State of the art on audience research within NIME: a systematic literature review

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Abstract

This paper presents a systematic review of NIME research addressing the role of the audience in musical performance. By analysing 99 papers from the NIME proceedings, we examine how audiences are engaged, studied, and conceptualized across participatory and non-participatory contexts. Our analysis highlights transparency and learning curve as two recurring dimensions shaping audience engagement in technologically mediated performances. The paper aims to provide a structured overview of current approaches and to support more methodologically grounded future research on audience experience.

Keywords

literature review, audience, methodologies

1 Introduction

In recent years, the role of the audience has become increasingly central within research on musical performance and interactive music systems. In particular, work presented within the NIME community has progressively moved beyond viewing audiences as passive recipients of sound, instead framing them as situated actors whose perception, understanding, and engagement are shaped by complex relationships between performers, technologies, and environments [42, 68, 94]. Taken together, these approaches conceptualize performance as an emergent sociotechnical phenomenon in which the audience is not external to the musical event, but structurally embedded within its ecological and relational dynamics. Indeed, from an ecological perspective on musical performance, the audience can be understood as an integral component of the performative system, participating — either directly or indirectly — in the co-construction of musical meaning. A few notable examples aiming at understanding and systematizing audience research exist. Bin, whose doctoral dissertation [13] and related papers [3, 14, 16] primarily focus on audience studies, is particularly relevant. Similarly some researchers presented overall discussion on audience participation. Tanaka and Parkinson discussed a number of projects developed between 2008–2015 inquiring how their work can "inform our understanding of the messy complexities of embodied, material reality" [106] and, inspired by the notion of "musicking" by Small [103], introducing the concept of "workshopping" as part of the participating ecosystem. Similarly, Xambo proposed a framework to analyse different forms of audience participation [118]. However, despite this growing interest, a systematic understanding of research addressing the audience within NIME has yet to be proposed. We argue that it might be beneficial as audience involvement is explored across a wide range of contexts, spanning non-participatory performance settings – where audiences are observed, surveyed, or otherwise studied – to participatory and interactive works in which audience members actively influence or co-create the musical outcome. Similarly, the degree of formality with which audiences are engaged and studied varies substantially, ranging from informal anecdotal reflection to more structured empirical approaches. This heterogeneity makes it difficult to obtain a clear overview of how audience engagement is currently conceptualized, designed for, and evaluated within the field. To address this gap, this paper presents a systematic literature review of NIME research explicitly concerned with the audience. This approach is in line with the tradition of self-reflective research in NIME [37, 70, 71]. This reflexive orientation has informed studies on DMI design [93], methodological practices and meta-analytical approaches [68, 71], studies adopting thematic analysis as an analytical framework [78], as well as inquiring into the value of community within NIME [22, 113], leading to self reflective papers specifically focusing on values [63, 69], critical discourse [17], and sustainable practices [69]. Other researchers have inquired about specific aspects of research such as scores [68] or voice [56].

In line with this research, and arguing that the audience is a central element in any performative music ecology, we propose here a systematic inquiry into how NIME researchers have accounted for the audience. Following the PRISMA methodology, we identified a corpus of papers from the official NIME proceedings repository – Zenodo – using *audience* as a primary search keyword. Through a structured screening and exclusion process, we derived a final corpus of 99 papers in which the audience plays a central role, either as active participants in interactive systems or as subjects of analysis and data collection. Building on this systematic reading, the paper presents two complementary analyses. The first provides an overview of the technologies and methodologies used within NIME to engage audiences or to collect data about audience experience, with particular attention to the distinction between participatory and non-participatory contexts. The second analysis focuses on recurring concerns related to audience engagement. We identified two closely interwoven dimensions that emerge as particularly salient: transparency and learning curve. These dimensions recur across a wide range of works and appear to play a key role in shaping how audiences perceive, understand, and engage with technologically mediated musical performances. By synthesizing existing approaches to audience engagement and situating them within a broader ecological and methodological perspective, this paper aims to clarify the current state of research on audiences in NIME. In doing so, it seeks to provide a structured foundation for future work, encouraging more systematic, reflective, and empirically grounded studies of audience experience in interactive and technologically mediated musical performances.

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2 Methodology

2.1 Identification of the corpus

We identified the corpus following the PRISMA method[1]. We performed our initial search using the Zenodo search engine[2], the official repository for the NIME proceedings, using *audience* as keyword, given that the primary objective of this literature review is to comprehensively map the full spectrum of research within the NIME community that explicitly addresses the role, experience, or conceptualization of the audience. This keyword search yielded a total of 158 papers.

These 158 papers were analysed in their entirety and the following exclusion criteria were applied:

- the audience was mentioned only marginally or hypothetically, without being explicitly investigated;
- the audience was referred to exclusively in the context of future work;
- the term audience was used with a different meaning (e.g., referring to students or learners rather than to the audience of a performance or installation).

