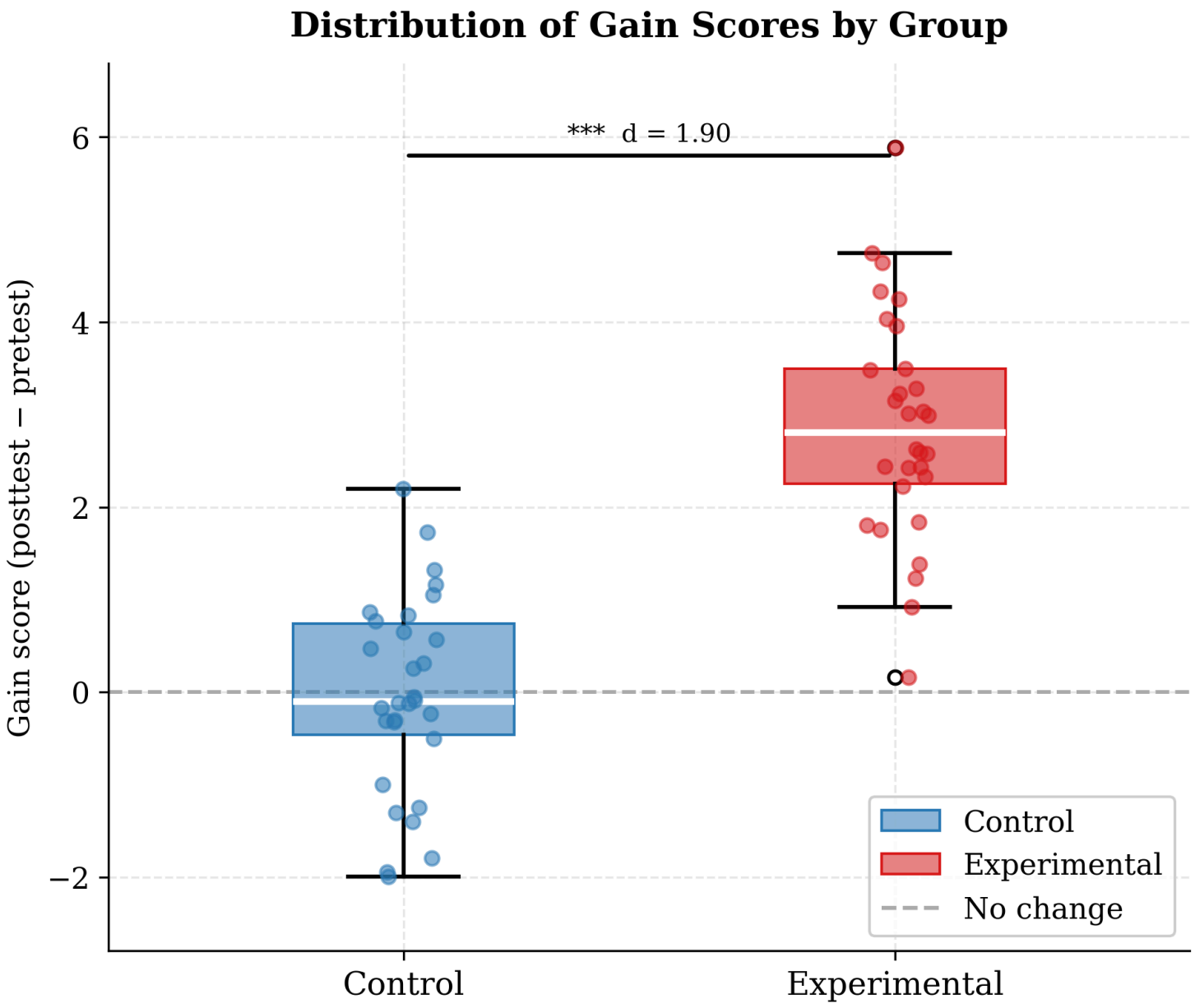

Figure 4

Distribution of gain scores (posttest − pretest) by instructional group. Gain scores in the experimental group are substantially larger and more consistently positive than those in the control group. The dashed line at zero denotes no change.

