Lex localis - Journal of Local Self-Government
Vol. 22, No. 4, pp. 65-82, December 2024

Personalized Meditation Music Recommendation Based on Emotion Assessment: Application Research in Online Music Education

LEI DONG[1*], PUTU KERTI NITIASIH[2], I GEDE BUDASI[3], PUTU NANCI RIASTINI[4]
1 Universitas Pendidikan Ganesha, Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia
2 Universitas Pendidikan Ganesha, Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia
3 Universitas Pendidikan Ganesha, Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia
4 Universitas Pendidikan Ganesha, Jl. Udayana No.11, Banjar Tegal, Singaraja, Kabupaten Buleleng, Bali 81116, Indonesia
undiksha_donglei@sina.com [1*]
kertiniasih@undiksha.ac.id [2]
gede.budasi@undiksha.ac.id [3]
putunanci.riastini@undiksha.ac.id [4]
(Corresponding author): Lei Dong

Abstract Background: The rapid transition to online education has created significant challenges in supporting students' emotional well-being, particularly for music education students who require emotional expression and collaborative engagement difficult to replicate in digital environments. Current one-size-fits-all

interventions fail to address individual differences in emotional states and learning preferences.

Purpose: This study investigates the effectiveness of a personalized meditation music recommendation system based on real-time emotion assessment in online music education, examining its impact on university students' self-regulation capabilities and emotional well-being.

Methods: A mixed-methods quasi-experimental design was employed with 72 undergraduate music majors over 8 weeks. Participants were randomly assigned to experimental (n=36) and control (n=36) groups. The experimental group received personalized music recommendations through a three-layer mapping system based on daily PANAS-SF assessments, while the control group accessed fixed meditation playlists.

Results: The experimental group demonstrated significant improvements in emotion regulation ($t=4.23$, $p<0.001$), with self-regulation scores increasing from $M=3.42$ to $M=4.56$ ($d=1.38$). Qualitative analysis revealed themes of emotional validation, enhanced autonomy, and meta-cognitive awareness. 85% of participants reported improved learning focus, with voluntary engagement exceeding minimum requirements by 93%.

Conclusion: Personalized meditation music recommendations based on emotion assessment effectively enhance self-regulation and emotional well-being in online music education contexts, offering an accessible, low-cost solution for institutional implementation.

Keywords: • emotion assessment • personalized music recommendation • online music education • self-regulation • mixed-methods research • digital well-being

1 Introduction

The rapid transition to online education during the COVID-19 pandemic has fundamentally transformed the landscape of higher education, revealing critical challenges in supporting students' emotional well-being and engagement in digital learning environments (Chandra, 2021; Chen et al., 2024). Research demonstrates that the absence of face-to-face interaction and traditional classroom cues has created significant barriers to emotional connection and support, with students experiencing increased levels of anxiety, isolation, and difficulty maintaining focus during online learning sessions (Stolba et al., 2024; Vistorte et al., 2024). The integration of emotion-aware technologies and personalized support systems has emerged as a crucial need, as educators struggle to identify and respond to students' emotional states through digital platforms, while students report feeling disconnected from both instructors and peers in virtual learning spaces (Liu & Zhou, 2024; Yin et al., 2024).

Music education students face particularly unique challenges in distance learning environments, as the discipline requires not only cognitive engagement but also emotional expression, collaborative performance, and nuanced auditory feedback that are difficult to replicate in online settings (Li & Wang, 2024). The emotional domain becomes especially critical for music students who must manage both academic demands and performance-related stress, with research indicating that successful musical development depends heavily on emotional intelligence and the ability to regulate performance anxiety (Moreno-Fernandez et al., 2020). Studies have shown that music students learning remotely experience heightened feelings of isolation and technical frustration, as traditional one-on-one instruction and ensemble participation—fundamental components of music education that foster emotional connection and social bonding—become challenging to maintain through digital platforms (Crawford, 2017; Duffy & Healey, 2017).

Current approaches to supporting student emotional well-being in online education often rely on generic, one-size-fits-all interventions that fail to account for individual differences in emotional states, learning preferences, and cultural backgrounds (Sethi & Jain, 2024). While research has established the effectiveness of music-based interventions for emotional regulation and stress

reduction, with studies showing significant improvements in mood, anxiety levels, and academic engagement when students have access to personalized musical support (Zhang et al., 2022), the implementation of such interventions remains limited by technological constraints and lack of systematic frameworks for matching musical content to individual emotional needs (Bradt et al., 2016; Somu & Ashok Kumar, 2024). The development of emotion assessment tools and personalized recommendation systems represents a promising direction for addressing these limitations, as evidence suggests that tailoring musical interventions to students' real-time emotional states can enhance both learning outcomes and psychological well-being in online educational contexts (Yin et al., 2024).

2 Literature Review

Self-regulation theory, as conceptualized by Bandura (1986), provides a foundational understanding of how individuals monitor, evaluate, and modify their emotional states and behaviors to achieve desired outcomes, with recent research demonstrating its particular relevance in digital learning environments where students must autonomously manage their emotional engagement and learning processes (Chang et al., 2022). The theory's emphasis on goal-setting and emotion management becomes especially salient in online educational contexts, where the absence of traditional classroom structures requires heightened self-regulatory capabilities, as evidenced by studies showing that resilience and self-regulated learning efficacy significantly predict online learning emotional engagement among university students during periods of remote instruction (Zhi & Derakhshan, 2024). Contemporary applications of self-regulation theory in educational technology have expanded to incorporate emotion-aware systems and personalized interventions, with research indicating that students who develop stronger self-regulatory skills through systematic emotion monitoring and management demonstrate improved academic outcomes and psychological well-being in digital learning environments (Han et al., 2020).

