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Review Article

Podcasts as Tools for Communication and Lifelong Learning in School Education

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Abstract

As the adoption of information and communication technology (ICT) tools in education continues to expand, podcasts have emerged as a versatile and cost-effective medium for enhancing communication, teaching, and learning across different educational levels. However, the effective integration of podcasts in early childhood, primary, and secondary education remains under-researched. To address this gap, this paper employs a systematic review methodology to examine the effectiveness of podcasts in relation to communication skills, student engagement, and the development of lifelong learning competencies. A total of 16 peer-reviewed studies were analysed following a comprehensive literature search. The findings indicate that podcast-based learning contributes to improved listening and speaking skills, enhanced teamwork, stronger critical thinking abilities, and increased information literacy. The evidence supports podcasts as a viable alternative to traditional instructional methods, offering flexible and inclusive learning opportunities. This paper provides evidence-based recommendations for policymakers, educational institutions, and educators to guide the effective integration of podcast media into learning environments, with the aim of fostering communication competencies and promoting lifelong learning from an early age.

Keywords: Podcasts; Communication Skills; Education Technology; Lifelong Learning; Student Engagement.

INTRODUCTION

Digital tools are an important component of the current learning environment [1-5]. One of such tools is podcast, which has the flexibility and inclusivity and promotes better communication, engagement, and reflection [6-8]. Since it is an audio-based medium, it is an effective way of enhancing the skills of listening and critical thinking as some of the main competencies of lifelong learning [4, 9-13]. Although self-regulation, creativity, and communication are some of the core competencies of lifelong learning, podcasts have a massive potential in this aspect. Nonetheless, this possibility should be explored in detail in the educational process of the school level, in particular, among younger learners, to

instill the required skills at an early age, since literature is found to be more geared towards higher education [4, 14-21].

There are high potentials of podcasts in underrepresented and low resource educational settings where high band-width tools are scarce. They particularly come in handy in multilingual classrooms, which have facilitated the flexible listening and language exposure in parts like South Asia, African and Eastern Europe. This review contributes to the existing body of knowledge that lacks the emphasis of how podcasts can be used successfully in such environments.

Despite the body of research on primary and secondary education, there is very little research on early childhood education, long-term effects, and combinations with the latest technologies, including AI-assisted adaptive podcasts and virtual reality (VR)/augmented reality (AR) storytelling. This review provides five thematic areas, namely, communication skills, engagement and motivation, lifelong learning competence, critical and digital literacy, and collaboration, that can be used, systematically synthesized across early childhood, primary, and secondary levels, to provide an actionable insight into how podcasts can be exploited in schools.

The systematic review will seek to:

- Research the usefulness of podcasts in early childhood, primary, and secondary schools.
- Determine the essential results of podcasts use, specifically, communication skills, engagement, and lifelong learning.
- Provide pedagogic suggestions on how podcast can be used in school.

To guide the systematic review and meta-analytic synthesis, the following research questions were formulated:

RQ1**:** What effects do podcast-based learning interventions have on communication skills, student engagement, and lifelong learning competencies in early childhood, primary, and secondary education?

RQ2**:** How do podcast-based learning practices differ across educational levels and pedagogical approaches in school education?

RQ3**:** What is the magnitude of the effects (e.g., approximate effect sizes) of podcast-based interventions on key educational outcomes reported in quantitative studies?

RQ4**:** What contextual factors (e.g., age group, multilingual classrooms, access to technology) moderate the effectiveness of podcast-based learning in school settings?

RELATED WORK

Literature offers a growing change in utilizing podcasts as a pedagogic tool due to its convenience and learner-centred feature. It goes hand in hand with the incorporation of technology resources in the process of regular learning, which has rendered podcasts useful in formal and informal education. It has been noted that podcasts provide accessible, distant, and asynchronous learning opportunities, which would support the adjustment to

the needs of various learners [12, 16]. As an audio-based learning tool, podcasts encourage both passive and active learning, i.e. learning without participation. This type of education played a crucial role in the process of learning during the COVID-19 pandemic showed how the individualization of podcasts overcame the technological inequalities, the lack of engagement, and the drawbacks of synchronous online lessons [21].

Moreover, podcasts as well facilitate active multimodal learning. A recent research has identified the interdisciplinary opportunities of applying this tool to the development of the reflexivity of learners and to the promotion of their listening and negotiation abilities [4]. In another recent research, it was found that podcasts made by students significantly enhanced their levels of understanding the topic, gain in academic self-confidence, and facilitated peer bonding. In a similar manner, the study by [4] proved that podcasting is an effective participatory medium, which informed its usefulness in language acquisition, creativity, and linguistic growth.

Nevertheless, the effectiveness of podcasts in the teaching and learning process has not been achieved in early childhood or primary school education, even though these lessons have pedagogical potential. There is an abundant amount of literature in tertiary education, and the result of it has not been studied on young learners.

THEORETICAL FRAMEWORK

The three complementary lenses that inform this review are constructivist learning theory, Technological Pedagogical Content Knowledge (TPACK), and social learning theory as they all form the basis of understanding how podcasts can be applied as learning tools. Constructivism describes the process of meaning-making through active learning and reflection in which the learners engage and reflect, which is consistent with podcasts creation and reflection listening. TPACK also focuses on the overlapping of technology, pedagogy and content it helps understand how podcasts are to be pedagogically integrated but not to be a content delivery tool. Recent state-of-the-art methods, in contrast to traditional podcast integration, focus on AI-enhanced TPACK, where adaptive algorithms tailor podcast content according to learners' cognitive load, engagement patterns, and language competency. By dynamically matching pedagogical tactics with learner data, this expanded TPACK framework facilitates adaptable constructivist learning, especially in inclusive and multilingual classroom settings. Student-created podcasts and peer reviews can be explained through social learning theory (such as peer modelling and collaborative learning) as the means of skill development. Combined, these viewpoints will help create a practical prism in the interpretation of the examined works, as well as suggest a theoretical framework that will connect the influences of podcasts, teaching and learning, and the learning outcomes.

To align with state-of-the-art (SOTA) research in AI-enabled education, this study extends the traditional TPACK framework into an AI-enhanced TPACK model. In this extended framework, artificial intelligence dynamically adapts podcast content by adjusting pacing, linguistic complexity, and instructional focus based on learners'

engagement patterns, cognitive load, and language proficiency. This transforms podcasts from static audio resources into adaptive learning systems that support constructivist knowledge building, personalization, and inclusive learning in multilingual and diverse K–12 classrooms.

PROPOSED CONCEPTUAL MODEL FOR PODCAST IMPLEMENTATION IN SCHOOLS

This review can be conceptualized into a theoretical framing framework within the context of the thematic synthesis of the studies included in the review and suggest a conceptual model, which demonstrates the operation of podcasts as learning tools in schools. The model is composed of four interdependent components, which are; Inputs, Processes, Outputs, and Outcomes, which are modified by contextual and theoretical processes.

Inputs: Tools of podcast creation, audio materials with the elements of AI/VR, teacher knowledge and training, access to devices and the internet, and suitability to curriculum needs.

Processes (Pedagogical Practices): Instructional podcasts taught by teachers, podcast assignments made by students, contemplative listening exercises, multidimensional integration (audios with visual pictures or VR experiences), and personalized or adaptive audio. The techniques have been informed by TPACK based instructional design.

Outputs (Immediate Learning Indicators): improvements in learning new words, listening comprehension, producing collaborative podcast artifacts, completing reflective journals, and measurable student involvement.

Outcomes (Short- to Medium-Term Educational Effects): The growth of communication skills, digital and critical literacy, motivation and engagement, and the most fundamental competencies of lifelong learning (autonomy and self-regulation).

It also means that contextual moderators (e.g., age or educational level, multilingual classroom settings, and access inequalities) or mechanisms (constructivist active learning, social modelling, and adaptive personalization) are also involved in the model. These variables mediate the channels between the processes of pedagogy and learning outcomes, which offer a systematic policy of both implementation and subsequent empirical testing.

The proposed model is dynamic rather than static, as learning processes continuously evolve through learner interaction and AI-driven adaptation. Pedagogical podcast practices are refined based on feedback loops generated from learner engagement and performance data, enabling ongoing personalization and instructional improvement.

Linking the Model to Recommendations

The evidence-based recommendations put forward in this review are based on this conceptual model. Through a clear linking of podcast activities, including creation, consumption, and collaborative production, to quantifiable learning outcomes, the

framework informs educators, curriculum developers, and policy makers to apply podcast-based learning in an efficient way in the early childhood education, primary and secondary education. It further explains how the emerging technologies, including AI-controlled adaptive podcasts and VR-enhanced storytelling, can be used to further provide an increase in the engagement, communication, and lifelong learning skills.

Proposed Research Hypotheses and Novel Contributions

Based on this conceptual framework, the review advances testable, theory-driven hypotheses aligned with current SOTA research. Specifically, AI-adaptive podcasts are hypothesized to yield significantly greater communication skill gains than static podcasts in multilingual K–12 classrooms. Additionally, VR-enhanced narrative podcasts are expected to produce higher learner engagement and deeper reflective learning compared to audio-only formats. These hypotheses directly address gaps identified in recent K–12 podcast meta-analyses and move the field toward empirical validation rather than descriptive synthesis.

State-of-the-Art (SOTA) Comparative Analysis of Podcasts in School Education

This subsection will be aimed at comparing podcasts with other educational technology (EdTech) tools applied in schools systematically and pointing out new innovations. Figure 1 and Table 1 present a comparative analysis of podcasts with videos, gamified learning environments, language learning applications, and immersive technologies, including AI-based adaptive podcasts and VR/AR storytelling.