From this procedure, 59 papers were excluded, with our corpus remaining of 99 relevant papers. In these papers, the audience constituted a central focus of the work, because either the audience is directly interacting with the proposed technology (e.g., participatory audience) or analytical tools, empirical methodologies, or data collection from the audience are presented.

2.2 Paper analysis

Similarly to recent literature reviews in the field of interactive music technology (i.e. [120]), for each paper in the final corpus we compiled a structured summary of selected aspects used for subsequent classification. In addition to the title, authors, year of publication, and paper typology (full, short, music paper), analytical categories such as the role of the audience, the type of technology involved, and the methodologies were included. Since these categories were predefined in accordance with the research objectives, the analysis can be framed within a deductive top-down epistemological approach (as in deductive thematic analysis [19]). Table 1 provides an overview of all the aspects considered in the analysis and illustrates how each aspect was systematically summarised. In addition, for each paper, we took notes on the main design considerations that were discussed.

Once each paper had been included in the table, these entries were manually recursively clustered based on similarities across the various papers. We first clustered the papers according to the type of paper: presenting a new specific system/study vs meta-reflection/literature reviews (meta-reflections are presented at the end of the result section).

First analysis: overview of all the methodologies and technologies used to collect data from the audience or to engage it in interactions with the performative system. Within the papers presenting a new specific system/study we first clustered the papers based on the role of the audience: whether the audience was actively interacting with the NIME or not. Afterward, we examined what type of data were collected from the audience, and what type of technology was used to collect those data from the audience (if any). For the papers where the audience actively interacts with the NIME we also examined the technology used to allow for such interaction. A map of this top-down classification is offered in Figure 1.

Second analysis: recurring themes in relation to the audience. Afterward, we used the summaries and the notes on design considerations of the papers to identify recurring themes following a bottom up clustering (inductive approach). This will be presented at the end of the paper and discussed against existing literature.

The first discriminating dimension we identified concerns the status of the audience: participatory or non-participatory within the performance or, more broadly, within the aesthetic creative act. We present these approaches separately, analysing within each of them the other aspects of interest, including methodologies, types of technologies, existing frameworks, and proposed design guidelines. The relationships and points of convergence between the two approaches will be touched in the discussion section.

Research Aspect	Formalisation	Motivation
Aim of the paper	The aim of the paper was synthesised	To gain an overall understanding and a summary for reference
Role of the audience	The audience role was identified, clarifying participation type and data collection	Understanding audience participation modes
Participants and context	Number of participants and study or performance context were recorded when applicable	Understanding the research context
Technologies	Technologies used in the paper were listed	Identifying the technological approach
Data and methodologies	Types of data collected and methodologies used were documented	Understanding how participation was assessed
Frameworks or guidelines	New frameworks or design guidelines were identified	Revealing recurring conceptual patterns

Table 1: Summary of research aspects and analysis criteria

3 Participatory audience

58 papers introduced new DMIs, technologies, or systems for performances or installations that explicitly aimed to involve audience members in the performative dimension of the event.

3.1 Type of technology for allowing audience participation

Here we present the technologies that allow for audience participation, specifically in cases where these technologies are directly operated by audience members. Across the corpus, a range of technological solutions has emerged, including mobile devices, wearable interfaces, sensing systems, and distributed networked platforms. These technologies are employed to support different modes of participation. Table 2 provides a general overview of the macro-categories of the technologies used. While a paper might combine multiple technologies, each paper was assigned to the macro-category most closely aligned with the primary mode through which audience participation was enabled.

An interesting point worth highlighting is the fact that audience participation might occur in installative context as much as

[1] see: https://www.prisma-statement.org/
[2] see: https://zenodo.org/communities/nime/records