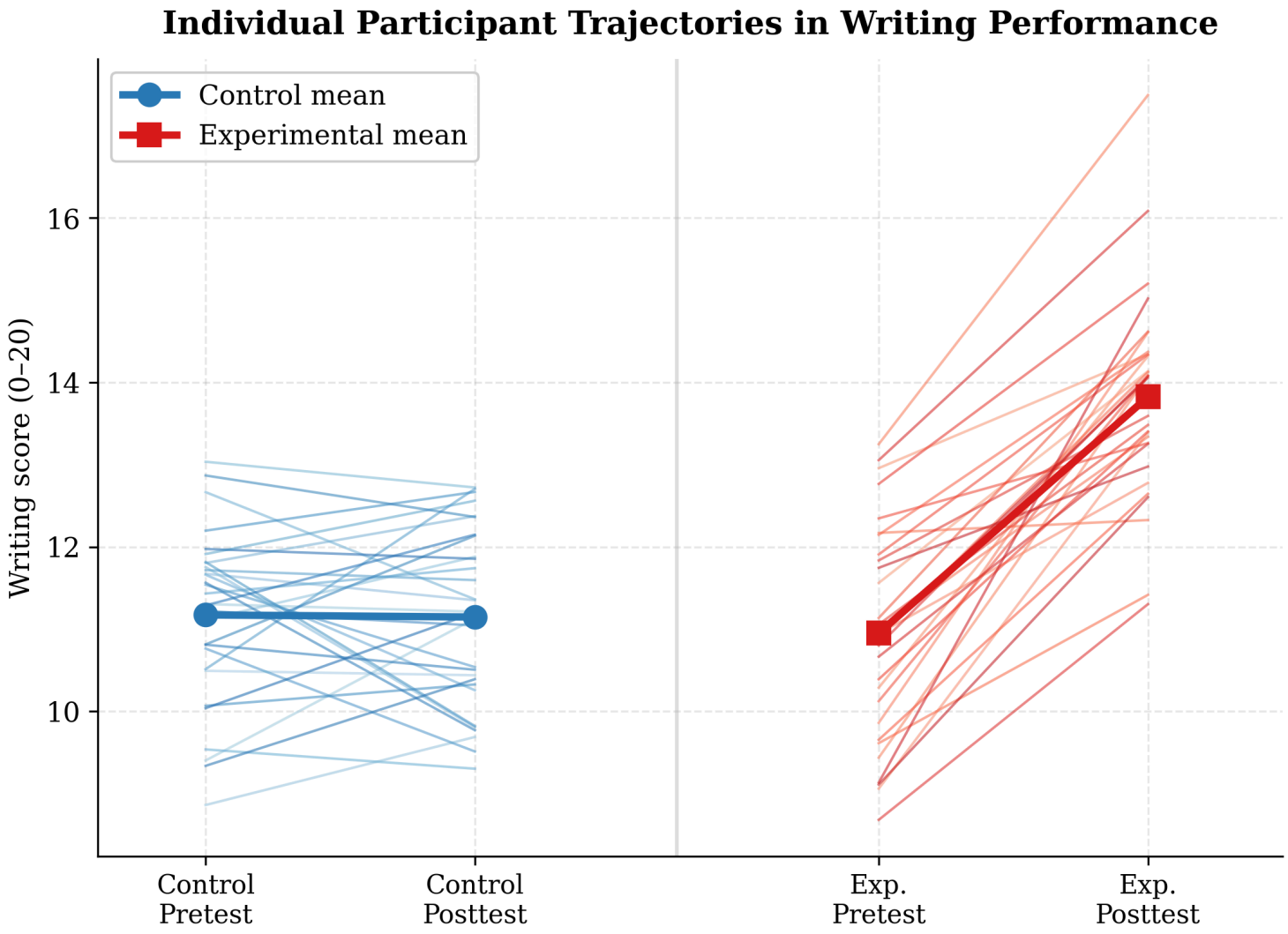

Figure 5

Individual participant trajectories in writing performance from pretest to posttest. Each line represents one participant. Control group trajectories are largely flat, while experimental group trajectories are broadly positive, indicating that the intervention effect was systematic across individual learners rather than driven by a small number of extreme improvers.