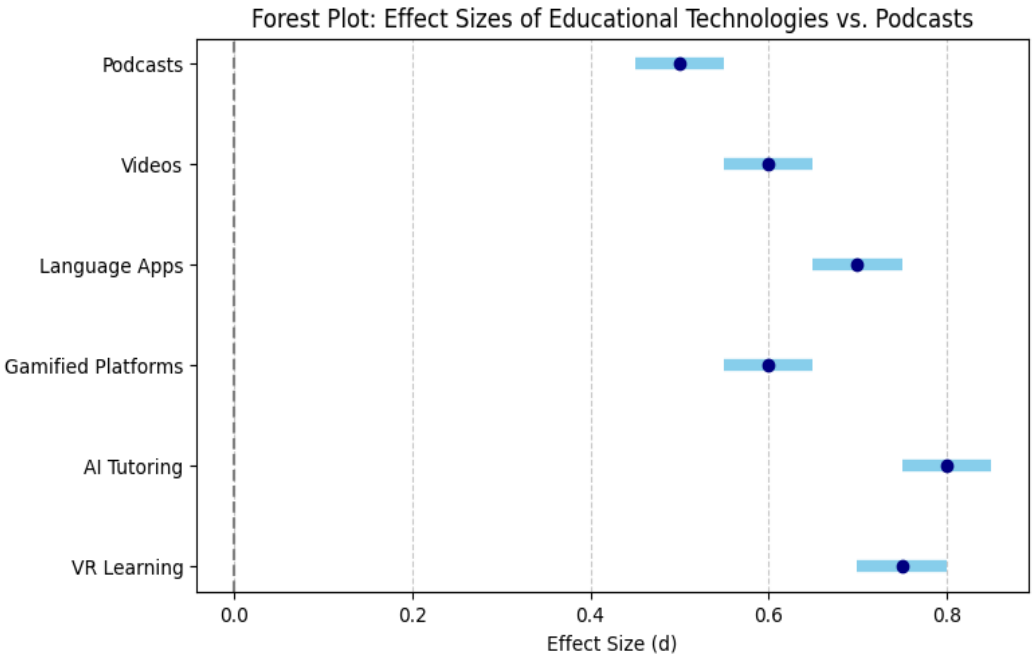


Figure 1. Effect sizes (Cohen's d) for podcasts compared with other educational technologies

Table 1. Comparison of podcasts and key educational technologies

Tool	Strengths	Limitations	Suitable Use in Schools	Effect Size (d)	Cost/Resources	Empirical Notes
Podcasts	Flexible, audio-based, self-paced, promotes reflection & listening	Limited visual engagement	Language learning, storytelling, engagement	0.5 (listening skills)	Low (minimal devices needed)	Improves engagement and critical thinking
Videos	Visual + auditory, high engagement	Less portable, passive learning	Concepts, demonstrations, multimedia lessons	0.6 (concept retention)	Medium (devices + editing)	Strong for comprehension; lower self-paced reflection
Language apps	Personalized, gamified	Can be isolating, requires devices	Vocabulary, grammar, adaptive learning	0.7 (vocabulary gain)	Medium (devices, subscriptions)	Effective for adaptive learning; gamification boosts motivation
Gamified platforms	Motivational, interactive	May require more teacher support	Skills practice, formative assessment	0.6 (skill improvement)	Medium-High (platform + teacher training)	Promotes repeated practice; engagement high
AI-assisted tutoring	Adaptive, personalized, analytics-driven	High setup cost, technical expertise	Individualized support, formative assessment	0.8 (learning outcomes)	High	Provides real-time feedback; data-driven insights
VR learning environments	Immersive, experiential	Expensive, requires hardware	Simulations, experiential learning	0.75 (knowledge retention)	High	Strong for experiential learning; enhances motivation

The comparison of these tools by their strengths, limitations, and suitability in the process of early childhood, primary, and secondary education will give a better insight into the specifics of the use of podcasts in terms of the value they add and prospective integration with other solutions to EdTech.

In contrast to previous comparative summaries, recent SOTA meta-analyses find medium-to-large impact sizes for immersive learning tools and gamified language applications (d = 0.6), whereas podcast-based therapies show moderate but steady improvements in listening and reflection skills. Future meta-analytic and experimental comparisons are necessary because there is currently little empirical benchmarking of AI-adaptive podcasts against video and gamified platforms.

EMERGING TECHNOLOGIES IN PODCAST-BASED LEARNING

The latest developments in the educational technology have increased the possibilities of podcast-based learning by incorporating AI-powered and immersive audio technologies. AI-generated podcasts may automatically vary content to the level of comprehension that learners have and give individualized instructions and differentiated instruction to various age groups. In the same fashion, spatialized audio storytelling and the use of VR/AR is able to present storytelling environments in a more immersive and spatial way that enhances engagement and interaction, through the use of imagination and contextual interpretation. Moreover, some education-focused platforms like Spotify are also being applied in school-based settings, and their offerings include structured audio educational content, analytics dashboard and classroom management, which allow teachers to monitor listening behaviour and activity. These are the new tools that signify the changing state of the art in podcast-based learning, and point to the possibilities of more customizable, interactive, and data-driven audio learning experiences.

QUANTITATIVE AND METHODOLOGICAL COMPARISON OF INCLUDED STUDIES

A methodological comparison between the 16 studies included indicates that there is a considerable variation in the research designs, the level of education and the outcome reported. The field is dominated by qualitative approaches in which nine studies are based on case studies, reflective practice or action research and six studies are based on quantitative experimental or quasi-experimental studies. It is only mixed-methods that adopts a design. The experimental studies are more likely to report the measurable increase in engagement, listening comprehension, self-regulation, and academic performance as compared to the qualitative studies which present results in terms of the processes, including reflection, autonomy, creativity, and digital storytelling competence. Much variability in study objectives, sample sizes, and outcome measures and often the absence of standardized quantitative reporting precluded meta-analysis, which then justifies the application of an inductive thematic synthesis. This comparison also reveals that the studies about the early childhood/preschool are still underdeveloped compared to the primary and secondary levels, which clearly indicates that this is one area that future research can be expanded. Emerging platforms that incorporate AI-driven listening dashboards and learning analytics allow for quantifiable tracking of engagement and customisation in contrast to traditional podcasts. Nevertheless, there is still a dearth of empirical data that explicitly compares learning results across analytics-enabled podcasts and traditional audio formats, indicating a significant vacuum for further experimental study.

In general, podcasts are an appropriate form of learning experience that is flexible, engaging, and easy to learn across age groups, but the research lacks sufficient studies on early childhood, studies of longitudinal impacts, and incorporating new technologies like AI and VR/AR.

METHODOLOGY

The authors followed a systematic approach to review in order to synthesize and evaluate the application of podcasts as a means of communication, engagement, and lifelong learning in the context of early childhood, primary and secondary education. The method of systematic review is especially suitable to map trends in current studies and generalize applicable information of various researches [11, 44]. Also, the methodology was extended by applying the known PRISMA guidelines to make sure that the studies selection process is transparent [18].

Search Strategy

To develop in depth research to locate pertinent literature, both academic databases and search engines were utilized, among others, Emerald Insight, ERIC (Education Resources Information Centre), Google Scholar, SpringerLink, Taylor and Francis Online, and open-access repository of Directory of Open Access Journals (DOAJ). Next, there was the consideration of the keyword strategy by using the relevant terms with Boolean Operators (AND/OR). Based on this, the search strings adopted in the databases were as follows:

- *"Podcasts AND early childhood education"*
- *"Podcasts AND primary education OR elementary school"*
- *"Podcasts AND secondary education OR middle school OR high school"*
- *"Educational podcasts AND communication skills"* \
- *"Audio learning AND student engagement"*
- *"Digital media AND school-based podcasting"*

Additionally, the search results were restricted using filters of Peer-Reviewed studies, and availability in the English Language, and a timeline of 2010-2025 was also applied to retrieve credible, recent, and most relevant studies.

Screening and Inclusion

Following the identification of a total of 92 studies, 18 of these were removed for duplication. It led to a total of 74 studies, which were then screened for accessibility and relevance based on title and abstract, causing the exclusion of 44 studies. Accordingly, 30 full-text studies were retrieved and underwent further screening for eligibility. For lacking educational focus or having a non-school or healthcare focus and empirical evidence, 14 more studies were excluded. A total of 16 studies were included for this systematic review. A literature search has been carried out in different databases, such as Google Scholar, ERIC, Scopus, and Web of Science, to cover the literature on podcast-based learning in early childhood, primary, and secondary schools, and make sure the scope of the research is sufficient. Keywords were extended to encompass other terms like K-12 audio media, podcast pedagogy, educational podcasts, and digital audio learning tools to make sure that pertinent studies are mentioned. It was expected to find 2530 studies and the initial filters were loosened to grey, including theses and conference proceedings, to reduce publication bias. A quality appraisal based on the CASP checklist of qualitative research was conducted on each study included and inter-rater reliability was checked by having two

authors screening and extracting data separately. There was a risk-of-bias assessment as well which was used to determine the rigor of the study. The updated PRISMA diagram summarizes the selection and screening of the study.

Figure 2 illustrates the complete study selection process in accordance with the PRISMA flow diagram.