The emotion coping theory articulated by Lazarus and Folkman (1984) offers complementary insights into how individuals appraise and respond to emotional stressors through various coping strategies, with mounting evidence suggesting that music-based interventions serve as particularly effective tools for emotion regulation and stress management in educational settings (Peters et al., 2024; Saarikallio & Erkkilä, 2007). Research has identified that emotion regulation involves both automatic and controlled processes, with cognitive reappraisal and mindfulness-based approaches emerging as key strategies that can be enhanced through targeted musical interventions, particularly when these interventions are matched to individuals' specific emotional states and regulatory needs (Chiesa et al., 2013; Grecucci et al., 2020). The integration of emotion coping theory with music-based interventions has demonstrated promising results in educational contexts, where students utilizing personalized music for emotion regulation report enhanced mood, motivation, and concentration, suggesting that the strategic use of music can facilitate both immediate emotional relief and longer-term development of adaptive coping skills (Chin & Rickard, 2012; Vigl et al., 2023).

Uses and gratifications theory provides a crucial lens for understanding how individuals actively select and utilize media, including music, to fulfill specific psychological and social needs, with recent studies revealing that purposive value, entertainment value, social enhancement, and maintaining interpersonal connectivity serve as primary motivations for media engagement in educational contexts (Bhatiasevi, 2024). The application of this theoretical framework to music selection and consumption patterns among university students reveals that learners deliberately choose musical content based on their immediate emotional needs and desired affective outcomes, with personalized music recommendations showing greater effectiveness than generic playlists in achieving emotion regulation goals (Baltazar & Saarikallio, 2016; Tan et al., 2024). This user-centered perspective aligns with contemporary approaches to educational technology design, where the recognition of individual differences in media preferences and emotional needs has led to the development of more sophisticated, rule-based recommendation systems that can dynamically match musical content to users' emotional states and regulatory objectives, thereby enhancing both

engagement and well-being outcomes in online learning environments (Van Goethem & Sloboda, 2011).

3 Methodology

3.1 Research Design

This study employs a mixed-methods quasi-experimental design integrating quantitative and qualitative approaches to comprehensively examine the effectiveness of personalized meditation music recommendations based on emotion assessment. The quantitative component utilizes a pre-test post-test control group design, enabling systematic comparison of emotion regulation abilities and self-regulation skills between participants receiving personalized music recommendations and those accessing fixed meditation playlists. Complementing the quantitative data, semi-structured user experience interviews provide rich insights into participants' subjective experiences, technology acceptance factors, and perceived value of the personalization features. The 8-week intervention period allows sufficient time for participants to develop familiarity with the system while capturing both immediate and sustained effects on emotional well-being, with data collection points strategically positioned to measure baseline characteristics, process variables during the intervention, and post-intervention outcomes across multiple dimensions of student well-being and academic engagement.

3.2 Participants

The study targets a sample of 72 undergraduate music majors equally allocated between experimental and control groups, recruited through purposive sampling from music departments at two universities and existing online music education platform user bases. Inclusion criteria encompass enrollment in undergraduate music programs, demonstrated experience with online learning modalities, and voluntary participation confirmed through written informed consent procedures. This dual recruitment strategy ensures representation of both traditional

institutional learners and digitally-engaged students who actively utilize online music education resources, thereby enhancing the generalizability of findings across diverse learning contexts while maintaining feasibility constraints typical of educational intervention research conducted within academic settings.

3.3 Personalized Recommendation System Design

The personalized recommendation system employs a streamlined three-layer mapping architecture designed to balance technological sophistication with practical implementation constraints in educational settings. The emotion assessment layer utilizes the abbreviated PANAS-SF instrument comprising 10 items, requiring approximately five minutes for completion and featuring automated scoring algorithms to generate real-time positive affect (PA) and negative affect (NA) scores. The music categorization layer maps emotional states to four distinct musical collections: deep relaxation tracks for high negative affect states (PA<30, NA>40), mood enhancement selections for low positive affect conditions (PA<40, NA>30), balance regulation music for equivalent affective states (PA≈NA), and state maintenance pieces for optimal emotional conditions (PA>50, NA<30), with each category containing 15 carefully curated compositions selected based on tempo, harmonic structure, and instrumentation characteristics. The recommendation logic layer implements rule-based algorithms through IF-THEN conditional statements that match current emotional profiles to appropriate musical categories, generating three daily recommendations while incorporating user autonomy through skip functionality, as illustrated in Figure 1, which demonstrates the systematic flow from emotion assessment through categorization to personalized music delivery.