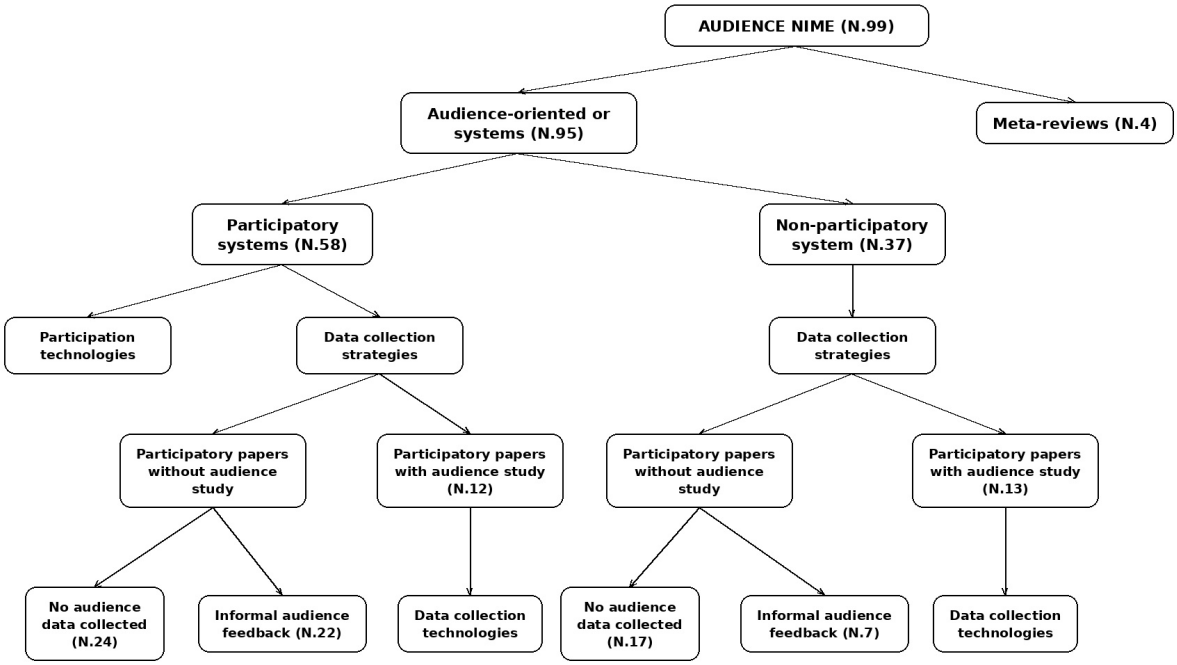

Figure 1: Distribution overview of classified corpus

in performative context further blurring the distinction between the two, this aspect will be furthered in the discussion.

3.2 Approaches to collect data from the audience

Within the macro-category of participatory audience, three main groups of works were identified , differentiated according to the degree of audience involvement and the approaches adopted for data collection (table 3). The first group comprises papers reporting formal data collection procedures - including the number of participants or audience members involved and methodological details - on how data were collected (N = 12). The second group consists of papers describing strategies or DMIs used in performances or events in which informal or anecdotal feedback was gathered from audience members (N = 22). The third group includes papers presenting new strategies or DMIs whose design explicitly prioritises audience engagement or appreciation, but without collecting any form of audience feedback (N = 24).

3.2.1 Participatory NIME with formal data collection. 8 papers that present audience participation also had formal data collection, table 4 highlights descriptive statistics.

A comparison between qualitative and quantitative participatory papers with formal data collection highlights a number of common tendencies as well as some differences in how audience studies are reported. Participatory qualitative studies are typically conducted with relatively small groups of participants, with reported audience sizes ranging from 9 to 60 participants (median = 15.5; mean = 22.4). These studies generally adopt context-sensitive approaches, drawing on interviews, observations, and other qualitative materials, and in several cases they also include complementary quantitative data. Participatory quantitative studies, on the other hand, tend to report somewhat larger and more variable audience sizes, ranging from 12 to approximately 90 participants (median = 25; mean = 38). While qualitative elements are occasionally present, these contributions primarily focus on the collection and analysis of quantitative data, such as surveys or system logs. Given the limited number of papers in each group, these observations should be interpreted cautiously; nevertheless, they suggest that differences in methodological emphasis may be associated with variations in the scale at which audience participation is examined.

We now provide an overview of the methodologies used to inquiry the audience and relative technologies in participative papers with formal data collection. A summary is available in table 5

From the table we can observe that new technology has been developed only to collect data during the performances.

3.2.2 Participatory NIME without formal data collection.

Participatory NIME with informal feedback from the audience. . 22 papers (8 full, 14 short/demo, 0 program notes) present works that collected informal feedback from the audience at the end of performances. Informal, anecdotal conversations with audience members are common within practice-based research, and in these cases feedback is typically reported in a descriptive rather than systematic manner. The absence of program notes in this category reflects the fact that approaches based on partial and informal audience feedback often do not entail a fully realized performative implementation, which program notes typically assume.

Participatory NIME without any feedback. . Among the papers presenting studies or devices involving audience participation, a subset of 24 works (4 full, 14 short/demo, 6 program notes) was identified in which the audience is not treated as a primary

Macro-category of Technology	Technologies Included	Audience Agency	Papers
Personal & Networked Interfaces	Audience personal devices (smartphones, tablets, PCs); web- and touch-based interaction interfaces; web-based control and pattern selection systems; audience input and feedback mechanisms; networked APIs	Intentional, discrete, distributed	[1, 6, 28, 29, 33, 34, 41, 43, 44, 51, 62, 64, 65, 67, 74, 75, 79, 89, 91, 95, 96, 105, 112, 115, 118, 119]
Tangible & Embodied Interfaces	Physically playable DMIs; tangible and hybrid sound objects; physical props and motorized control elements; haptic and wearable interaction systems; visual feedback elements	Embodied, continuous, performative	[5, 24, 31, 40, 45, 48, 59, 73, 77, 81, 92, 100, 101, 108]
Sensing-Based Participation	Motion, posture, proximity, audio, vision, light, and biosensing technologies	Implicit or partial	[12, 21, 27, 32, 36, 50, 80, 83, 88, 99, 110, 111]
Spatial & Immersive Systems	GPS-enabled and location-based interaction systems; spatial audio; VR environments; audio-visual AR systems	Situated or immersive	[23, 52, 54, 55, 84, 98]