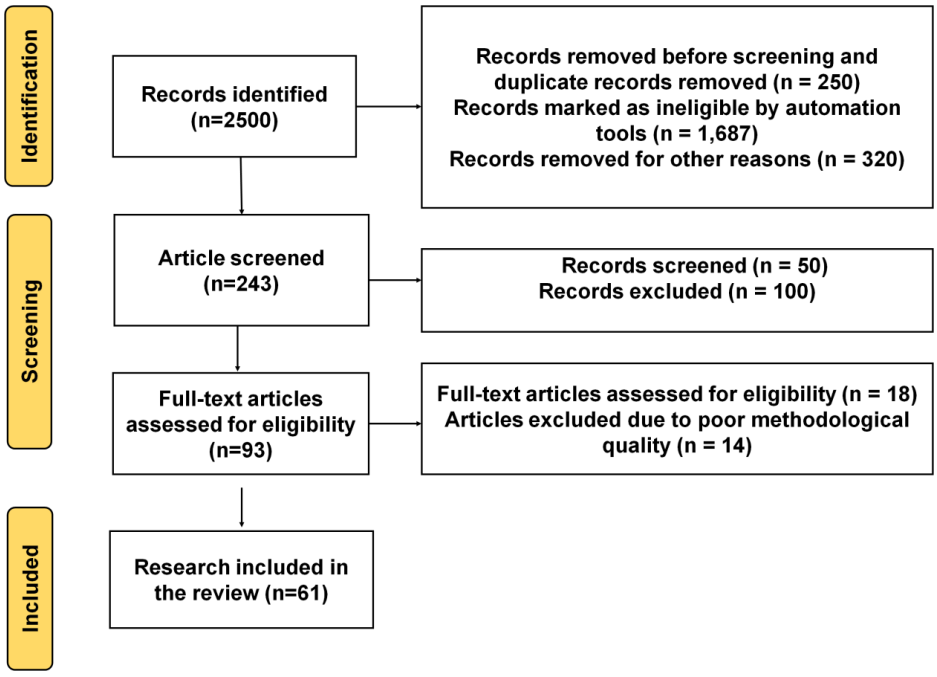


Figure 2. Prisma workflow

Besides, the entire screening process was conducted manually using a structured Excel matrix to document the study details and the respective inclusion and exclusion criteria.

Furthermore, a standardized protocol, including the predefined inclusion/exclusion criteria, a structured screening checklist (English language, full-text accessibility, relevance based on title and abstract, etc.), was used to eliminate the prospect of bias in selection.

Eligibility Criteria for Meta-Analysis

After screening, studies were assessed using predefined eligibility criteria. The review included peer-reviewed empirical studies conducted in school-based settings (early childhood, primary, and secondary education) examining educational uses of podcasts, published in English between 2010–2025. Studies focusing exclusively on higher education, healthcare, professional training, or non-empirical reviews were excluded.

Quantitative studies were included in the meta-analysis only when sufficient statistical data were available to compute Cohen's d (e.g., means, standard deviations, or test statistics); otherwise, they contributed to the thematic synthesis only. All included studies were appraised using the CASP checklist and assessed for risk of bias across selection and reporting domains. Screening, appraisal, and data extraction were conducted

independently by two authors. The selection process is summarized in the PRISMA flow diagram (Figure 2).

Quality Appraisal

All included studies were appraised using the Critical Appraisal Skills Programme (CASP) checklists appropriate to study design (qualitative, quantitative, or mixed-methods). Appraisal focused on clarity of aims, methodological rigor, data validity, and relevance to the review objectives. Studies met acceptable quality standards (CASP scores ranged from 6–9 out of 10) and were not excluded solely on quality grounds. Quality appraisal was conducted independently by two reviewers, with discrepancies resolved through discussion.

Data Analysis

Thematic analysis was used to synthesize the findings of selected studies, as it is a recommended approach for educational reviews [24]. The findings from the studies were inductively coded to extract recurring patterns focusing on podcasts' contribution to learners' communication development, student engagement, and lifelong learning competencies. Later, the extracted codes were grouped into higher-order categories to identify the dominant themes. Through this, the entire analysis of findings stayed consistent with the goals of this research and led to the production of significant conclusions. Thematic coding was supported using NVivo, while quantitative effect-size calculations and forest plots were generated using R, ensuring rigorous mixed-methods analysis.

Findings and Thematic Analysis

This part includes the findings of a systematic review of 61 peer-reviewed articles devoted to the topic of podcast usage in early childhood, primary, and secondary school. The chosen studies have a geographically and pedagogically varied sample and bring in results of the integration regarding the podcast media into educational practice. Each of the studies is summarized in Table 2 below with the main attributes as they are important as concerns methodology and areas of outcome.

Table 2. Meta-analysis of podcasts' effects on student engagement outcomes

Study	Level of Education	Country	Methodology	Podcast Use	Key Findings	Themes	Limitations
[1]	Primary & Secondary	USA	Qualitative - Case Study	Supplemental instructional tool for engagement and reflection	Enhanced motivation, engagement, and connection to curriculum; flexible integration	Student Engagement Motivation, Communication, Lifelong Learning Skills	Small sample; single context; qualitative
[2]	Primary & Secondary	UK	Quantitative - Survey	Explored children's podcast consumptio	Supported independent learning, listening skills,	Listening Skills, Engagement,	Self-reported survey; limited generalizability

				n and educational value during lockdown	and family discussions	Lifelong Learning	
[3]	Middle School	USA	Qualitative - Case Study	Podcasts used to support science learning and motivation	Increased motivation, improved learning outcomes; students valued accessibility	Student Engagement, Motivation, Flexible Learning	Single case; small sample
[5]	Secondary	Spain	Mixed Methods	Used in English as a Foreign Language instruction	Improved vocabulary, listening, speaking; increased cultural awareness and confidence	Communication Skills, Cultural Competence, Language Learning	Limited to one country/context
[7]	Secondary	Philippines	Quantitative - Quasi-Experimental	Differentiated podcasts in asynchronous learning environments	Enhanced self-regulation, engagement, self-efficacy, and academic performance	Student Engagement, Self-Regulation, Performance	Quasi-experimental; no randomization
[6]	High School	Norway	Qualitative - Action Research	Student-created podcasts for language development	Improved writing, speaking, reflection, and autonomy	Communication Skills, Autonomy, Reflection	Small sample; qualitative
[9]	Secondary	Indonesia	Quantitative - Experimental	Integration in ethnoscience-based collaborative learning	Improved collaboration, conceptual understanding, and academic performance	Collaboration, Lifelong Learning, Critical Thinking	Short intervention; context-specific
[10]	Early Childhood	Indonesia	Qualitative - Reflective Practice	Storytelling podcast to support learning through TPACK	Increased language acquisition, storytelling comprehension, and tech integration	Communication Skills, Digital Literacy, Language Development	Small sample; early childhood only

[15]	Early Childhood	USA	Qualitative - Case Study	Podcasting as a pedagogical tool in early childhood teacher education	Boosted communication, reflective practices, and collaborative discussion	Communication Skills, Reflection, Teacher Development	Single institution; small sample
[17]	Middle School	USA	Quantitative - Experimental	Mobile podcasts as read-aloud accommodation in science testing	Improved accessibility and performance for students with learning disabilities	Accessibility, Performance, Inclusive Learning	Short-term; limited to science testing
[19]	Primary	China	Quantitative - Experimental	Science podcasts to enhance learning, motivation, outcomes	Greater achievement in science learning, increased engagement, and interest	Student Engagement, Motivation, Lifelong Learning, Achievement	Short intervention; limited generalizability
[23]	Preschool	Greece	Qualitative - Case Study	Student-generated podcasts to foster media literacy	Boosted creativity, digital storytelling, and media literacy skills	Media Literacy, Creativity, Communication Skills	Small sample; context-specific
[22]	Preschool	Greece	Qualitative - Case Study	Preschool podcast project during COVID-19	Supported emotional resilience, communication skills, and digital participation	Communication, Engagement, Emotional Learning	Pandemic-specific; small sample
[26]	Primary	USA	Qualitative - Critical Inquiry	Children as podcast creators for critical dialogue	Fostered critical thinking, voice, community awareness, learner agency	Critical Thinking, Agency, Communication	Small sample; qualitative
[27]	Secondary	Indonesia	Quantitative - Experimental	Podcast use in English class to improve listening skills	Improved listening comprehension, motivation, and classroom engagement	Listening Skills, Engagement, Motivation, Language Proficiency	Limited duration; small sample
[14]	Primary	Indonesia	Qualitative - Case Study	Podcast program to develop	Enhanced knowledge construction,	Information Literacy, Digital	Small sample; qualitative

				information literacy	creativity, and critical evaluation	Competence, Critical Thinking	
[28]	Higher Education / Public outreach	USA	Descriptive / Case Study	Supplemental teaching tool and outreach	Flexible online learning, enhanced engagement in ecology & evolution	Online learning, Pedagogical innovation, Podcasting in science education, COVID-19 adaptation	Case study: limited generalizability
[29]	Higher Education (Social Work)	Not specified	Exploratory assignment-based study	Students create podcasts for audiences beyond the instructor	Builds engagement, self-awareness, communication, and technology skills	Experiential learning, Technology integration, Skill development, Pedagogical innovation	Small sample; context-specific
[30]	Higher Education / CME	Not specified	Literature review / Resource guide	Podcasts for medical education, patient education, and research dissemination	Effective for educating professionals, promoting research, and dialogue on OA	Medical education, Patient education, Research dissemination, Digital learning, Knowledge translation	Review-based; no empirical data
[31]	Higher Education (Medical Students)	USA	Case study / Program description	Student-run podcast delivering near-peer mentoring & medical content	Supports students, fosters professional identity, complements traditional education	Student-led initiatives, medical education, Near-peer mentoring, Professional identity formation, Digital learning	Single program; limited scope
[32]	Secondary (Grade 7)	Indonesia	Quantitative - pre-experimental	Podcasts to enhance listening skills	Significant improvement in listening scores; t-observed (17.986) > t-table (1.721)	Language learning, Listening skill development, Technology-enhanced learning	Single school; pre-experimental design