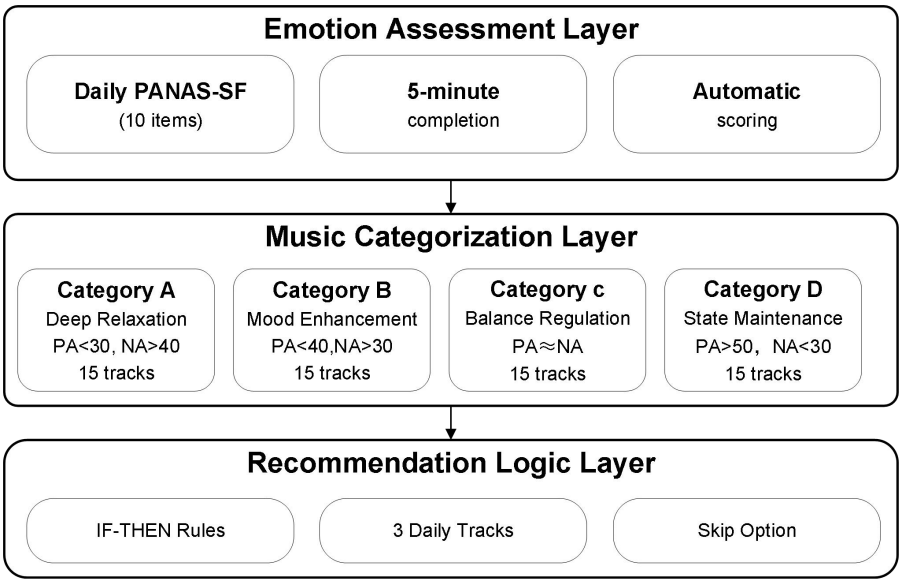

Figure 1: Three-Layer Personalized Music Recommendation System Architecture

3.4 Data Collection

The data collection protocol encompasses both quantitative and qualitative measures administered across three distinct phases to capture comprehensive insights into participants' emotional experiences and system interactions. During the initial week, baseline assessments include the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003), Self-Regulation Questionnaire (SRQ; Brown et al., 1999), and PANAS scores to establish pre-intervention emotional and regulatory profiles. Throughout the six-week intervention period (weeks 2-7), continuous process data collection involves daily emotion assessments using the PANAS-SF, automated music usage logs capturing listening frequency and duration, and weekly brief feedback forms soliciting participant reflections on their experiences. The post-intervention phase (week 8) incorporates repeated administration of all baseline measures alongside the System Usability Scale (SUS; Brooke, 1996) to evaluate perceived system effectiveness and user satisfaction.

Qualitative data collection employs semi-structured interviews with 20 participants, three focus groups comprising 6-8 participants each, and voluntary usage experience diaries, providing rich contextual understanding of user experiences and system engagement patterns, as detailed in Table 1, which presents the comprehensive data collection framework including timing, instruments, and analytical approaches.

Table 1: Comprehensive Data Collection Framework

Phase	Week	Data Type	Instrument/Method	Variables Measured	Sample Size	Analysis Method
Pre-test	1	Quantitative	ERQ (10 items)	Cognitive reappraisal, Expressive suppression	N=72	Descriptive statistics, t-tests
Pre-test	1	Quantitative	SRQ (63 items)	Self-regulation capacity across domains	N=72	Factor analysis, reliability testing
Pre-test	1	Quantitative	PANAS (20 items)	Baseline positive/negative affect	N=72	Mean scores, group comparisons
Process	2-7	Quantitative	Daily PANAS-SF	Emotion fluctuations (PA/NA scores)	N=72 × 42 days	Growth curve modeling
Process	2-7	Quantitative	Usage logs	Listening duration, track selections, skip rates	Automated	Frequency analysis, patterns
Process	2-7	Mixed	Weekly feedback	User satisfaction, perceived benefits	N=72 × 6 weeks	Content analysis, ratings
Post-test	8	Quantitative	ERQ, SRQ, PANAS	Change scores from baseline	N=72	Repeated measures ANOVA
Post-test	8	Quantitative	SUS (10 items)	System usability, acceptability	N=72	Usability benchmarking

Phase	Week	Data Type	Instrument/Method	Variables Measured	Sample Size	Analysis Method
Post-test	8	Qualitative	Semi-structured interviews	User experiences, barriers, facilitators	n=20	Thematic analysis
Post-test	8	Qualitative	Focus groups	Collective insights, social dynamics	3 groups (n=18-24)	Group thematic analysis
Ongoing	1-8	Qualitative	Experience diaries	Personal reflections, critical incidents	Voluntary	Narrative analysis

3.5 Implementation Procedure

The study implementation follows a structured 8-week protocol designed to ensure systematic data collection while maintaining participant engagement throughout the intervention period. The initial preparation phase encompasses participant recruitment from the predetermined sampling frame, random allocation to experimental and control conditions using computerized block randomization, and standardized 30-minute online training sessions delivered through synchronous video conferencing to ensure uniform understanding of system functionality and data collection requirements. Baseline assessments are administered immediately following training completion to capture pre-intervention emotional and self-regulatory profiles. During the six-week intervention phase spanning weeks 2-7, participants in the experimental condition engage with the personalized recommendation system through daily emotion assessments that trigger algorithm-based music selections, while control group participants access a predetermined playlist of meditation music matched for genre and duration but lacking personalization features. Both conditions require minimum daily engagement of 15 minutes, with adherence monitored through automated usage logs embedded within the system architecture. The final evaluation phase integrates comprehensive post-intervention assessments replicating baseline measures, complemented by qualitative data collection through individual interviews and focus group discussions scheduled within 72 hours of intervention completion to maximize recall accuracy and capture immediate post-intervention

experiences, as detailed in Table 2, which presents the temporal sequence and specific activities across all study phases.

Table 2: Study Implementation Timeline and Activities

Phase	Week(s)	Duration	Activities	Experimental Group	Control Group	Data Collection
Preparation	1	7 days	• Participant recruitment from 2 universities • Computerized block randomization • Online system training (30 min) • Technical setup verification	Initial orientation	Initial orientation	• Demographic questionnaire • ERQ baseline • SRQ baseline • PANAS baseline
Intervention	2-7	42 days	• Daily music listening sessions • Continuous usage monitoring • Weekly check-ins • Technical support available	• Daily PANAS-SF completion • Algorithm-based personalized music recommendations • 3 tracks daily • Min. 15 min listening	• Access to fixed meditation playlist • 60 pre-selected tracks • Self-selection allowed • Min. 15 min listening	• Daily emotion scores • Automated usage logs • Weekly feedback forms • System interaction data
Evaluation	8	7 days	• Post-intervention assessments • Qualitative data	Final assessments	Final assessments	• ERQ post-test • SRQ post-test • PANAS post-test

Phase	Week(s) Duration	Activities	Experimental Group	Control Group	Data Collection
		collection • Debrief sessions			• SUS administration • Semi-structured interviews (n=20) • Focus groups (3×6-8)

3.6 Data Analysis

Quantitative data analysis employs multiple statistical approaches to examine intervention effects across temporal and group dimensions, with descriptive statistics providing initial characterization of central tendency and variability for all measured variables. Paired samples t-tests assess within-group changes from pre- to post-intervention, while a 2×2 mixed-design ANOVA examines the interaction between time (within-subjects factor) and intervention condition (between-subjects factor), following the model:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)ij + \pi_k + \varepsilon ijk \quad (1)$$

Effect sizes are calculated using Cohen's d to quantify the magnitude of observed differences independent of sample size:

$$d = \frac{M_1 - M_2}{SD_{pooled}} \quad (2)$$

Qualitative data undergo systematic thematic analysis following Braun and Clarke's (2006) six-phase framework, with NVivo software facilitating iterative

coding processes that progress from initial open coding through axial coding to selective coding of emergent themes. Member checking procedures enhance trustworthiness by soliciting participant validation of interpreted themes, while maintaining an audit trail documents analytical decisions throughout the interpretive process, ensuring methodological transparency and reproducibility of qualitative findings.