Table 2: Macro-categories of technologies and audience agency models in participatory music performance

Feedback Type	Program notes	Short / Demo	Full	Total	Papers
Formal data collection	0	3	9	12	[12, 24, 29, 33, 52, 55, 59, 75, 89, 91, 95, 119]
Informal feedback	0	14	8	22	[27, 28, 32, 43–45, 48, 50, 67, 73, 74, 81, 83, 84, 96, 98, 99, 105, 110, 111, 115, 118]
Without any feedback	6	14	4	24	[1, 5, 6, 21, 23, 31, 34, 36, 40, 41, 51, 54, 62, 64, 65, 77, 79, 80, 88, 92, 100, 101, 108, 112]

Table 3: Distribution of feedback types and documentation formats across the analysed corpus

analytical focus. These papers typically introduce a specific instrument, system, or performance and, while these systems allow for the audience to interact, this aspect is not evaluated. References to audience participation are framed as considerations within the design of the system or of the performance. For this reason, while these works do not offer insights on how to collect data from the audience, they offer valuable insights on how audience participation can be embedded in the conceptualisation and development of new DMIs. The majority of these papers adopt a practice-based or practice-led approach.

3.3 Performance vs Installation

A further necessary sub-categorisation emerging from the group of papers in which the audience assumes a participatory role concerns the distinction between the performative act (*performance*) and the *installative* contexts. In music, the concept of the audience has historically developed within the context of concert performance, understood as a temporally bounded event with a defined beginning and end, and with clearly delineated roles between performers and listeners. The advancement of interactive technologies, together with the expansion of sonic and sound art practices, has progressively challenged this configuration, introducing forms of audience involvement within interactive sound installations. This shift, accompanied by theoretical reframings such as *musicking* [103], has been widely discussed in the literature and has highlighted both continuities and divergences between participatory concert settings and installation-based practices. While participatory performances are typically characterised by temporal boundedness, co-presence, and heightened notions of liveness, participatory installations tend to foreground spatial continuity, open-ended interaction, and distributed forms of audience agency. This distinction proved analytically relevant, as it affects how audience participation is structured, experienced, and sustained over time and space, and consequently informs the technological, methodological, and aesthetic choices observed across the corpus. Within the analysed group, 33 papers pertain to a performative context or related strategies (e.g. descriptions of performances or performance-oriented strategies or DMIs), while 25 papers can be attributed to an installation-based context (e.g. descriptions of installations and installation-oriented strategies or DMIs).

4 Non-participatory audience

37 papers addressing audiences presented new strategies or DMIs designed for performances that did not target participation in the performative aspect of a performance by any audience members. We included these papers in our analysis because they offer interesting and valuable insight on how the audience is considered by NIMErs in traditional performances.

In this case, the analysis does not address the specific mechanisms or technologies through which audience participation is enabled, as these aspects are not directly relevant to the study

Table 4: Descriptive statistics of participatory papers with formal audience data collection

Metric	Value
Participatory qualitative papers	
Number of papers considered	8 papers (3 include both qualitative and quantitative data)
Number of papers excluded	0 papers
Minimum number of participants	9 participants
Maximum number of participants	60 participants
Arithmetic mean	22.4 participants
Median	15.5 participants
Participatory quantitative papers	
Number of papers considered	7 papers (3 include both qualitative and quantitative data)
Number of papers excluded	0 papers
Minimum number of participants	12 participants
Maximum number of participants	90 participants
Arithmetic mean	38 participants
Median	25 participants

of the audience itself. Instead, the focus is placed on how and why audience data are collected, adopting the same analytical structure used in the preceding sections.

4.1 Approaches to collect data from the audience

Within the macro-category of participating audience, we identified three main groups of works, differentiated by the degree of audience involvement reported, as we did for the papers with audience participation. The first group comprises papers that report formal data collection, including the number of participants or audience members and methodological details about how data was gathered (N=17). The second group encompasses all the papers that did not present formal data collection, either describing DMIs used in performances or events where informal or anecdotal feedback was collected from the audience (N=7) or presenting new strategies whose design explicitly prioritizes audience engagement or appreciation, but without gathering any form of audience feedback (N=13).

Table 6 resumes these papers and their distribution across different classification.

Type of feedback	Program notes	Short / Demo	Full	Total	Papers
Formal data collection	0	4	13	17	[7–10, 15, 18, 25, 26, 39, 57, 76, 85, 87, 90, 97, 109, 117]
Informal feedback	0	3	4	7	[11, 20, 38, 49, 58, 82, 86]
Without any feedback	3	7	3	13	[2, 4, 30, 35, 46, 53, 61, 66, 72, 102, 104, 116, 121]

Table 6: Distribution of feedback types and documentation formats across the analysed corpus

4.1.1 Non-participatory NIME with formal data collection. 17 papers included formal studies with the audience as participants of these, 13 are full papers and 4 are short papers. Table 7 highlights descriptive statistics.