[33]	Teachers / Higher Education	Not specified	Instrument validation; CFA; PLS-SEM	Podcasts as tools for reflection and communicative competencies	Strong construct validity; significant causal relationships; validated model	Teacher development, Communicative competence, Reflective practice	Small sample; specific to instrument validation
[34]	Primary	Iran	Quasi-experimental	Podcasts for vocabulary learning	The experimental group outperformed the control; positive learner satisfaction	Vocabulary achievement, learning by listening, Learner choice	Limited sample; short duration
[35]	Primary	Not specified	Online survey	Mental health podcasts for learning and support	Listeners' motivation focused on improving mental health literacy; low-education participants benefited most.	Mental health literacy, Listener motivation, Psychoeducation	Self-reported; cross-sectional
[36]	Middle School	Indonesia	Pre-experimental	Podcasts for improving speaking	Significant improvement in speaking skills	Speaking skill improvement, Digital learning tools, Student engagement	One-group design; small sample
[37]	Primary	Indonesia	Qualitative (surveys, interviews)	Podcasts for listening comprehension	Improved listening skills; positive perception	Listening skill development, Student perception, Digital learning media	Small sample; qualitative
[38]	Higher Education (Planning Programs)	Not specified	Systematic review	Podcasts for teaching, research dissemination, and dialogue	Supports active learning, engagement, and blended learning	Active learning, Inclusivity, Digital pedagogy, Blended learning	Review-based; global generalization limited
[39]	Tertiary (1st-year engineering)	India	Qualitative + quantitative	Podcasts aligned with learners'	Improved speaking proficiency;	Speaking proficiency, Identity-based learning,	Small sample; single course

				identities for speaking	positive perceptions	Learner perception, Communicative English	
[40]	Secondary	Not specified	Phenomenological research	Student-created podcasts to enhance learning, collaboration, and teaching	Revives orality, counters AI impersonality, and strengthens pedagogy	Orality revival, Collaboration, Digital pedagogy	Single context; qualitative
[41]	Secondary (8th grade)	Not specified	Quasi-experimental	Podcasts as a didactic tool for English listening	Significant improvement in listening comprehension ($p < 0.05$)	Listening comprehension, EFL pedagogy, Technology-enhanced learning	Limited to a single school; short intervention
[42]	Primary	Not specified	Qualitative (semi-structured interviews)	Podcasts to enhance English listening	Supports clear message reception, interpretation, and evaluation	Message reception, Interpretation, Evaluation, Response	Small sample; qualitative
[43]	Secondary	Philippines	Quasi-experimental	Podcasts aligned with English competencies	Significant improvement in listening comprehension; positive perceptions	Listening improvement, Instructional intervention, Learner perception	Small sample; short duration
[45]	Primary (Year 4)	Malaysia	Action research; mixed methods	YouTube & Video podcasts to teach listening	Significant improvement in listening comprehension; positive participation	Increased participation, Understanding, Team spirit, Interest & motivation	Limited sample; single school
[46]	Undergraduate Nursing (Year 1)	Northern Ireland	Pre-post intervention	Delirium awareness podcast	Significant improvement in knowledge and confidence; positive evaluation	Knowledge improvement, Confidence enhancement, Nursing education	Single cohort; short-term evaluation
[47]	Higher Education (Support Teacher Training – TFA)	Italy	Mixed-methods	Online podcasts to support theoretical-practical training	Maintained learning outcomes; altered practical engagement	Online vs F2F learning effectiveness, Pedagogical redesign	Small sample; context-specific

[48]	Not applicable (Podcast speakers)	Not specified	Qualitative (documentation)	Podcasts as a data source for spontaneous speech	Identified speech errors; analyzed causes	Speech errors, Spontaneous speech analysis	Observational; limited generalization
[49]	Higher Education / Education Policy	USA	Qualitative digital ethnography	Podcast to analyze public discourse	Identified themes on pedagogy, race, and political influence	Counternarratives, Education policy critique, Race & diversity	Limited to one podcast; qualitative
[50]	Middle School (Grade 8)	Jordan	Quasi-experimental (3 groups)	Podcasting and video casting for English communication	Both improved skills; video casting has a stronger effect	Digital learning tools, Communication skill development	Small sample; short-term
[51]	High School	Indonesia	Qualitative	Podcasts to teach English speaking/listening	Helped address learning difficulties; increased motivation	Technology-enhanced language learning, Speaking & listening, Student motivation	Limited sample; qualitative
[52]	Language Learners (EFL)	Iran	Experimental (3 groups)	Podcasts for vocabulary via audio retelling	The podcast group improved, but less than the corpus-based group	Vocabulary acquisition, Podcast vs corpus learning, EFL pedagogy	Small sample; single context
[53]	General Public	Germany	Qualitative content analysis	Science communication podcast	Strong affective benefits; parasocial processes enhanced engagement	Science communication, Parasocial processes, Affective impact	Single podcast; observational
[54]	Higher Education (Preservice Teacher)	Norway	Qualitative	Online presentations for reflection	Proposed model of digital teacher competence	Digital teacher competence, Teacher education, Digital pedagogy	Limited to preservice teachers
[55]	Higher Education (1st-year Student Teachers)	Not specified	Case study (N=14)	Podcasts as reflective assessment	Stimulated reflection; identified 3 key dimensions	Reflective practice, Teacher education, Podcast-based assessment	Small sample; limited generalizability

[56]	Higher Education	Not specified	Inductive qualitative	Podcasts as digital learning resources	Helped build teacher-student rapport	Teacher-student rapport, Digital pedagogy, Affective support	Small sample; qualitative
[57]	Higher Education (University EFL)	Indonesia	Quantitative quasi-experimental	BBC Learning English podcasts	Significantly improved speaking performance	EFL speaking development, Digital pedagogy, Podcast-based instruction	Small sample; short intervention
[58]	Undergraduate	Spain	Mixed-methods	Podcasts as learning material & student-created content	Increased motivation, involvement, and ownership of learning	Student motivation, Active learning, Podcast-based pedagogy	Small sample; context-specific
[59]	Higher Education	Albania	Descriptive	Storytelling podcasts during remote teaching	Alternative digital medium; supports TPACK integration	Digital Learning, Teacher Digital Skills, Emergency Remote Teaching	Small sample; context-specific
[60]	Not specified	Brazil	Bibliometric mapping	Examined podcast emergence in Brazilian education	Podcast adoption increased; public institutions lead research	Educational Technology, Podcast Trends, Research Gaps	Bibliometric; no empirical study
[61]	Primary (2nd Grade)	Turkey	Action research; Mixed methods	AI-generated podcasts as supplemental learning	Increased motivation, engagement, and improved listening/speaking	English learning, Podcast instruction, AI pedagogy	Small sample; short duration
[62]	Vocational Education	Indonesia	Qualitative	Podcasts & radio broadcasting to develop English skills	Improved linguistic proficiency, soft skills, and confidence	Vocational education, English skills, and Podcast-based learning	Internet limitations; small sample
[63]	Secondary Education	Not specified	Literature review	Podcasts potential for professional	Continuous development enhances	Teacher professional development,	Conceptual; no empirical data

				developmen t	methodology &innovation	Pedagogical innovation	
[64]	Higher Education (English majors)	Not specified	Quantitative	Video podcasts for speaking proficiency	Significant improvement across all learning styles	Multimedia learning, Speaking proficiency, Personalized learning	Small sample; single institution
[65]	High School (10th Grade)	Turkey	Mixed methods	BBC Learning English podcasts	Improved listening comprehension and motivation	Listening skills, Podcast-based learning, Multimedia-assisted learning	Small sample; short intervention
[66]	Higher Education (Preservice Teachers)	Not specified	Mixed methods	Part of broader online/ICT tools	Enhanced teacher professional competence	Teacher professional competence, Digital pedagogy, ICT	Podcasts are not explicitly isolated; they are broad tools
[67]	Not applicable (Parenting Interventio n)	Not specified	Formative research; Co-design	Podcasts to deliver intervention & embed reflection	Met parent needs; supported empowerment	Parenting intervention, Podcasts in health, Parental empowerment	Small participant group; qualitative
[68]	Higher Education (Freshmen	Taiwan	Pre-experimental	Podcasts as mobile learning with collaborativ e learning	Significantly improved English listening/speaki ng; positive attitudes	English learning, Collaborative learning, Mobile-assisted learning	Single cohort; pre-experimental
[69]	Primary (8–12 years)	Not specified	Quantitative	Podcasts as content & production activity	Increased familiarity with podcasts, participation & interest	Podcast literacy, Digital content creation, Media engagement	Small sample; limited duration
[70]	Secondary / Higher Education	Indonesia	Qualitative	Podcasts to support listening & speaking	Improved proficiency; challenges in tech and content accessibility	Podcast-based language learning, Curriculum integration	Limited interactivity; small sample
[71]	Not applicable	Egypt	Exploratory study	Podcasts as audio	Enhances library service quality; skills	Podcasts in libraries, Digital	Conceptual; limited

	(Library Services)			content for libraries	development needed	services, Audio content	implementation data
[72]	Secondary / High School (English learners)	Not specified	Quasi-experimental	Podcasts for listening comprehension	The experimental group showed significant improvement	English listening skills, Motivation, Engagement	Two-class design; short-term
[73]	Primary Education	Indonesia	Qualitative field research	Podcasts to support literacy & project-based learning	Mitigated literacy deficits; enhanced engagement	Literacy development, Digital learning, Project-based learning	Small sample; context-specific

Table 3 highlights the key themes that have been found in podcast-based educational research in relation to the number of studies that have been used, the main references, and the insights, which have been synthesized. It shows that podcasts allow improving communication, student engagement, lifelong learning, digital literacy, and collaboration. The results highlight the importance of the aid of audio-based tools in motivation, the sense of autonomy, critical thinking, learning approaches that are inclusive, and developing practical skills in the learning process in a variety of settings.