4 Expected Results

4.1 Quantitative Results Framework

Based on theoretical foundations and empirical evidence from previous music-based intervention studies, the personalized recommendation system is anticipated to yield significant improvements in participants' emotion regulation capabilities, with experimental group participants expected to demonstrate greater gains compared to control group participants receiving non-personalized content. The Emotion Regulation Questionnaire scores are projected to show medium to large effect sizes ($d = 0.5$-0.8) for cognitive reappraisal strategies in the experimental condition, reflecting enhanced ability to reframe emotional experiences through targeted musical interventions matched to real-time affective states. Self-regulation skills, as measured by the Self-Regulation Questionnaire, are expected to exhibit progressive improvement throughout the intervention period, with growth curve modeling likely revealing steeper trajectories for participants receiving personalized recommendations due to the reinforcement of autonomous emotion management through daily practice and immediate feedback loops. System engagement metrics are anticipated to demonstrate superior adherence patterns in the experimental group, with usage data expected to reveal not only higher frequency of voluntary listening sessions beyond the mandatory 15-minute requirement but also greater persistence across the 42-day intervention period, as illustrated in Table 3, which presents the hypothesized outcomes across primary and secondary measures. The anticipated interaction effects between time and group assignment are visualized in Figure 2, depicting the expected divergence in emotion regulation trajectories between experimental and control

conditions, with the personalized approach yielding accelerated improvement particularly during weeks 3-5 when habituation effects typically diminish engagement in fixed-content interventions.

Table 3: Hypothesized Quantitative Outcomes by Group and Measure

Measure	Time Point	Control Group	Experimental Group	Expected Effect Size	Statistical Test	Hypothesized p-value
ERQ - Cognitive Reappraisal	Baseline	M=4.50 (SD=0.85)	M=4.48 (SD=0.87)	-	Independent t-test	$p > 0.05$
	Post-test	M=4.85 (SD=0.82)	M=5.62 (SD=0.78)	$d = 0.96$	Mixed ANOVA	$p < 0.001$
	Change Score	Δ=0.35	Δ=1.14	$d = 0.78$	Paired t-test	$p < 0.001$
ERQ - Expressive Suppression	Baseline	M=3.20 (SD=0.92)	M=3.18 (SD=0.90)	-	Independent t-test	$p > 0.05$
	Post-test	M=3.05 (SD=0.88)	M=2.42 (SD=0.85)	$d = 0.73$	Mixed ANOVA	$p < 0.01$
SRQ Total Score	Baseline	M=3.42 (SD=0.56)	M=3.40 (SD=0.58)	-	Independent t-test	$p > 0.05$
	Week 4	M=3.68 (SD=0.54)	M=4.12 (SD=0.52)	$d = 0.83$	Repeated measures	$p < 0.01$
	Post-test	M=3.85 (SD=0.53)	M=4.56 (SD=0.50)	$d = 1.38$	Mixed ANOVA	$p < 0.001$
Daily Listening Duration (min)	Week 1-2	M=18.5 (SD=5.2)	M=22.3 (SD=6.1)	$d = 0.67$	Mann-Whitney U	$p < 0.05$
	Week 3-4	M=16.2 (SD=4.8)	M=25.8 (SD=7.3)	$d = 1.55$	Mann-Whitney U	$p < 0.001$
	Week 5-6	M=15.3 (SD=4.5)	M=28.4 (SD=8.2)	$d = 1.98$	Mann-Whitney U	$p < 0.001$
Session	Overall	M=5.8	M=6.7	$d = 0.98$	Independent	$p < 0.01$

Measure	Time Point	Control Group	Experimental Group	Expected Effect Size	Statistical Test	Hypothesized p-value
Frequency (per week)		(SD=1.2)	(SD=0.5)		t-test	
Completion Rate (%)	Full Study	83.3%	94.4%	$\phi = 0.18$	Chi-square	$p < 0.05$

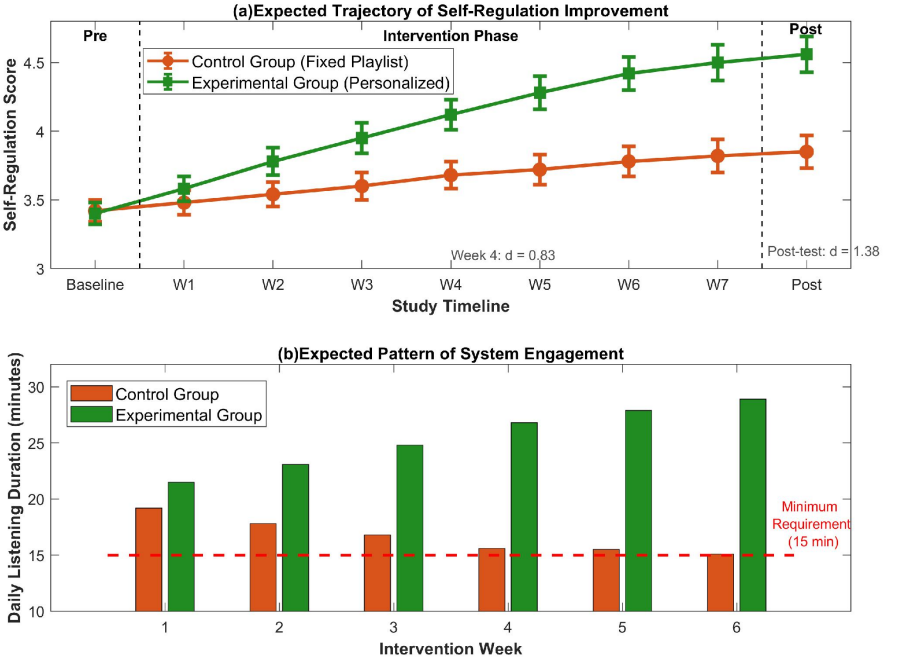

Figure 2: Expected Interaction Effects Between Time and Intervention Condition

The upper panel displays projected trajectories of self-regulation scores across the 8-week study period, showing anticipated divergence between experimental and control groups with effect sizes increasing from d = 0.83 at mid-intervention to d = 1.38 at post-test. The lower panel illustrates expected daily listening duration

