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Technology-Mediated Feedback in Instrumental Music Learning: A Systematic Review of Feedback Architectures, Performance Outcomes, and Effect-Size Feasibility

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ADMINISTRATIVE INFORMATION

Support - Guangzhou Municipal Postdoctoral Research Funding Program (grant 625136-35) and the Education Science Project (Higher Education Special) of the Department of Education of Guangdong Province (grant 2025GXJK0482).

Review Stage at time of this submission - Retrospective registration. All review stages (searches, screening, data extraction, quality appraisal, and analyses) were completed before this registration. The review was not registered prospectively because PROSPERO does not accept reviews without health-related outcomes. This registration documents the protocol as executed, to provide a public, citable record prior to journal submission.

Conflicts of interest - None. The funders had no role in the design, conduct, analysis, or reporting of the review.

INPLASY registration number: INPLASY202670069

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 19 July 2026 and was last updated on 19 July 2026.

INTRODUCTION

Review question / Objective RQ1: What instruments, learner populations, technological systems, and study designs have been examined? RQ2: What instrumental-performance outcomes have been assessed, and how have they been measured? RQ3: How has technology-mediated feedback been configured in terms of modality, timing, information type, function, and performance target? RQ4: To what extent does the literature include retention, transfer, or feedback-withdrawal assessments? RQ5: To what extent can the reported evidence support defensible standardized-effect calculation and quantitative synthesis?

Rationale Existing syntheses have organized evidence around technological devices rather than feedback functions, and no systematic review has treated feedback function as the primary analytical unit within a corpus bounded to instrumental performance. The feasibility of standardized-effect calculation and quantitative synthesis in this literature has not been established.

Condition being studied Instrumental music learning, practice, and performance. The review examines learner-level instrumental-performance outcomes, including pitch or intonation, rhythm or timing, sequencing, movement or technique, posture, tone or sound quality, error magnitude, and expert-rated or global performance.

METHODS

Search strategy Searches combined three concept groups: (a) instrumental music, musical instruments, or instrumental performance; (b) technology-mediated, augmented, visual, auditory, haptic, automated, sensor-based, or AI-supported feedback; (c) learners, students, instruction, practice, or training. Syntax was adapted to each database. Search period 2000-2026; final searches completed in May 2026. Full database-specific strings are archived in the review's supplementary search-strategy file.

Participant or population Children, adolescents, university students, adult learners, and musicians across levels of expertise undertaking a defined instrumental learning, practice, or performance task. Studies focused exclusively on singing, passive listening, music appreciation, or non-musical motor training were excluded; mixed vocal-instrumental studies were eligible only when instrumental evidence could be identified separately.

Intervention Technology used to detect, transform, generate, evaluate, or deliver information about instrumental performance or performance-related behavior, serving a feedback-related function. Eligible carriers included visual or auditory displays, haptic or vibrotactile devices, motion- or posture-sensing systems, video, virtual or embodied environments, automated assessment, AI-supported systems, and multicomponent configurations.

Comparator No single comparator was required at eligibility. Comparator structure (between-group, within-participant, matched, factorial, or single-group pre-post) was classified after extraction because these designs require different effect-size calculations and estimands.

Study designs to be included Randomized, non-randomized, repeated-measures/within-participant, factorial, single-group pre-post, quantitative descriptive, and mixed-method studies contributing learner-level instrumental-performance evidence.

Eligibility criteria Reports evaluating only algorithmic accuracy, signal-processing performance, technical validation, or system description without learner-level performance evidence were excluded, as were reviews, theoretical papers, editorials, commentaries, and technical reports. Publication period 2000-2026; no language restrictions.

Information sources Scopus, RILM Abstracts of Music Literature, Web of Science Core Collection, APA PsycINFO, and ERIC. Records were managed in Covidence. No citation searching or grey-literature searching was conducted.

Main outcome(s) Directly assessed instrumental performance or performance-related behavior: pitch or intonation, rhythm or timing, sequencing, movement or technique, posture, tone or sound quality, error magnitude, and expert-rated or global performance, coded for measurement type, assessment time, and direction of improvement.

Additional outcome(s) Affective, motivational, usability, workload, self-report, and physiological measures were recorded descriptively but excluded from the performance-effect synthesis unless explicitly operationalized as instrumental performance.

Data management Records were deduplicated and screened in Covidence. Two reviewers independently screened titles/abstracts and full texts; disagreements were resolved by consensus; proportionate agreement and Cohen's kappa were calculated. An extraction-stage source and eligibility verification step preceded coding of study characteristics, feedback characteristics (modality, timing, information type, target, function), and outcomes.

Quality assessment / Risk of bias analysis Mixed Methods Appraisal Tool (MMAT) 2018 at criterion level, supplemented by domain-specific reporting indicators (sample-size clarity, comparator clarity, baseline measurement, retention/transfer assessment, measurement type, assessor blinding, rater reliability, statistical sufficiency for effect-size calculation). GRADE was not applied because the review did not prespecify a single homogeneous intervention-outcome contrast.

Strategy of data synthesis Four layers: descriptive study mapping; feedback-characteristic and target mapping (evidence-gap map); methodological and reporting appraisal; and a staged effect-size feasibility audit. Standardized mean differences were expressed as Hedges' g with small-sample correction where calculation was defensible; a strict subset was defined as independent between-group post-test contrasts with sufficient numerical information. Quantitative pooling was to be undertaken only for a conceptually comparable effect set; otherwise synthesis followed the Synthesis Without Meta-analysis (SWiM) guideline, avoiding vote counting.

Subgroup analysis None. Formal heterogeneity, moderator, meta-regression, and publication-bias analyses were reserved for a sufficiently large and conceptually comparable effect set.

Sensitivity analysis Effects from non-standard comparators, matched-pair approximations, or uncontrolled single-group pre-post designs were retained separately as sensitivity or diagnostic estimates and were not treated as equivalent to the strict subset.

Language restriction No language restrictions were applied; search strings used English-language keywords.

Country(ies) involved China.

Other relevant information This is a retrospective registration completed after the review was finished and before journal submission; it documents the methods as executed. Supplementary materials and effect-size calculation files are deposited on Figshare (reserved DOI: 10.6084/m9.figshare.32904536).

Keywords technology-mediated feedback; augmented feedback; instrumental music learning; music performance; music education; systematic review; effect size.

Dissemination plans Publication in a peer-reviewed open access journal; supplementary materials publicly available on Figshare.

Contributions of each author

Author 1 - Shengwen Zhang - Contributions: conceiving and designing the review; searches; screening; data extraction; coding; quality appraisal; analyses; figures; writing.

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