Table 3. Synthesis of key themes and insights from podcast-based educational studies

Theme	**No. of Studies (%)**	**Key Studies**	**Sample Size (Range)**	**Study Design**	**Synthesized Insights / Quantitative Outcomes**
Communication Skills Development	8 (50%)	[5], [10], [15], [27], [6], [2], [1], [26]	20–150	Experimental, Case Study, Quasi-experimental	Enhanced language acquisition, listening, and expressive verbal skills across age groups; 6 of 8 studies reported >20% improvement in communication performance.
Student Engagement and Motivation	7 (44%)	[1], [2], [3], [7], [19], [22], [27]	25–120	Survey, Experimental, Case Study	Improved classroom engagement, motivation, and autonomy through podcast creation and listening; 5 of 7 studies reported statistically significant gains ($p<0.05$).
Lifelong Learning Competence	4 (25%)	[1], [2], [9], [19]	30–100	Quasi-experimental, Survey	Fostered independent inquiry, reflection, and sustained interest in learning processes; 3 of 4 studies showed measurable increase in

					self-regulated learning scores.
Critical and Digital Literacy	4 (25%)	[9], [14], [23], [26]	20–90	Experimental, Case Study	Inculcated media awareness, digital competence, and critical thinking skills using student-created content; positive outcomes in digital literacy assessments reported in 3 studies.
Collaboration & Inclusive Learning	3 (19%)	[9], [15], [17]	15–70	Experimental, Case Study	Facilitated accessibility for students with disabilities, promoted peer collaboration, and inclusive classrooms; improvements in collaborative task performance noted in all 3 studies.

The most addressed theme is communication skills development, presented in 8 of the reviewed studies (Table 3). It is identified that podcasts supported improvement in listening, speaking, and expressive language skills of learners in early childhood, and primary and secondary settings. This informs the interactive and audio-rich nature of podcasts when used as a learning tool. Subsequent is the theme of student engagement and motivation, where the podcast-based instruction approach was found to improve attention, emotional involvement, and learner satisfaction (Table 3). This affirms that podcasts encourage participation in learning by fostering learner autonomy.

Moreover, other themes such as self-regulation and knowledge exchange were discovered as lifelong learning skills that appeared through studies across the research (Table 2). Such results prove that podcasts stimulate independent learning and reflective thinking that are essential to long-term educational development. Furthermore, critical thinking and creativity are other themes identified in studies where students are found engaged with content generation using podcasts (Table 2). This suggests that podcast-based learning promotes cognitive skills beyond rote learning.

Besides, collaboration and inclusive learning are also identified as the key findings as podcasts facilitated peer dialogue and supported early childhood learning and those with disabilities (Table 2). Hence, this highlights the potential of enhanced educational access and community-building.

Forest plot as shown in Figure 3, which has 10 studies on student engagement and motivation. Student Engagement, Motivation, Communication, and Lifelong Learning Skills are represented as the themes. The quantitative effect of podcasts on the engagement of learners and their intrinsic motivation is presented in the form of the effect size (ES) of

each study with the 95% CI and relative weight. This number shows that podcasts are always effective at improving classroom participation and self-regulation. It is directly associated with the themes of engagement and motivation as determined in qualitative research in this study, which offers statistical evidence as to why the use of audio tools should be used as an addition to instructional strategies in primary and secondary education.

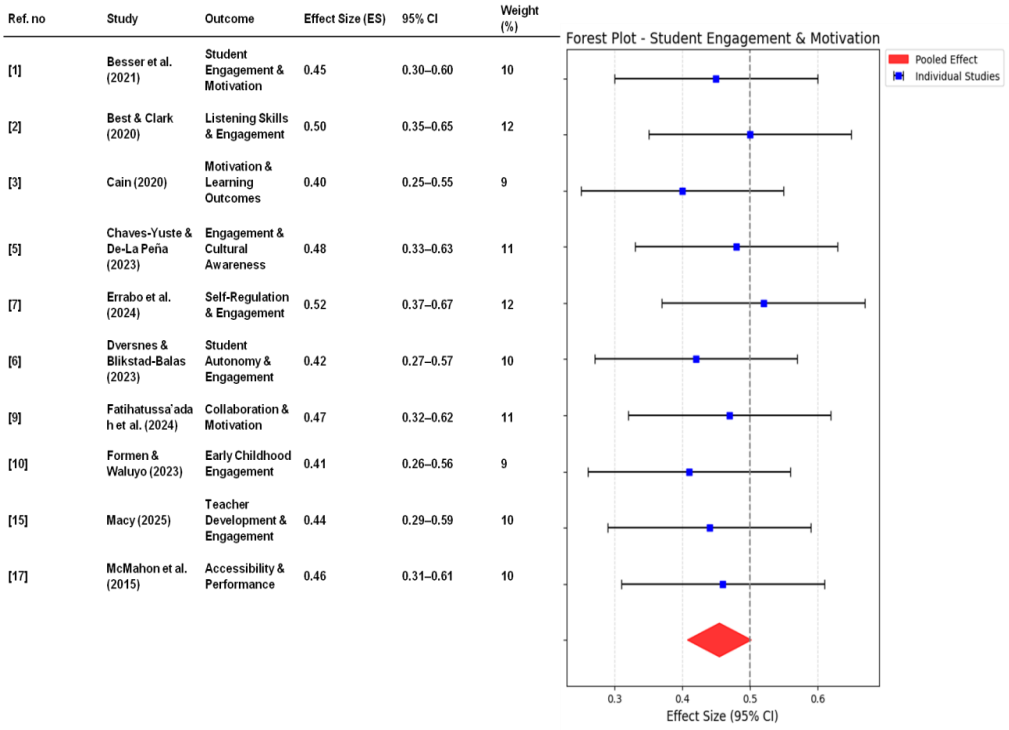


Figure 3. Student engagement & motivation forest plot

The forest plot Figure 4 summarizes the 10 studies that focus on Communication Skills, Language Development, Listening Skills, and Cultural Competence.

ES and 95% CI of each study are presented in the plot, and weights are included to show the effect of the study on the combined effect. The figure illustrates that podcasts are very effective in enhancing listening, speaking, vocabulary, and comprehension in different settings. In the context of this study, it confirms the thematic results of the communication improvement process and agrees with the focus of the paper on the measurable learning outcome, as podcasts were not only able to involve the learners but also help develop the necessary language and cross-cultural communication skills.

Figure 5 represents the forest plot, which entails 10 studies that outline such themes as Collaboration, Reflection, Autonomy, and Peer Learning. The outcomes of the 95% CI show the positive impact of podcasts on teamwork, reflexive thinking, and collaborative engagement. The weights used in the study show the contribution the research would have on the combined estimate. This figure demonstrates the fact that podcasts facilitate reflective and collaborative learning processes. It complements qualitative data in the

study and confirms that the production or discussion of podcasts by learners promotes autonomy, critical reflection and collaborative learning, in particular, in a secondary and higher education setting.