Table 7: Descriptive statistics of Non-participatory papers with formal audience data collection

Metric	Value
Non-participatory qualitative papers	
Number of papers considered	15 papers (13 include both qualitative and quantitative data)
Number of papers excluded	0 papers
Minimum number of participants	3 participants
Maximum number of participants	150 participants
Arithmetic mean	43.8 participants
Median	34 participants
Non-participatory quantitative papers	
Number of papers considered	15 papers (13 include both qualitative and quantitative data)
Number of papers excluded	0 papers
Minimum number of participants	3 participants
Maximum number of participants	150 participants
Arithmetic mean	45.53 participants
Median	37 participants

A meaningful comparison between non-participatory qualitative and quantitative studies proves difficult, as the two corpora are largely overlapping. Of the 19 studies identified overall, 17

are classified as qualitative and 17 as quantitative, with 15 papers common to both groups. This substantial overlap makes it almost impossible to isolate distinct methodological trends attributable specifically to qualitative or quantitative approaches. As a consequence, a unified analysis is more appropriate, focusing on descriptive differences rather than attempting formal statistical comparisons. Within this shared set of studies, sample sizes display considerable variability, ranging from as few as 3 to as many as 150 participants. In the qualitative subset, the arithmetic mean is 43.8 participants and the median is 34, while in the quantitative subset the mean increases slightly to 45.53 and the median to 37. These modest differences suggest that quantitative studies tend to involve marginally larger samples, yet the proximity of the central tendency measures indicates that both approaches operate at a comparable empirical scale. Importantly, the broad dispersion observed in both cases limits the interpretability of these differences. Larger studies exert a moderate influence on the mean values, but the medians remain relatively close, pointing to similar typical study sizes across methodologies. Given the small number of unique papers and the high degree of overlap between groups, these variations cannot support inferential statistical analysis and should instead be read as indicative patterns. We offer here a synthetic analysis overviewing the methodologies and eventual technologies adopted to formally collect data from the audience in table 8. We want to point out that smartphones have been the main technology used to collect data during the performances, allowing for real-time collection of feedback, rather than post-hoc data gathering. This idea was introduced by Bin and colleagues [3], and resembles a technological infrastructure typically used for real-time participation of the audience in the performance.

4.1.2 *Non-participatory NIME without formal data collection.*

Non-participatory NIME with informal feedback from the audience. 7 papers (4 full, 3 short/demo) collected informal feedback from the audience at the end of performances. Informal chat with the audience is common in practice based research. As in these works the audience is not interacting with the proposed systems or instruments, we do not focus on the types of technologies here. Similarly as these studies do not involve audience members, we do not account for methodologies here.

Non-participatory NIME without any feedback. Among the papers presenting studies or devices that do not involve audience participation, we identified 13 papers (3 full, 7 short/demo, 3 program notes) that do not address audiences within the primary goals of the paper. Rather they present a specific instrument/system or performance and in doing so the authors pinpoint the relevance of engaging with the audience. In this category of paper these aspects were not actively evaluated, but simply mentioned as elements accounted for in the design. For this reason we were on the verge of excluding them because the audience is not central. However, we decided to include them as they provide additional nuances on how the audience is considered in the design of a new strategy.

5 Engagement: transparency and learning curve

In our second analysis, we identified recurring themes across papers in relation to the audience which we present here. The core element across most of the papers seems to revolve around audience appreciation and engagement. Across the surveyed papers, two recurrent and tightly interwoven dimensions emerged as elements that can contribute to shaping an effective and positive relationship between audience and technology: transparency, and learning curve.