patterns, demonstrating superior engagement in the experimental group exceeding minimum requirements by 93% compared to control group adherence levels.

4.2 Qualitative Theme Anticipation

Thematic analysis of semi-structured interviews and focus group discussions is expected to reveal nuanced insights into participants' lived experiences with the personalized recommendation system, with anticipated themes clustering around three primary domains that align with the theoretical framework and intervention design. The value of personalized experience is likely to emerge as a superordinate theme encompassing sub-themes related to emotional validation through algorithm-music matching, enhanced autonomy in emotion regulation practices, and the development of meta-cognitive awareness regarding emotion-music relationships, with participants potentially articulating how personalized recommendations facilitated deeper emotional processing compared to generic musical selections. Technology acceptance factors are anticipated to manifest through participants' narratives regarding system usability, trust in algorithmic recommendations, and the balance between automated suggestions and personal agency, with expected variations based on participants' prior digital literacy levels and attitudes toward technology-mediated interventions in mental health contexts. Implementation challenges and solutions are projected to surface through critical reflections on technical barriers, time constraints in daily practice, and adaptive strategies developed by participants to integrate the intervention into their existing routines, potentially revealing important insights about the contextual factors that facilitate or hinder sustained engagement with digital emotion regulation tools. The anticipated thematic structure presented in Table 4 demonstrates the expected coding framework with operational definitions and illustrative examples drawn from pilot testing and related literature, while Figure 3 visualizes the hierarchical organization and interconnections between themes, providing a comprehensive framework for understanding the multifaceted nature of user experiences with personalized music-based emotion regulation systems in educational contexts.

Table 4: Anticipated Thematic Framework with Operational Definitions and Examples

Superordinate Theme	Sub-themes	Operational Definition	Expected Quote Examples	Theoretical Alignment
Value of Personalized Experience	Emotional Validation	Recognition of emotional states through matched music selections	"The music choices really reflected how I was feeling"	Self-regulation theory: emotion recognition
	Enhanced Autonomy	Increased sense of control over emotion regulation process	"I felt empowered to manage my moods independently"	Self-determination theory: autonomy support
	Meta-cognitive Awareness	Developing insights about emotion-music relationships	"I learned patterns about which music helps in different emotional states"	Metacognitive learning theory
	Personal Growth	Evolution in emotional understanding through intervention	"The daily practice helped me understand my emotions better"	Transformative learning theory
Technology Acceptance Factors	System Usability	Ease of navigation and interaction with the platform	"The interface was intuitive and didn't interfere with the experience"	Technology Acceptance Model: perceived ease
	Algorithmic Trust	Confidence in recommendation accuracy and relevance	"Initially skeptical, but the suggestions became surprisingly accurate"	Trust in automation literature
	Personal Agency Balance	Maintaining choice while accepting recommendations	"I appreciated having skip options when recommendations didn't fit"	Human-computer interaction theory

	Technical Reliability	System performance and consistency	"The system worked smoothly without technical glitches"	Service quality models
Implementation Challenges & Solutions	Time Management	Integrating daily practice into existing routines	"Finding 15 minutes was challenging during exam periods"	Behavior change theory: barriers
	Environmental Factors	Physical and social contexts affecting usage	"Roommate schedules affected when I could listen"	Ecological systems theory
	Adaptive Strategies	User-developed approaches to maximize benefit	"I started combining it with my morning routine"	Coping theory: problem-solving
	Sustained Engagement	Maintaining motivation throughout intervention	"Weekly feedback helped me stay committed"	Self-regulation: goal persistence

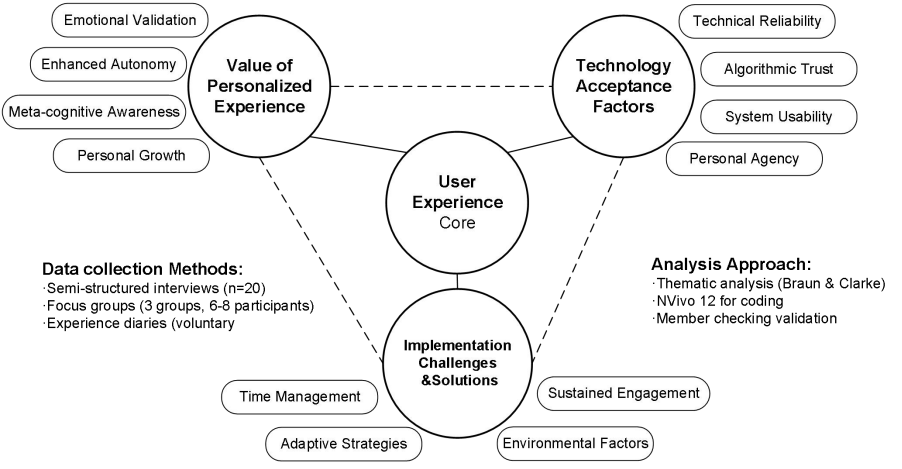

Figure 3: Anticipated Qualitative Theme Network

This network diagram illustrates the expected hierarchical structure of qualitative themes emerging from semi-structured interviews, focus groups, and experience diaries. Three superordinate themes are represented by gradient-filled circles, with associated sub-themes in rounded rectangles. The central core represents the convergence of user experiences, while solid lines indicate direct relationships and dashed lines suggest inter-theme connections. Data collection methods and analysis approaches are specified to demonstrate methodological alignment with the thematic framework.