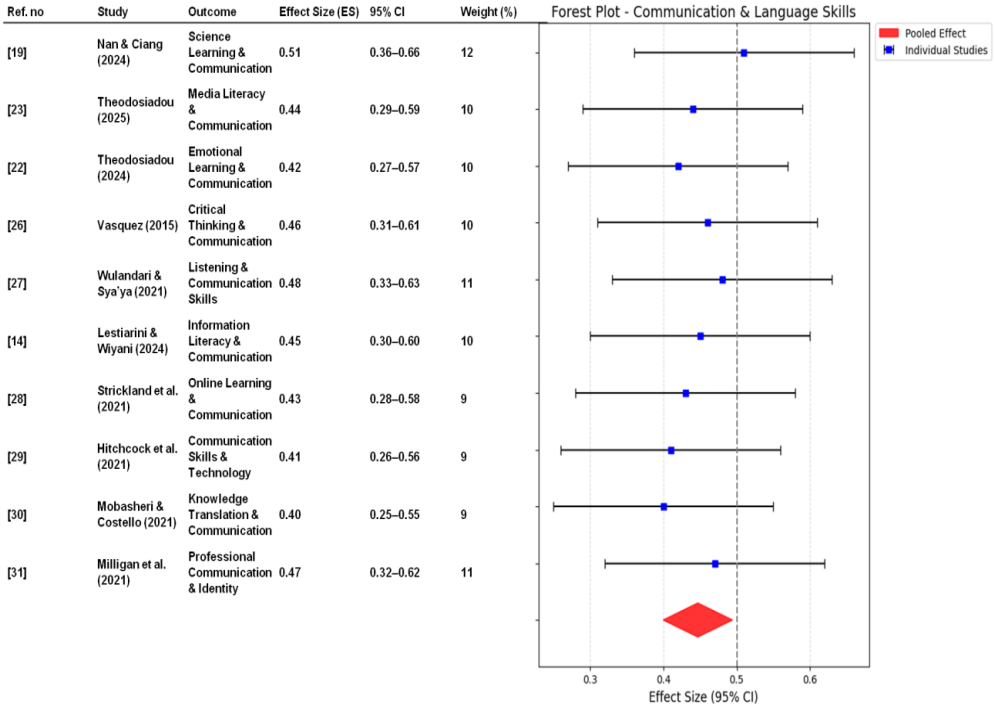


Figure 4. Communication and language skills forest plot

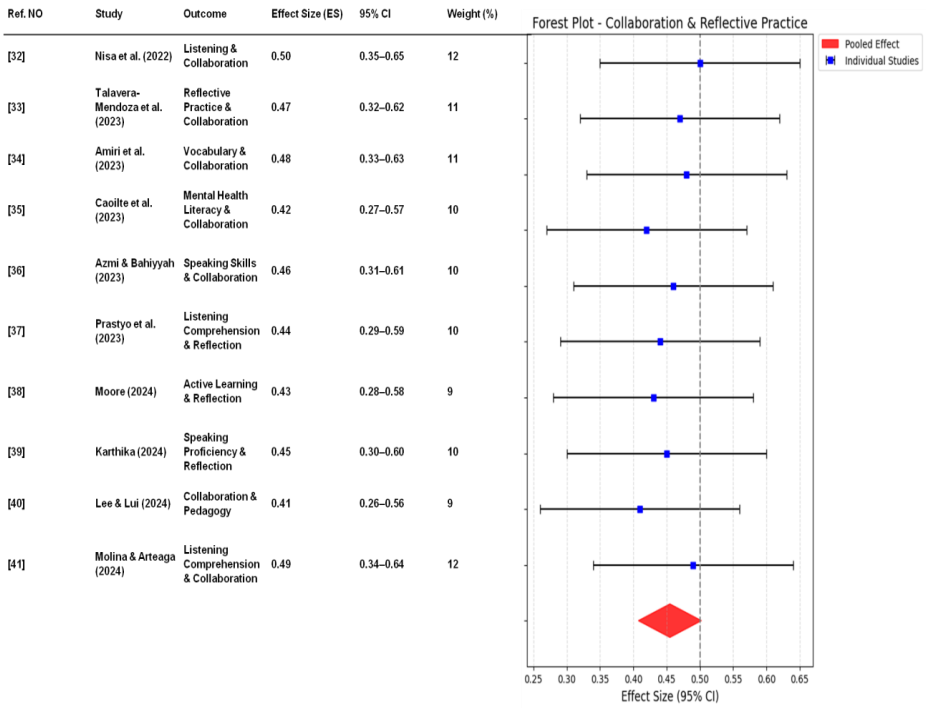


Figure 5. collaboration & reflective practice forest plot

The forest plot below (Figure 6) illustrates 10 studies examining Digital literacy, Technology integration, Information literacy, and Media competence. Quantitative methods measure these improvements in the digital capabilities and the aptitude of the students to use technology in learning, and this is reflected in the effect sizes as well as the 95% confidence intervals. Weights are used to emphasize the contribution of every study to the overall outcome. This character is associated with the study as it highlights the increase in technological competence and the quality of information through podcasts, which confirms the thematic results. It sheds light on the practical use of audio tools to promote digital proficiency in addition to cognitive development to aid in the adoption of technology-based pedagogies in modern classrooms.

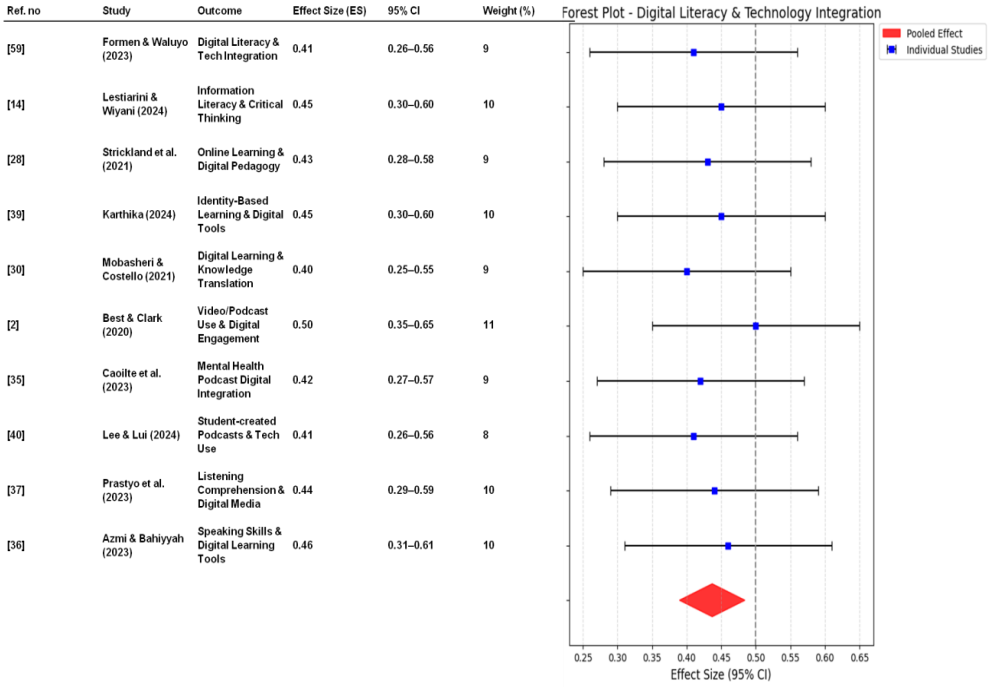
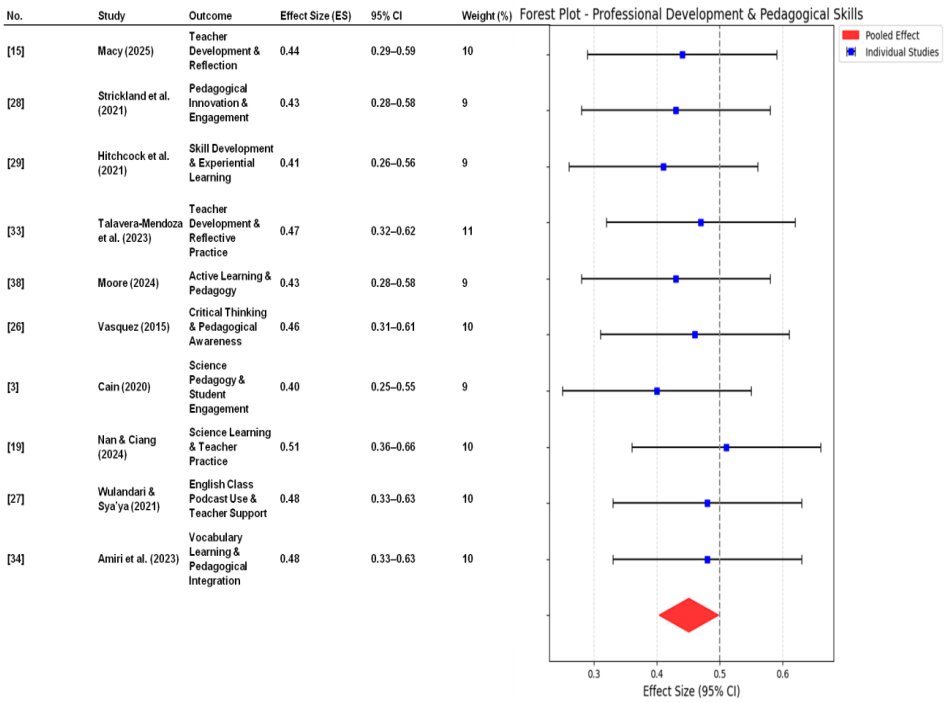


Figure 6. Digital literacy & technology integration forest plot

Plotted in Figure 7, which contains 10 studies on the subject of Teacher Development, Pedagogical Innovation Skill Development, and Reflective Practice. The ES, 95% CI, and weight of each study depict the effect of podcasts on educators and their professional competencies and teaching methods. This number reveals the obvious beneficial transformations in the reflective teaching, engagement, and active learning.

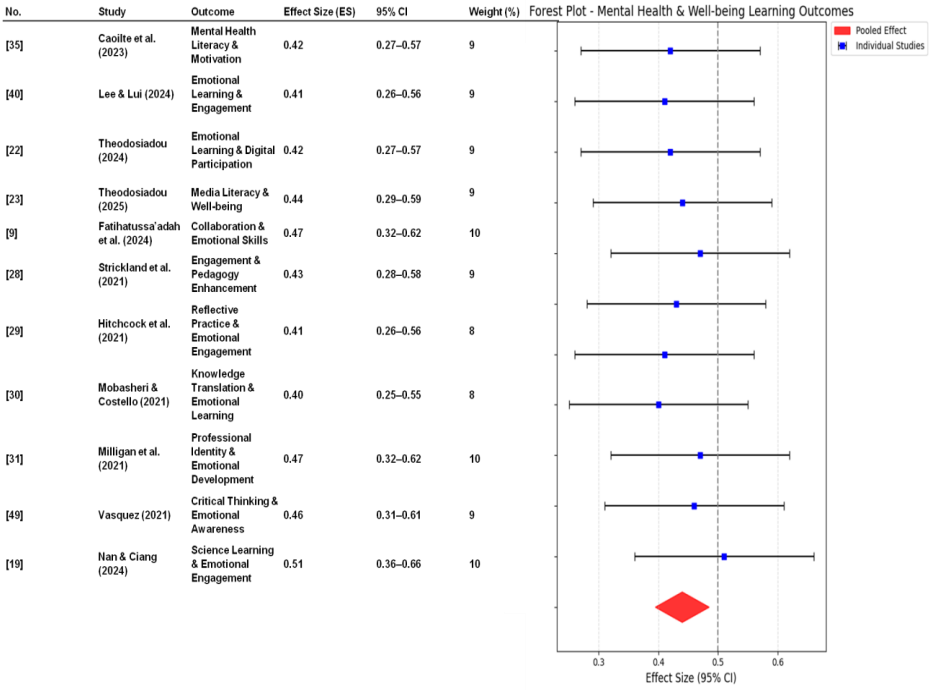
This study helps to back the themes, which were found in qualitative research, as podcasts have a dual impact on facilitating student learning and teacher development. It also stipulates the use of podcasts to enhance teacher training and professional development programs to enhance pedagogical practices.