5.1 Transparency and legibility

Engagement is repeatedly framed not merely as sustained attention, but as a *visceral*, *emotional*, and *reciprocal* mode of participation. To achieve engagement there seems to be a consensus that transparency and legibility can play an important role. In contexts of performances where the audience is not participating, transparency and legibility tend to be referred to performers actions. For instance, Ong and colleagues explicitly associate audience disengagement with the lack of visible cues in performance, noting how the absence of an evident visual component can lead to misunderstanding and detachment, encapsulated in the "commonly heard audience comment that performers look to be checking emails on stage," even when they are executing highly complex real-time musical actions [86]. This observation foregrounds a broader issue within technologically mediated performance: when the performative gesture is obscured by opaque interfaces, the audience struggles to establish a perceptual and affective connection with the musical process. Feng further elaborates this point by arguing that music appreciation "does not only happen at the moment when music reaches the audience, but is also stimulated by watching the visual interactions between the musician and the instrument" [38]. In this sense, engagement is deeply tied to *legibility of embodied actions*, and audiences tend to remain more involved when causality, effort, and intentionality in performers' actions is transparent. On the same ethos, Ong et al. discuss the idea of *visceral engagement*, aiming "to engage the audience viscerally from the beginning and maintain this connection throughout the piece's progression" [86]. Here, engagement is conceived as a continuous experiential state, sustained through perceptual immediacy rather than post hoc understanding. This emphasis on perceptual richness is echoed in works that explore multisensory and immersive environments. Xambó argues that multi-sensory immersive experiences are often more inclusive and entertaining, while also serving as a mechanism to preserve the flow of improvisational practices [118]. Similarly, Camara Halac has highlighted how the integration of visual, auditory, and haptic feedback in virtual environments can foster accessibility, particularly for participants with hearing or mobility impairments, thus expanding engagement beyond normative sensory hierarchies [23]. The relationship between understanding and enjoyment is aligned with other research on the audience not published at NIME. For instance, Bin concluded that "That the large version [with more visible gestures] was rated significantly higher than the laptop for Enjoyment and Interest" [14]. At a general level, Hopkins' work offers a particularly instructive example by framing transparency through the lens of *trust* between performer and audience [45]. In his study, moments of cooperative musical exchange were associated with visibly changing visualizations of trust, leading to higher intimacy and musical engagement. At the same time, Hopkins reports that "the visualization of trust using neuroimaging [was] confusing for some" [45], prompting a redesign to make the mapping between data and representation more explicit. This underscores a recurring pattern: transparency is not guaranteed by data availability alone, but depends on intuitive, culturally legible mappings that

audiences can quickly interpret. Comparable concerns appear in Kim et al., who explicitly frame real-time visualization as a means "to help the audience to understand the whole music-making process clearly and intuitively," [53] enabling them to appreciate inter-performer interactions more effectively. Transparency here becomes a prerequisite for engagement, ensuring that technological mediation enhances rather than obscures musical communication. In the context where the audience is interacting, the issue of transparency becomes relevant in terms of allowing the audience to understand what they are doing. On this point, Hindle notes that in large-scale participatory contexts, "one problem with a large number of participants is that each participant wants to hear their contribution" [43], pointing to a fundamental tension between individual perceptibility and collective coherence. Weitzner et al. similarly argue that as the number of participants grows, it becomes increasingly difficult to balance the transparency of individual contributions with the intelligibility of the collective musical product [115].

5.2 Learning Curve

Closely related to transparency is the issue of the *learning curve*, frequently addressed through discussions of usability and ease of use. For instance, Hindle documents how even basic technical requirements - such as connecting a mobile device to a specific local Wi-Fi network - might become an issue when users lack the necessary prior knowledge [43]. To try to propose a form of instant participation, Hirabayashi and Eshima presented a case where audiences can engage simply by downloading an application [44]. Kiefer emphasizes that "easy reconfiguration of the device" [52] is a critical design factor, while Schacher articulates a more radical stance by aiming to "present a seamless experience that convey[s] as little technological complexity as possible" [98], deliberately eliminating audience-controllable elements and setup procedures. These approaches reflect a shared concern: lowering the barrier to entry in order to preserve immediacy and engagement. Importantly, learning curve considerations are not limited to technical fluency but extend to conceptual and musical understanding. For instance, in terms of understanding how a system works and facilitating transparency of the audience's own actions, Fan's BioSync interface proposes a self-versus-group visualization designed to be immediately interpretable, allowing audience members to quickly situate their contribution within a collective context [36]. Everett's work on sonifying chemical evolution explicitly frames audience participation as both an engaging artistic experience and an educational opportunity, allowing participants to grapple with complex scientific principles through embodied interaction [35]. Similarly, Studley's *SwimTunes* explores gamification as a strategy to enable novice audiences to co-create music, deepening engagement while redefining performer–audience relationships [105].

5.3 Reconfiguring Performer–Audience Relations

Across many of these contributions, engagement, transparency, and learning curve converge in a broader reconfiguration of performer–audience relations. Allison et al. describe performances as "overlapping cycles of control and audio generation between performer, audience, network, and machine," dissolving traditional hierarchies of musical agency [1]. Baba's *Freqtric Drums* [5] literalizes this shift by transforming audience members into an extension of the performer's instrument, while Kim's *SVOrk* [55] envisions performers and audiences coexisting within a shared virtual concert space. Egozy and Lee [33] articulate the normative implications of this shift most explicitly, arguing that if audience participants are to have a genuinely engaging and communicative music-making experience, they must be "elevated to the status of performing musicians" and treated as musical equals. From this perspective, engagement is no longer a passive response but the outcome of meaningful inclusion, supported by transparent systems and carefully calibrated learning curves.

6 Papers presenting frameworks and meta-reviews

4 papers were classified as meta-reviews. Taylor constructs a genealogy of distributed music [107]; Lee reframes screen mirroring as a theoretical and performative device [60]; Hsu and Sosnick formalise an HCI-informed evaluative framework REF HSU [47]; and Weisling et al. employ a survey-based methodology with thematic analysis to map contemporary audiovisual practices [114]. Taken together, these works converge on the need to develop historical and methodological frameworks capable of rendering heterogeneous practices comparable and of clarifying the relationship between system, performer, and audience.

