Bringing LuminAI to Life: Studying Dancers' Perceptions of a Co-Creative AI in Dance Improvisation Class

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Abstract

The intersection of dance and artificial intelligence presents fertile ground for exploring human-machine interaction, co-creation, and embodied expression. This paper reports on a seven month four-phase collaboration with fifteen dancers from a university dance department, encompassing a preliminary study, redesign of LuminAI-a co-creative AI dance partner-, a contextual diary study, and a culminating public performance. Thematic analysis of responses revealed LuminAI's impact on dancers' perceptions, improvisational practices, and creative exploration. By blending human and AI interactions, LuminAI influenced dancers' practices by pushing them to explore the unexpected, fostering deeper self-awareness, and enabling novel choreographic pathways. The experience reshaped their creative sub processes, enhancing their spatial awareness, movement vocabulary, and openness to experimentation. Our contributions underscore the potential of AI to not only augment dancers' immediate improvisational capabilities but also to catalyze broader transformations in their creative processes, paving the way for future systems that inspire and amplify human creativity.

CCS Concepts

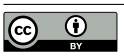
• **Human-centered computing** → **User studies**; • **Do Not Use This Code** → **Generate the Correct Terms for Your Paper**; *Generate the Correct Terms for Your Paper*; Generate the Correct Terms for Your Paper; Generate the Correct Terms for Your Paper.

Keywords

co-creativity, co-creative AI,co-creative agents, dance improvisation, movement improvisation, AI agents, computational creativity, dance, dance technology, diary study

ACM Reference Format:

Jasmine Kaur, Milka Trajkova, Andrea Knowlton, and Brian Magerko. 2025. Bringing LuminAI to Life: Studying Dancers' Perceptions of a Co-Creative AI in Dance Improvisation Class. In *Creativity and Cognition (C&C '25), June 23–25, 2025, Virtual, United Kingdom.* ACM, New York, NY, USA, 13 pages. https://doi.org/10.1145/3698061.3726925



C&C '25, Virtual, United Kingdom

ACM ISBN 979-8-4007-1289-0/25/06
https://doi.org/10.1145/3698061.3726925

1 Introduction

Co-creativity (i.e. real-time creative partnerships), manifests in our daily lives as an ongoing process of creative negotiation. It involves a close-knit interaction between the participants, working together to produce a shared outcome—whether in the form of an artifact or performance—in contexts such as dance, sports, work, and play [24, 71]. Research has examined how co-creativity involves cognitive, perceptual, and behavioral processes between humans and computers [3, 19, 39, 40] in art [16, 50, 68], languages [67], music [21, 34] and dance [75]. Although HCI research has explored co-creative tools in labs and museums [16], to the author's knowledge, no prior work examines the extended use of such tools in real-world settings and its implications for designing co-creative AI. This research explores how co-creative AI can be integrated into the practices of formal dance classes.

We seek to investigate how an embodied co-creative AI tool, called *LuminAI*, can support the creative processes and experiences of college-level dancers over the course of a semester-long movement improvisation class. The goal of the class was to create a collaborative performance showcased to the public at the end of the semester. By examining this unique context, we aim to uncover insights into the design, implementation, and long-term use of co-creative AI systems in educational settings–shedding light on their potential to enhance creativity and innovation in the performing arts. The studies we present in this paper stem from a larger ongoing project that aims to understand the design of co-creative AI for movement improvisation.

We aim to answer the following research questions: **RQ1: How can we (re)design an embodied co-creative AI, LuminAI, for a college-level dance environment?; RQ2: How does LuminAI influence dancers' perceptions and sub-processes of creativity in a semester-long movement improvisation class?** We collaborated with a dance department within a large southeastern United States university for seven months to understand how we can design and subsequently evaluate LuminAI. We conducted a preliminary study with five dancers to evaluate initial use and performed an open coding analysis to extract themes and design

changes. We then introduced the tool in the following semester in a movement improvisation class with ten dancers and one instructor. We conducted a contextual diary study [32, 44] across 13 class sessions to explore improvisational dance movements with an embodied co-creative AI tool, focusing on the user experience of dancers and how barriers impact their creative expression. The gap in designing co-creative AI for prolonged use that co-create with humans in embodied domains is addressed, fostering innovation through interactions and real-time movement generation. The idea of working in a group with the AI as an extra collaborator was emphasized, as participants reflected on its ability to inspire and generate improvisational choreography ideas [6, 7, 20, 33, 86].

We take a holistic approach to create an intuitive and flexible tool that tracks individual creative styles and leverages AI to generate meaningful, human-friendly suggestions [62]. Ultimately, the focus is on improving how machines interact, respond, and collaborate with us [53, 54] for which we built our agent to possess creative agency and support open-ended improvisational interactions [24]. We are building towards developing guidelines for AI software to support embodied interactive agents that can co-create in movement-based improvisational domains in a transparent and flexible manner.

2 Foundational Research

Previous work developed LuminAI, an interactive installation where an AI agent, projected onto a holographic screen, collaborates with a human partner to improvise movement [74]. Using an Azure Kinect for motion capture, the AI analyzes the human's movements through movement theories, learning from past gestures and generating new ones. LuminAI was initially designed with a top-down approach, based on computational formalizations of improvisational movement theories from theater- Viewpoints Theory [8] and dance-Laban Movement Analysis [42], and tested mainly with non-dancers. Trajkova et al. [75] shifted to a more human-centered approach involving dance students in the design process to explore a model for deeper communication and coordination dynamics that emerge from years of practice. In this study, we translate the model into an interface for dancers to interact with in the classroom while creating an AI agent capable of expert-level improvisation and ensure its usefulness to dancers.