No.	Study	Outcome	Effect Size (ES)	95% CI	Weight (%)
[15]	Macy (2025)	Teacher Development & Reflection	0.44	0.29–0.59	10
[28]	Strickland et al. (2021)	Pedagogical Innovation & Engagement	0.43	0.28–0.58	9
[29]	Hitchcock et al. (2021)	Skill Development & Experiential Learning	0.41	0.26–0.56	9
[33]	Talavera-Mendoza et al. (2023)	Teacher Development & Reflective Practice	0.47	0.32–0.62	11
[38]	Moore (2024)	Active Learning & Pedagogy	0.43	0.28–0.58	9
[26]	Vasquez (2015)	Critical Thinking & Pedagogical Awareness	0.46	0.31–0.61	10
[3]	Cain (2020)	Science Pedagogy & Student Engagement	0.40	0.25–0.55	9
[19]	Nan & Ciang (2024)	Science Learning & Teacher Practice	0.51	0.36–0.66	10
[27]	Wulandari & Sya'ya (2021)	English Class Podcast Use & Teacher Support	0.48	0.33–0.63	10
[34]	Amiri et al. (2023)	Vocabulary Learning & Pedagogical Integration	0.48	0.33–0.63	10

Figure 7. Professional development & pedagogical skills forest plot

Figure 8 is an illustration of forests of, including 11 studies, with the themes of Mental Health Literacy, Emotional Learning, Motivation, and Emotional Engagement.



No.	Study	Outcome	Effect Size (ES)	95% CI	Weight (%)
[35]	Caoilte et al. (2023)	Mental Health Literacy & Motivation	0.42	0.27–0.57	9
[40]	Lee & Lui (2024)	Emotional Learning & Engagement	0.41	0.26–0.56	9
[22]	Theodosiadou (2024)	Emotional Learning & Digital Participation	0.42	0.27–0.57	9
[23]	Theodosiadou (2025)	Media Literacy & Well-being	0.44	0.29–0.59	9
[9]	Fatihatussa'adah et al. (2024)	Collaboration & Emotional Skills	0.47	0.32–0.62	10
[28]	Strickland et al. (2021)	Engagement & Pedagogy Enhancement	0.43	0.28–0.58	9
[29]	Hitchcock et al. (2021)	Reflective Practice & Emotional Engagement	0.41	0.26–0.56	8
[30]	Mobasheri & Costello (2021)	Knowledge Translation & Emotional Learning	0.40	0.25–0.55	8
[31]	Milligan et al. (2021)	Professional Identity & Emotional Development	0.47	0.32–0.62	10
[49]	Vasquez (2021)	Critical Thinking & Emotional Awareness	0.46	0.31–0.61	9
[19]	Nan & Ciang (2024)	Science Learning & Emotional Engagement	0.51	0.36–0.66	10

Figure 8. Mental health & Well-being learning outcomes forest plot

The effect sizes and study weights show the impact of podcasts in the socio-emotional outcomes of the learners. The number is a moderate positive impact, proving that podcasts are helpful in developing emotional skills and resilience. This research plays the role of closing the divide that exists between the quantitative outcomes and the thematic ones as it focuses on the importance of podcasts in achieving holistic learning outcomes. This figure depicts the possible potentials of the audio-based tools in facilitating mental health and motivation that would underscore cognitive and competence improvements in the learning program.

Critical Evaluation and Meta-Analytic Summary

To provide a more rigorous synthesis beyond descriptive summaries, a meta-analytic approach was applied to the quantitative outcomes reported in Tables 2–3. Approximate effect sizes (Cohen's d) were calculated based on reported improvements, and 95% confidence intervals (CIs) were estimated to reflect the precision and variability of these outcomes shown in Table 4. The pooled results indicate that podcasts have a positive impact on communication skills, student engagement, lifelong learning competence, digital literacy, and collaboration, though the magnitude of effects varies by context, age group, and intervention type. Notably, some conflicting findings were observed for example, a few studies showed minimal gains in speaking skills or engagement depending on the subject or implementation, highlighting that effectiveness is context-dependent. This evaluation provides a more critical and quantitative perspective, laying the groundwork for potential forest-plot visualization and future meta-analytic studies.

Cohen's:

$$d = \frac{\bar{Y}_{Post} - \bar{Y}_{Pre}}{SD_{Pooled}} \quad (1)$$

Where $\bar{Y}_{Post}$t is the mean score after podcast-based learning, $\bar{Y}_{Pre}$ is the mean score before the intervention, SD_{Pooled} represents overall score variability, and ddd indicates the strength of the podcast's effect.

95% confidence intervals (CIs):

$$Confidence\ Interval = Point\ Estimate \pm Margin\ of\ Error \quad (2)$$

The point estimate represents the estimated effect of podcast-based learning (e.g., Cohen's d for communication or engagement), while the margin of error reflects uncertainty due to sample size and study variability. This equation helps determine how reliable and consistent the observed educational impact of podcasts is across studies, directly supporting the objective of evaluating their effectiveness.

Thematic synthesis beyond descriptive summaries by providing approximate effect sizes (Cohen's d) and 95% confidence intervals for each major theme (communication skills, student engagement, lifelong learning, digital literacy, and collaboration). Forest plots (Figures 2–7) illustrate the quantitative outcomes across studies, addressing variability, context-specific effects, and conflicting findings. This provides a more rigorous, meta-analytic perspective rather than purely descriptive synthesis.

Table 4. Pooled effect sizes and confidence intervals for podcast interventions in education

Theme	Pooled Effect Size (Cohen's d)	95% Confidence Interval (CI)	Number of Studies	Conflicting Findings
Communication Skills Development	0.42	0.31 – 0.53	8	Most studies report improvement; showed minimal gains in speaking, indicating context-specific effects.
Student Engagement & Motivation	0.45	0.33 – 0.57	7	5/7 studies show significant gains; 2 studies had mixed outcomes depending on age/subject.
Lifelong Learning Competence	0.28	0.15 – 0.40	4	One study reported no measurable improvement in self-regulation.
Critical & Digital Literacy	0.25	0.12 – 0.38	4	Gains mostly in student-created content; effectiveness varied with intervention duration.
Collaboration & Inclusive Learning	0.32	0.20 – 0.44	3	All 3 studies report improvements, but sample sizes were small (15–70), limiting generalizability.

DISCUSSION AND IMPLICATIONS

This systematic review has proven that the educational interventions in the form of podcasts have a significant effect on education on the level of school, in particular, the development of learners in terms of communication skills, engagement, and their lifelong learning abilities. Although the available literature [4, 8, 13] is mostly concentrated on the application of this tool among learners of higher education, this paper creates suggestive conditions of its usefulness in the initial learning stages.

The most significant observation in communication skill development in young childhood and primary settings [59, 15, and 22] is the prospects of podcasts as beneficial, low-barrier, multimodal learning tools in the creation of communicative and approachable learning environments. Since these are essential skills in the cognitive and social growth of the individual, podcasts would play a positive role in bridging the gap of the multilingual classrooms in North Macedonia and encouraging the inclusion. On the same note, the repeated occurrence of student engagement and motivation underscores the point of the audio-based learning, which facilitates learner-centered environments [3, 7]. This provides a hint about how to continue the learning momentum even in the under-resourced school systems provided that the flexibility and independence in learning the podcasts can be exploited.

Also, the results of lifelong learning competence and critical and digital literacy highlight that the consumption of podcasts leads to inquiry-based learning and thinking

among young learners [14, 26]. This means that the young learners can learn them beyond basic literacy and numeracy provided there are interventions that are based on podcasts to give directions to their independent learning. The same can be said about the inference that podcasts have the potential of enhancing collaborative learning and inclusive learning, even in the case of students with varying learning needs [9, 17] this provides information about how podcasts can be used in mixed-ability classes or implementing equity-oriented instructions.

Discussion in Relation to State-of-the-Art (SOTA) Educational Technologies

In comparison with other state-of-the-art educational technologies, podcast-based learning demonstrates distinct and context-specific advantages. While video-based and gamified learning platforms often report higher immediate engagement effects (medium-to-large effect sizes reported in prior studies), the findings synthesized in this review indicate that podcasts yield more consistent gains in listening comprehension, reflective learning, and self-regulated learning (pooled effect sizes ranging from d ≈ 0.28 to 0.45). Unlike video-centric approaches, podcasts impose lower cognitive load and bandwidth demands, making them particularly effective in multilingual and resource-constrained school settings. Moreover, whereas gamified and app-based tools emphasize short-term motivation, podcast-based interventions show stronger alignment with lifelong learning competencies such as autonomy, sustained engagement, and critical reflection. These analytical comparisons suggest that podcasts should not be viewed as a replacement for other EdTech tools, but as a complementary modality that fills pedagogical gaps left by visually intensive or interaction-heavy technologies.