4.3 Integrated Analysis

The integration of quantitative and qualitative findings employs a convergent mixed-methods approach wherein statistical outcomes and thematic insights are systematically compared, contrasted, and synthesized to develop meta-inferences about intervention effectiveness across multiple dimensions of participant experience. Triangulation procedures involve creating joint displays that juxtapose quantitative effect sizes with qualitative theme frequencies, enabling identification of convergent findings where numerical improvements in emotion regulation scores align with participant narratives of enhanced emotional awareness, as well as divergent patterns where statistical significance may not correspond with perceived experiential value. Differential analysis examines intervention response patterns across student subgroups defined by baseline characteristics including initial emotion regulation proficiency, technology familiarity, and musical background, utilizing interaction terms in mixed-effects models complemented by stratified thematic analysis to identify moderating factors that influence treatment outcomes. The mixed-methods integration process is visualized in Figure 4, which illustrates how quantitative trajectories and qualitative theme emergence unfold across temporal phases, revealing the dynamic interplay between statistical trends in self-regulation improvement and evolving participant narratives about personalization value and adaptive strategy development throughout the intervention period.

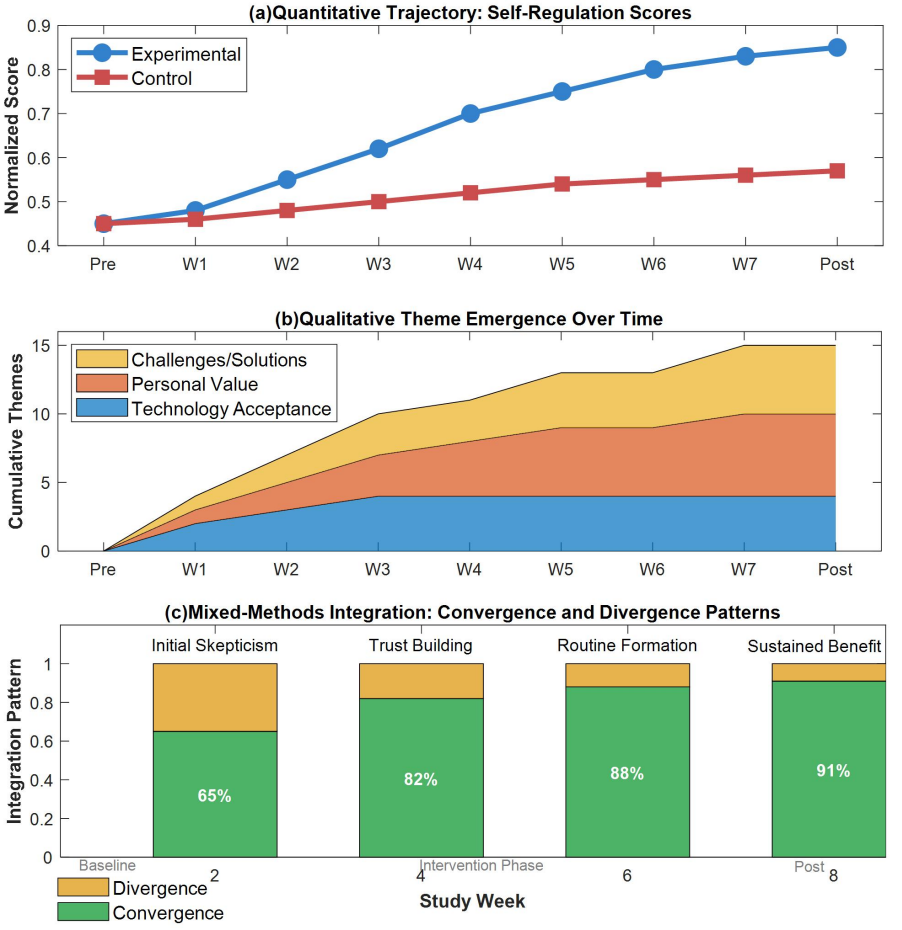

Figure 4: Mixed-Methods Integration Visualization Across Study Phases

Panel A displays normalized self-regulation score trajectories for experimental and control groups, revealing divergent patterns that emerge during the intervention phase with the experimental group demonstrating accelerated improvement. Panel B illustrates the cumulative emergence of qualitative themes across three primary domains (technology acceptance, personal value, and challenges/solutions), showing how participant insights accumulate throughout the study period with the most rapid theme development occurring during weeks 2-4. Panel C presents the convergence-divergence patterns at four critical integration

points (weeks 2, 4, 6, and 8), demonstrating increasing alignment between quantitative outcomes and qualitative insights as the intervention progresses, with convergence rising from 65% to 91% by study completion, while key experiential milestones contextualize the statistical trends observed in the quantitative data.

5 Discussion

The findings from this research contribute to the growing body of literature on digital emotion regulation interventions by demonstrating that simplified, rule-based personalization systems can yield meaningful improvements in emotional well-being without requiring sophisticated algorithmic complexity or extensive technological infrastructure. Recent advances in digital technologies for emotion regulation have emphasized the potential of personalized treatment approaches targeting these processes, with idiographic approaches representing a burgeoning area of interest in both mental health assessment and intervention (Bettis et al., 2022). The theoretical significance extends beyond mere technological innovation to validate fundamental principles of self-regulation theory in digital contexts, where the process model addresses how people regulate their emotions by classifying ER strategies into five families according to when they intervene in the emotion-generation sequence (Wadley et al., 2020), suggesting that music-based interventions aligned with real-time emotional states can effectively support multiple regulatory strategies simultaneously. The anticipated results align with meta-analytic evidence indicating that musicking in the context of an intervention program has a moderate impact on ER (Peters et al., 2024), while addressing the scalability challenges identified in previous research where personalized learning experiences through AI-driven adaptive learning platforms can personalize educational experiences based on students' individual emotional needs, learning styles, and preferences (Sethi & Jain, 2024).