7 Discussion and Conclusions

From our meta analysis of the audience in NIME, we propose two final points, the first related to methodologies for audience studies, the second related to suggestions to promote engagement

7.0.1 Methodological consideration. The audience represents a crucial component of musical performance, particularly when performance is approached from an ecological perspective that considers music-making as a situated and relational practice (as discussed above). However, despite the centrality of the audience in many technologically mediated performances, further studies would be highly beneficial. The vast majority of papers presented in NIME that address audience experience rely primarily on informal observations or anecdotal feedback. Notably, only Bin [18] reports the systematic collection of audience data during the performance itself, highlighting a significant methodological gap in the current literature.

7.0.2 Design suggestions to promote engagement. To conclude, based on the work conducted so far from NIME researchers, we synthetise the following suggestion (divided for settings where the audience is participating and settings where the audience is not).

For participatory audience settings:

- **Lower the barrier to entry by minimizing setup**, configuration, and required prior technical knowledge.
- **Provide immediate feedback on audience actions**, helping participants understand their individual contribution within the collective outcome.
- **Treat audiences as co-performers**, reconfiguring performers–audience relations through transparent systems and carefully calibrated learning curves.

For Non-participatory audience settings:

- **Make performer actions legible** so audiences can clearly perceive causality, effort, and intention behind sounds and visuals.

- **Design for intuitive transparency**, using mappings that are immediately understandable or technically explicit solutions.
- **Support visceral and continuous engagement** by prioritizing perceptual immediacy over delayed explanation or interpretation.
- **Leverage multisensory feedback** (visual, auditory, haptic) to increase inclusivity, immersion, and accessibility.

In light of the above, the investigative strategies advanced in particular by Bin [15] and Xambó [118] appear to articulate an expansion of the epistemological horizon of audience studies, opening up more nuanced reflections on the role of the audience and the performative ecologies that emerge from it, in meaningful convergence with the concept of workshopping proposed by Tanaka and Adam [106].

8 Conclusions

With this paper, we outlined the current state of research addressing audience involvement in musical performance. We distinguished between participatory and non-participatory contexts, the first encompassing contexts in which the audience is actively interacting, the latter including performances in which data are collected from the audience without direct interaction. We also identified levels of formality in how data and feedback are collected from audiences across existing works. Furthermore, we synthesized prior discussions on engagement, with particular attention to the roles of transparency and learning curve in shaping effective audience–technology relationships. We hope that this paper can serve as a foundation for future studies, encouraging more systematic and methodologically grounded research on audience experience in technologically mediated musical performance.

9 Ethical Standards

The authors declare that this systematic review on audience within NIME was conducted in the absence of any financial, professional, or personal conflicts of interest that could have influenced the analysis, interpretation of the data, or presentation of the results. Since none of the authors is a native English speaker, the authors relied on an AI tool to refine the syntax, grammar, and spelling.

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Table 5: Overview of methodological approaches, audience size, and data collection strategies

Methodological approach	Paper	Audience size reported	Type of data collected on the audience	Used technologies for collecting data / Purpose of data collection
Quantitative	Sound Surfing Network (SSN)	20 participants (2 groups)	Quantitative (during performance: device position and shaking gesture data; post-performance: Likert questionnaire)	During performance: audience smartphones, mobile app. Purpose: evaluation of audience experience.
Quantitative	Understanding Cloud Support for Crowd in C[loud]	~48 simultaneous users (69 active users)	Quantitative (system logs: connections, messages, timing, transferred bytes, participation length)	Audience smartphones, browser-based interface. Purpose: infrastructure and scalability analysis.
Quantitative	Synthetic Ornithology: Machine Learning, Simulations and Hyper-Real Soundscapes	37 participants (listening study only)	Quantitative (MOS survey with Likert scale)	No dedicated technology reported. Purpose: evaluation of soundscape generation and audience perception.
Quantitative	Composing and Performing Interactive Music using the HipHop.js language	42 students; ~150 adults (~90 active)	Quantitative (pre-performance: pattern activation events; during performance: system logs)	Audience personal devices (smartphones, tablets, PCs), browser-based interface. Purpose: system use and behavioural analysis.
Mixed-methods	A Web Application for Audience Participation in Live Music Performance: The Open Symphony Use Case	13 audience members, 4 performers	Mixed-methods: qualitative (open comments), quantitative (Likert-scale survey)	Audience smartphones, browser-based mobile voting interface. Purpose: evaluation of audience experience and usability.
Mixed-methods	12*: Mobile Phone-Based Audience Participation in a Chamber Music Performance	12 performing audience members (9 respondents)	Mixed-methods: qualitative (open answers), quantitative (post-performance Likert survey)	During performance: audience smartphones, browser-based interface. Purpose: evaluation of audience experience.
Mixed-methods	Augmented Stage for Participatory Performances	25 spectators (9 active, 16 passive)	Mixed-methods: qualitative (open comments), quantitative (post-performance Likert questionnaires)	During performance: audience mobile devices (smartphones, tablets). Purpose: evaluation of audience participation.
Qualitative	Expanding the Role of the Instrument	5 families (usability lab), 12 users (rehabilitation center)	Qualitative (ethnographic data, video recordings, interviews)	No dedicated technology reported. Purpose: evaluation of audience relationship with the system.
Qualitative	Reflets: Combining and Revealing Spaces for Musical Performances	~30 participants in public demos; 8 performers in workshops	Qualitative (written comments and group discussions)	No dedicated technology reported. Purpose: evaluation of audience experience.
Qualitative	SVOrk: Stanford Virtual Reality Orchestra	~60 audience members across 5 concerts; 21 questionnaire responses	Qualitative (post-concert anonymous survey, open-ended responses)	No dedicated technology reported. Purpose: audience feedback on immersion, interaction, social experience, and VR concert framing.
Qualitative	REXband: A Multi-User Interactive Exhibit for Exploring Medieval Music	18 participants (controlled lab study); several hundred visitors in public exhibition	Qualitative (observations, retrospective interviews)	No dedicated technology reported. Purpose: evaluation of learning, engagement, and usability in an educational interactive exhibit.
Qualitative	Towards New Modes of Collective Musical Expression through Audio Augmented Reality	9 participants in small groups (art installation setting)	Qualitative (group interviews, grounded theory analysis)	No dedicated technology reported. Purpose: evaluation of audience experience using audio AR to support collective musical expression.