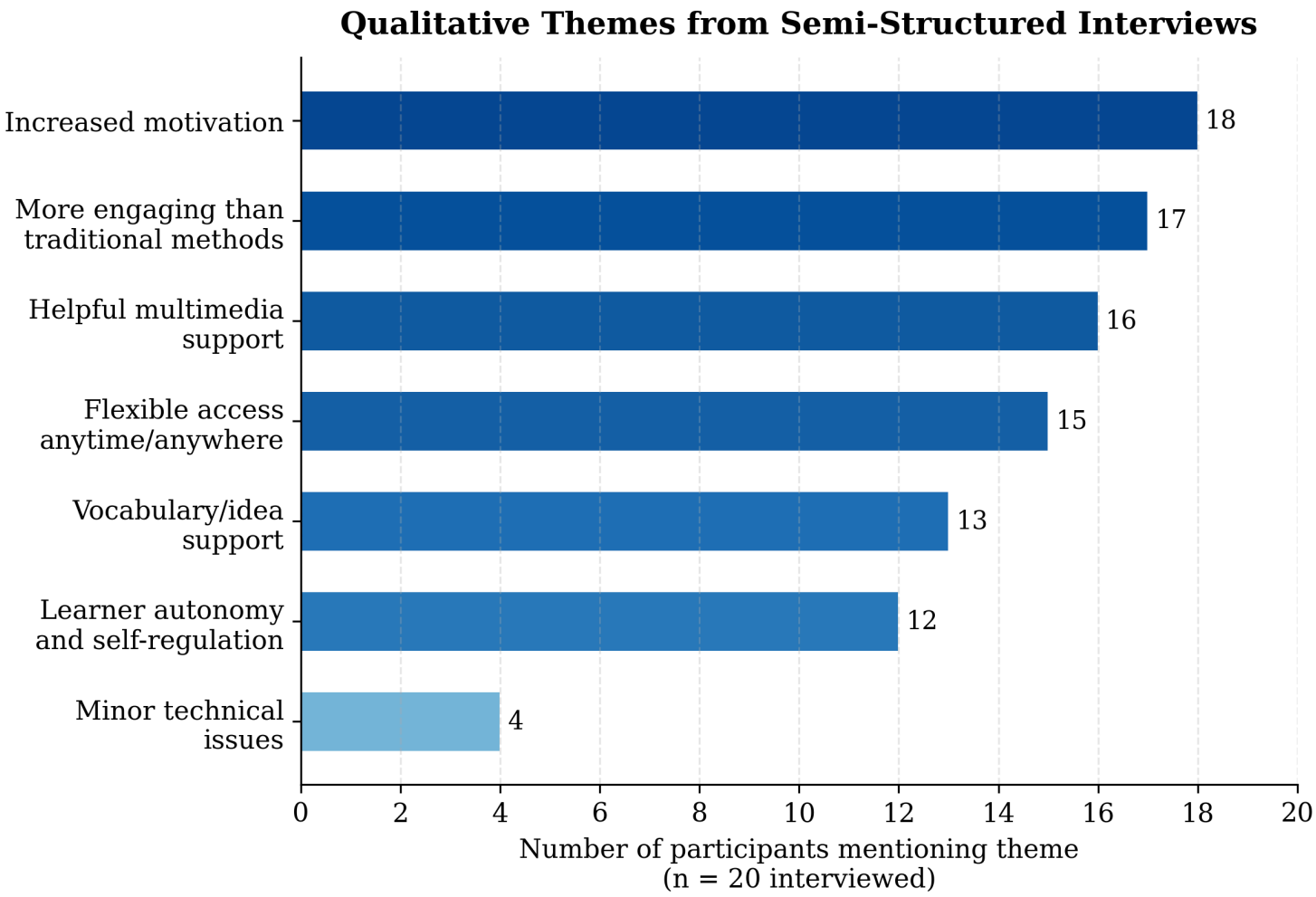

Figure 6

Frequency of themes identified through thematic analysis of semi-structured interviews (n = 20). The most frequently endorsed themes were increased motivation and enhanced engagement, consistent with the quantitative finding of significant writing gains in the experimental group.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- rawdata.csv
- codebook.csv
- qualitativethemes.csv
- README.txt
- cleaneddata.csv
- statisticalanalysis.py