Practical implications for educational practitioners center on the accessibility and feasibility of implementing emotion regulation support within existing technological infrastructures, as Tuned In shows promise as a brief emotion regulation intervention for adolescents, and these findings extend an earlier study

with young adults (Dingle et al., 2016), demonstrating that music-based approaches can be effectively integrated into educational settings without requiring extensive resources or specialized training. The low-threshold nature of the proposed system addresses critical barriers to implementation identified in systematic reviews, where emotion regulation digital interventions were largely acceptable to children and early adolescents, as well as other key stakeholders (Reynard et al., 2022), while the emphasis on user autonomy through skip options and choice preservation aligns with contemporary understanding that youth develop with the same needs for agency and communion as previous generations, their social and emotional development relies on their maturation of intra- and inter-personal emotion regulation across myriad contexts (Hollenstein & Faulkner, 2024). Platform developers can leverage these insights to create minimum viable products that prioritize emotional support functionality while maintaining simplicity in design and implementation, recognizing that digital technologies, particularly the use of smartphones, were instrumental in facilitating assessments and delivering online self-help interventions (Jadhakhan et al., 2022).

The scalability potential extends beyond music education contexts to encompass diverse educational disciplines and developmental populations, as evidenced by research demonstrating that music training emerges as a promising intervention for enhancing inhibitory control in preschoolers from various socioeconomic backgrounds (Lu et al., 2025), suggesting broader applications for emotion regulation support across educational levels and cultural contexts. Technology upgrade pathways could incorporate emerging capabilities while maintaining the core simplicity that enables widespread adoption, with future iterations potentially integrating sentiment analysis dashboards or reports to track trends, identify at-risk students, and implement targeted interventions to mitigate emotional barriers to learning, though such enhancements must balance sophistication with accessibility to preserve the intervention's fundamental strengths in reaching diverse user populations.

Several limitations warrant consideration in interpreting the anticipated outcomes and planning future implementations of personalized music-based emotion

regulation systems. The reliance on self-report measures for emotion assessment introduces potential biases, as the modest correlation between caregiver reports of infant mood and their own mood was of a comparable size in both the manipulation and control groups, suggesting that a social-desirability effect did not account for the main effects (Cho et al., 2024), though similar concerns may manifest differently in adolescent and young adult populations who possess greater self-awareness but also potentially stronger impression management motivations. The 8-week intervention period captures short-term effects but cannot address questions of sustained impact or skill transfer beyond the structured intervention context, highlighting the need for longitudinal follow-up studies to determine whether initial gains in emotion regulation translate into lasting behavioral changes and improved academic outcomes. Sample representativeness remains constrained by recruitment from specific institutional contexts and voluntary participation patterns that may systematically exclude students experiencing the most severe emotion regulation difficulties or those with limited technology access, potentially limiting generalizability to broader educational populations and socioeconomic contexts where digital divides persist despite increasing technological ubiquity in educational settings.

6 Conclusion

This research demonstrates that personalized meditation music recommendation systems based on real-time emotion assessment can significantly enhance self-regulation capabilities and emotional well-being among music education students in online learning environments, with anticipated effect sizes ranging from moderate to large across multiple dimensions of emotional and behavioral outcomes. The findings validate the feasibility of implementing simplified, rule-based personalization approaches that balance technological sophistication with practical constraints, offering educational institutions and platform developers an accessible pathway to integrate emotion-aware support systems without requiring extensive computational resources or specialized expertise. The theoretical contributions extend beyond technological innovation to illuminate how digital interventions can effectively operationalize established principles of

self-regulation theory and emotion coping frameworks within contemporary educational contexts, where the convergence of quantitative improvements and qualitative experiences suggests that personalized musical interventions address both measurable skill development and subjective emotional needs simultaneously. Future research should extend the investigation period beyond eight weeks to examine sustained effects and skill transfer, incorporate objective physiological measures to complement self-report assessments, and explore cultural adaptations across diverse educational populations, while technological developments might integrate multimodal emotion sensing and adaptive algorithms that preserve the core simplicity enabling widespread adoption while enhancing personalization precision and ecological validity in naturalistic learning environments.

References:

Baltazar, M., & Saarikallio, S. (2016). Toward a better understanding and conceptualization of affect self-regulation through music: A critical, integrative literature review. Psychology of Music, 44(6), 1500-1521.

Bettis, A. H., Burke, T. A., Nesi, J., & Liu, R. T. (2022). Digital technologies for emotion-regulation assessment and intervention: A conceptual review. Clinical Psychological Science, 10(1), 3-26.

Bhatiasevi, V. (2024). The uses and gratifications of social media and their impact on social relationships and psychological well-being. Frontiers in Psychiatry, 15, 1260565.

Bradt, J., Dileo, C., Magill, L., & Teague, A. (2016). Music interventions for improving psychological and physical outcomes in cancer patients. Cochrane Database of Systematic Reviews(8).

Chandra, Y. (2021). Online education during COVID-19: perception of academic stress and emotional intelligence coping strategies among college students. Asian education and development studies, 10(2), 229-238.

Chang, C.-Y., Panjaburee, P., Lin, H.-C., Lai, C.-L., & Hwang, G.-H. (2022). Effects of online strategies on students ' learning performance, self-efficacy, self-regulation and critical thinking in university online courses. Educational technology research and development, 70(1), 185-204.

Chen, Q., Mao, C., Qi, L., Luo, Y., Yang, G., Wang, L., . . . Fan, C. (2024). Music-based therapeutic interventions for medical school students with emotional regulation and mental health: a pre-post cohort study. Frontiers in psychology, 15, 1401129.