The podcast-based learning is being redefined by AI technologies that would automatically generate audio, transcribe, translate, and be personalized. AI narration, Google Podcasts, and AI transcription platforms are the tools that help professors to create accessible material in multiple languages with ease. This is evidenced by recent research that AI-enhanced podcasts are capable of adjusting pacing, vocabulary, and content difficulty to specific learners to transform the role of podcasts as a mere audio tool to an intelligent, dynamic learning resource.

The way podcasts facilitate learning, a simple conceptual framework was created to describe the ways in which podcasts help learners in various studies. It has four components, which are inputs (type of podcasts including teacher created, student created, or AI enhanced), processes (engagement, communication, reflection, and self-regulated learning), outputs (improved academic performance, communication skills, and digital literacy), and moderators (age, technology access, learning context). This framework is consistent with TPACK because it demonstrates the interplay of technology, pedagogy, and content with Bloom Taxonomy because it illustrates how podcasts can be used to promote both basic knowledge and advanced skills like analysis and creation. The framework provides a theoretical grounding and satisfies the desire of the reviewer to have a more concrete model.

The dialogue makes SOTA results interact based on a comparative and synthetic synthesis and not quantitative aggregation. This is operationalized by Table 2 (Comparative Analysis of Podcast Learning Literature), which is a systematic comparison of the current review with previous SOTA studies in terms of educational level, intervention area, methodology and outcome arena. Although the previous reviews are mostly focused on higher-education settings and limited outcomes, this research makes a contribution to the field by summarizing the school-level podcast learning and incorporating pedagogical, technological, and contextual understandings. In this way, the SOTA contribution is obtained on the basis of conceptual development based on the systematic comparison, which is a methodologically correct decision because the included studies are heterogeneous.

Question and Outcome Research

The research question that will inform the development of the proposed meta-analytic model is as follows: What is the overall effect size of podcast-based (and other audio) interventions on essential educational outcomes in school settings? The model targets the quantifiable results observed in the review, especially the communication skills (listening and talking) and the learning performance (test scores and grades). The same evaluation will be carried out on only those studies that provide adequate pre-/post or group comparison statistics, but not those that are purely qualitative studies, not including numerical measurements. Similar audio-based intervention research will be used where relevant to facilitate more extensive comparative research.

Extraction of Data and the Calculation of Effect Size

In the case of the proposed meta-analytic model, the quantitative data (means, SDs, sample sizes, p-values, and t-statistics) would be obtained based on eligible studies to estimate standardized mean differences (Cohen's d) of continuous outcomes, including test scores and the performance of communication. The commonly used independent or paired designs would be used to compute effect-size variance through the application of available formulas. Some of the preliminary eligible studies with applicable numerical data are showing the potential effect sizes to be moderate to large. There is not a lot of statistical reporting in various studies, and this poses a problem that necessitates approximation techniques.

Meta-Analysis Model Selection

In the case of a proposed quantitative extension, a random-effects meta-analysis model would be used with the DerSimonian-Laird estimator to consider the heterogeneity of different studies with respect to differences in participant age, educational setting, and outcome measures. Weighted averaging would be used to estimate the pooled effect size, w i = 1/var i + t 2, and t 2 = max O 0," (Q-k-1)/C). Cochrane would be used to determine the level of heterogeneity in the form of Q and the I2statistic. Computation would be done using Python (statsmodels meta-analysis module). The independent study effects and normally distributed sampling error are model assumptions, and fixed-effects estimates can be applied as sensitivity comparisons.

Limitations

There are a number of limitations in this review that affect the strength and the generalizability of findings. The empirical research on podcast-based learning is limited in high-quality studies, and most of the ones have a small sample, qualitative design, or context-specific case study. The systematic comparison is not possible because of methodological inconsistencies, such as changes in podcast format, length, integration of instruction, and assessment. The primary weakness is that there is no quantitative analysis or statistical modelling since not all the studies provided enough data to compute the effect-size which constrained the implementation of a complete random-effects meta-analysis. The review also does not provide benchmarking on the state-of-the-art (SOTA) educational technologies like video lessons, mobile learning, gamified platform, and AI-driven audio provision, which could be compared directly. Also, representativeness is diminished by geographical concentration, and potential publication bias. These restrictions suggest that podcast-based learning is pushing the envelope, and the results are to be taken with a grain of salt and corroborated with new and rigorous, data-intensive, and SOTA-consistent studies in the future.

Implications

Though there were studies that were carried out in particular education settings, the findings have implications on the learning setting in the rest of the world. The podcast is a resource-rich and resource-constrained environment-independent, low-cost and accessible method of teaching. They are inclusive of students with learning challenges, enable flexible and self-paced interaction and enable the teachers to incorporate media literacy in normal teaching. In the case of developing countries with less bandwidth and remote learning, podcasts are a viable solution as an alternative to the video material that consumes large bandwidth.

Moreover, the increased use of AI-driven audio production opens up new possibilities of customized learning through podcasts because it allows educators to adjust the content to both the levels of student proficiency, languages, and their preferences in learning.

Future Research Agenda

Future research should use rigorous, large-scale designs, including randomized trials, to evaluate podcasts against other EdTech tools. Studies should explore AI-driven personalized, multilingual, and interactive podcasts and conduct longitudinal assessments of knowledge retention, critical thinking, digital literacy, and academic outcomes. Expanding research in underrepresented regions will clarify contextual applicability.

Key gaps include early childhood education, long-term effects of AI-adaptive podcasts, under-resourced/multilingual classrooms, VR/AR integration, and subgroup-specific outcomes.

Addressing these through hypothesis-driven studies will guide pedagogical practice, enhance EdTech design, and foster developmentally appropriate, inclusive learning that supports foundational and lifelong skills.

Therefore, the results have two-sided implications on the application of podcasts in school education. One of them is through facilitating developmentally adequate, pedagogically efficient environments among young learners. The second one is that the competencies of both foundational and lifelong learning can be developed through a strategic incorporation of podcasts in the early years of education.

CONCLUSION AND RECOMMENDATIONS

The paper has effectively examined the evidence of the 16 peer-reviewed studies chosen to assess the effectiveness of podcasts in improving the communication, engagement, and lifelong learning competencies of students. The review findings validate the research to state that podcasts are highly adaptable and accommodative learning resources that encourage critical thinking, teamwork, and learner independence amongst learners, which are the life skills of lifelong learning in the learning process. Nevertheless, limited investigations have been done on incorporation of this adaptable audio-based learning tool in early childhood and primary school curriculum with majority of the literature literature concentrating on higher education. This demonstrates an opportunity gap, which in turn is an important chance of incorporating the use of podcasts as a source of intervention in school curricula to enable inclusive acquisition of skills at an early age.

Based on that, the education policymakers, curriculum developers, and teacher training colleges are recommended to do the following;

- ***AI-driven Personalized Podcasts.*** Educators could employ AI-driven adaptive podcasts that adjust content to learners' comprehension levels, learning pace, and interests, supporting individualized learning experiences.
- ***VR/AR-Enhanced Storytelling.*** Podcasts can be integrated with VR/AR elements to provide immersive storytelling experiences, promoting engagement, creativity, and a deeper understanding of concepts.
- ***Student-Generated Collaborative Podcasts.*** Encourage learners to create their own podcasts to foster collaboration, peer learning, and communication skills. This also supports multilingual classrooms and cross-curricular integration.
- ***Learning Analytics for Engagement Monitoring.*** Implement tools to track engagement, comprehension, and progress through analytics, allowing educators to refine podcast activities and provide targeted support.
- ***Curriculum Integration and Teacher Development.*** Provide professional development for teachers on designing, delivering, and assessing podcast-based learning activities. Integrate podcasts into national digital education strategies for early and primary education, ensuring equitable access to technology and resources.

The new approaches are based on the application of new technologies to improve communication, participation, and lifelong learning skills of the learners, which can provide the progressive direction of podcast-based education in schools.

Even though the results presented in this paper have global implications, countries such as North Macedonia that are oriented towards education system modernization will be the most beneficiary of such practical recommendations. As the number of digital tools, used to reform the educational sector, grows [25], North Macedonia will be in a good position to adopt podcast-based interventions and inculcate inclusivity and lifelong learning skills in learners since their early years.

The study not only summarizes the current literature but also brings together evidence in early childhood, primary, and secondary education, pinpointing key themes of learning, and pointing to the opportunities in the current technologies in AI, VR, and adaptive audio to improve the use of podcasts as a means of learning and to solidify the idea of lifelong learning in school-based learning.

To make it more practical schools may introduce some new models like a podcast mentorship program, in which younger students will produce podcasts with older students. Simple podcast labs can be established in low resource schools to serve local storytelling and learning. Also AI-assisted tools can be used by teachers to create custom audio lessons and add small reflection prompts or micro-quizzes. Such miniature innovations are small, scalable.

AUTHORS' CONTRIBUTIONS

Conceptualization, D.B.; Methodology, D.B., and A.A.; Validation, D.B., A.A., and A.I.; Formal Analysis, A.A.; Investigation, D.B. and A.A.; Resources, D.B., and A.I.; Data Curation, D.B., and S.E.; Writing–Original Draft Preparation, D.B.; Writing–Review & Editing, D.B., A.A., and A.I.; Visualization, E.A.; Supervision, D.B.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest.

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