Table 8: Overview of Non-participatory NIME with formal data collection.

Titolo paper	Type of data collected on the audience	Methods for collecting data (technologies or traditional)
Movement in a Contemporary Dance Work and its Relation to Continuous Emotional Response	Quantitative: movement and audio data	pARF and PDAs with touchscreen and stylus; continuous ratings of arousal (sleepy vs. excited) and valence (sad vs. happy).
Liveness Through the Lens of Agency and Causality	Quantitative: agency and confidence ratings	Traditional methods: questionnaires (scale 1–10).
Visualizing Gestures in the Control of a Digital Musical Instrument	Mixed-methods: quantitative and qualitative (author observation of audience)	Traditional methods: post-performance questionnaires (Likert scale 1–5) and open comments.
Movement to emotions to music: using whole body emotional expression as an interaction for electronic music generation	Mixed-methods: quantitative and qualitative	Traditional methods: questionnaires and open comments.
Considering Audience's View Towards an Evaluation Methodology for Digital Musical Instruments	Mixed-methods: quantitative and qualitative	Traditional methods: post-performance questionnaires (Likert scale 1–5) and open questions.
Using a seeing/blindfolded paradigm to assess audience response of a live-electronic performance with voice	Mixed-methods: quantitative and qualitative	Traditional methods: open written responses and guided written responses.
Evaluating the Audience's Perception of Real-time Gestural Control and Mapping Mechanisms in Electroacoustic Vocal Performance	Mixed-methods: quantitative and qualitative	Traditional methods: Likert-scale questions and free-text responses (thematic analysis and percentage comparison of occurrence).
residUUm: user mapping and performance strategies for multilayered live audiovisual generation	Mixed-methods: quantitative and qualitative	Traditional methods: post-performance questionnaires (Likert scale 1–5) and open questions (thematic analysis).
Skip the Pre-Concert Demo: How Technical Familiarity and Musical Style Affect Audience Response	Mixed-methods: quantitative and qualitative	Traditional methods: post-performance questionnaires (Likert scale 1–5) and open questions (thematic analysis).
Risky Business: Disfluency as a Design Strategy	Mixed-methods: quantitative and qualitative	Metrix mobile interface for real-time interaction (enjoy vs. error), followed by post-performance questionnaires (Likert scale 1–5) and open questions.
All You Need Is LOD: Levels of Detail in Visual Augmentations for the Audience	Mixed-methods: quantitative and qualitative	Traditional methods: questionnaires (Likert scale 1–7) and post-performance interviews; ANOVA, non-parametric tests, Bayesian factors (BF).
Feel What You Don't Hear: A New Framework for Non-Aural Music Experiences	Mixed-methods: quantitative and qualitative	Traditional methods: post-performance questionnaires and interviews.
The Hyper-Ney: An Enhanced Traditional Flute	Mixed-methods: quantitative and qualitative	Traditional methods: post-performance questionnaires (scale 1–10) and open questions.
PORTAL: An Audiovisual Laser Performance System	Mixed-methods: quantitative and qualitative	Interactive online survey, free-association tasks, and open comments.
Illusio: A Drawing-Based Digital Music Instrument	Mixed-methods: quantitative and qualitative	Traditional methods: interactive online survey (Likert scale 1–5) with open and closed questions.
Gesture and Narrative: Blending Human Performance with Visual Storytelling	Qualitative	Online survey with open-ended questions.
Audience experience in sound performance	Qualitative	Semi-structured interviews of approximately 10 minutes conducted post-performance.