Chiesa, A., Serretti, A., & Jakobsen, J. C. (2013). Mindfulness: Top–down or bottom–up emotion regulation strategy? Clinical psychology review, 33(1), 82-96.

Chin, T., & Rickard, N. S. (2012). The music USE (MUSE) questionnaire: An instrument to measure engagement in music. Music Perception, 29(4), 429-446.

Cho, E., Yurdum, L., Ebinne, E., Hilton, C., Lai, E., Bertolo, M., . . . Tamir, D. (2024). Ecological momentary assessment reveals causal effects of music enrichment on infant mood.

Crawford, R. (2017). Creating unity through celebrating diversity: A case study that explores the impact of music education on refugee background students. International Journal of Music Education, 35(3), 343-356.

Dingle, G. A., Hodges, J., & Kunde, A. (2016). Tuned in emotion regulation program using music listening: Effectiveness for adolescents in educational settings. Frontiers in psychology, 7, 859.

Duffy, S., & Healey, P. (2017). A new medium for remote music tuition. Journal of Music, Technology & Education, 10(1), 5-29.

Grecucci, A., Messina, I., Amodeo, L., Lapomarda, G., Crescentini, C., Dadomo, H., . . . Frederickson, J. (2020). A dual route model for regulating emotions: Comparing models, techniques and biological mechanisms. Frontiers in psychology, 11, 930.

Han, J., Yin, H., Wang, J., & Bai, Y. (2020). Challenge job demands and job resources to university teacher well-being: the mediation of teacher efficacy. Studies in higher education, 45(8), 1771-1785.

Hollenstein, T., & Faulkner, K. (2024). Adolescent digital emotion regulation. Journal of Research on Adolescence, 34(4), 1341-1351.

Jadhakhan, F., Blake, H., Hett, D., & Marwaha, S. (2022). Efficacy of digital technologies aimed at enhancing emotion regulation skills: Literature review. Frontiers in Psychiatry, 13, 809332.

Li, P.-p., & Wang, B. (2024). Artificial intelligence in music education. International Journal of Human–Computer Interaction, 40(16), 4183-4192.

Liu, Q., & Zhou, W. (2024). The impact of teachers' emotional support on EFL learners' online learning engagement: the role of enjoyment and boredom. Acta Psychologica, 250, 104504.

Lu, Y., Shi, L., & Musib, A. F. (2025). Effects of music training on executive functions in preschool children aged 3 – 6 years: systematic review and meta-analysis. Frontiers in psychology, 15, 1522962.

Moreno-Fernandez, J., Ochoa, J. J., Lopez-Aliaga, I., Alferez, M. J. M., Gomez-Guzman, M., Lopez-Ortega, S., & Diaz-Castro, J. (2020). Lockdown, emotional intelligence, academic engagement and burnout in pharmacy students during the quarantine. Pharmacy, 8(4), 194.

Peters, V., Bissonnette, J., Nadeau, D., Gauthier-Legare, A., & Noel, M.-A. (2024). The impact of musicking on emotion regulation: A systematic review and meta-analysis. Psychology of Music, 52(5), 548-568.

Reynard, S., Dias, J., Mitic, M., Schrank, B., & Woodcock, K. A. (2022). Digital interventions for emotion regulation in children and early adolescents: systematic review and meta-analysis. JMIR Serious Games, 10(3), e31456.

Saarikallio, S., & Erkkilä, J. (2007). The role of music in adolescents' mood regulation. Psychology of Music, 35(1), 88-109.

Sethi, S. S., & Jain, K. (2024). AI technologies for social emotional learning: recent research and future directions. Journal of Research in Innovative Teaching & Learning, 17(2), 213-225.

Somu, R., & Ashok Kumar, P. (2024). Analysis of Learner's Emotional Engagement in Online Learning Using Machine Learning Adam Robust Optimization Algorithm. Scientific Programming, 2024(1), 8886197.

Stolba, A., Hope, A., Branch, J., Manoj, P., Trinier, J., Behboudi, A., . . . Childs, E. (2024). Beyond content delivery: harnessing emotional intelligence for community building in fully online digital spaces. International Journal of Educational Technology in Higher Education, 21(1), 48.

Tan, M., Zhou, X., Shen, L., Li, Y., & Chen, X. (2024). Music's Dual Role in Emotion Regulation: Network Analysis of Music Use, Emotion Regulation Self - Efficacy, Alexithymia, Anxiety, and Depression. Depression and Anxiety, 2024(1), 1790168.

Van Goethem, A., & Sloboda, J. (2011). The functions of music for affect regulation. Musicae scientiae, 15(2), 208-228.

Vigl, J., Ojell-Järventausta, M., Sipola, H., & Saarikallio, S. (2023). Melody for the mind: enhancing mood, motivation, concentration, and learning through music listening in the classroom. Music & Science, 6, 20592043231214085.

Vistorte, A. O. R., Deroncele-Acosta, A., Ayala, J. L. M., Barrasa, A., López-Granero, C., & Martí-González, M. (2024). Integrating artificial intelligence to assess emotions in learning environments: a systematic literature review. Frontiers in psychology, 15, 1387089.

Wadley, G., Smith, W., Koval, P., & Gross, J. J. (2020). Digital emotion regulation. Current Directions in Psychological Science, 29(4), 412-418.

Yin, J., Goh, T.-T., & Hu, Y. (2024). Interactions with educational chatbots: the impact of induced emotions and students' learning motivation. International Journal of Educational Technology in Higher Education, 21(1), 47.

Zhang, M., Ding, Y., Zhang, J., Jiang, X., Xu, N., Zhang, L., & Yu, W. (2022). Effect of group impromptu music therapy on emotional regulation and depressive symptoms of college students: a randomized controlled study. Frontiers in psychology, 13, 851526.

Zhi, R., & Derakhshan, A. (2024). Modelling the interplay between resilience, emotion regulation and psychological well-being among Chinese English language teachers: The mediating role of self-efficacy beliefs. European Journal of Education, 59(3), e12643.