We work towards augmenting dancer creativity and reshaping artistic and pedagogical practices. Drawing from previous work with non-dancers, the focus in this work is understanding the attitudes towards and perceptions of introducing a co-creative AI in a dance class. LuminAI, has been tested in public spaces like museums [46] and been studied with various machine learning approaches to better understand how to visualize improvisational movements for co-creative domains. The system utilizes a dyadic call and response system–allowing the human and AI to collaboratively generate improvisational movements.

3 Related Work

Drawing from diverse fields including dance improvisation, dance technologies, creativity enhancement through digital tools, and co-creation in artistic contexts, this work investigates the integration of AI in improvisational dance, exploring how technological advancements can influence and collaborate with embodied human creativity in dance education and performance.

3.1 Dance Improvisation

Improvisation is one of the most rigorous forms of creative behavior [5, 57] and is pivotal for artistic exploration, cultural preservation, and innovation in dance [4, 7, 7, 37, 51, 57]. Dance improvisation is the concurrent creation and performance of movement. This movement is conceived without prior planning by dancers [11, 57]. Essentially, it is the spontaneous "movement of the moment" [7] demanding immediate action and interaction from dancers. Dance improvisation involves the interdependent thoughts and actions of performers, where each performer's cognitive and behavioral requirements go beyond their perspective to involve the decisions and responsiveness of others [58]. It fosters creativity, permits exploration of new movement configurations, and facilitates personal expression [25, 48].

3.2 Dance Technologies

Traditional tools like mirrors [59, 60] and modern technologies such as motion capture through Kinect, depth cameras [14, 70] and mixed reality [17, 69, 82, 84] have influenced dance, with diverse applications ranging from creative composition tools to systems supporting dance education. Notably, early explorations into the intersection of technology and dance can be traced back to the work of Merce Cunningham, who in the 1990s began experimenting with computer-generated choreography using the LifeForms software to create movement sequences [66]. The former offers positive static movements but hinders technique, kinesthetic awareness, and retention while also simultaneously influencing body image [23, 59] and the latter not only displays movement in a virtual setting but also records the student's motion and offers immediate feedback [61]. There also has been recent work studying interactive AI dance tools [77, 78], however, there is limited work in incorporating AI-driven decision-making specifically for improvisation in the arts.

We focus our attention on the potential of AI in the field of improvisational dance, which has been explored in several studies including multimodal dance movement recognition based on AI image technology by Zeng [83], the application of dynamic process neural network model identification in ethnic dance online teaching systems, demonstrating the use of AI in dance education by Hu & Hou [35], application of AI in college dance teaching and its performance analysis, discussing the potential of AI in enhancing dance education by Wang & Zheng [80] and concept of artificial improvisation, where AI-based conversational agents performed improvisational theater alongside human actors by Mathewson & Mirowski [49], among others. Liu and Sra have adopted a web design led strategy to support ideation to create choreographic prototypes in DanceGen by generating dance sequences with a user-friendly interface to highlight the iterative process of dance choreography [45].

These studies collectively demonstrate the potential and diverse applications of AI in the field of improvisational dance. To evaluate the impact of these collaborative technologies, Filippo et al. recommend defining common constraints for humans and AI and have a human audience evaluation factor [22]. Technology in artistic

domains has also been subject to various lenses of evaluation, including Candy's model [15] and Kaufman's creative subprocesses [9]. We build on these studies to explore the positionality and experience of AI in improvisational dance classrooms.

3.3 Enhancing Creativity and Collaboration through Technology

Embodied human-AI learning in dance education integrates physicality with digital tools, enhancing the creative process through interactive, data-driven feedback and collaborative virtual experiences [36]. The synergy between body and technology creates a hybrid learning model, as dancers utilize video analysis [31, 47, 81], digital choreography tools [26, 52], and interactive learning resources to augment traditional training methods. Mobile technology applications, such as movement analysis apps, allow dancers to capture and critique their performances with precision, helping refine techniques and prevent injuries through measurable insights [2, 27, 85]. Furthermore, digital platforms facilitate asynchronous and remote rehearsals, fostering collaborative projects that transcend geographic limitations [12, 56]. This integration not only expands access to diverse resources but also supports a democratic learning environment where dancers from various backgrounds can contribute and express their unique perspectives.

Despite these advancements, challenges in embodied AI learning highlight the importance of maintaining physical presence and community in dance education [29]. Over-reliance on digital tools can detract from the somatic, experiential elements fundamental to dance, potentially leading to reduced physical engagement and increased cognitive overload [30]. The forced shift to online platforms during the COVID-19 pandemic underscored both the possibilities and limitations of digital dance instruction, where students gained autonomy yet often faced isolation from in-person guidance and peer connection [63]. Addressing these concerns, embodied AI learning must balance digital support with an emphasis on physical practice, allowing dancers to internalize embodied knowledge while leveraging the rich, co-creative potential of technology to foster innovation and inclusion in the art form.

3.4 Co-Creation in Dance

In the context of co-creation, projects like LuminAI have introduced AI as an improvisational partner in dance [75]. LuminAI allows dancers to collaborate with the system in real-time, generating fresh, innovative sequences. By offering novelty in its movement response, LuminAI steers dancers away from their habitual patterns, fostering creativity and spontaneity. The collaboration between human and AI in such projects highlights the equilibrium between control and spontaneity in dance, offering fertile ground for exploration into embodied expression. LuminAI emphasizes unpredictability, where dancers must react to the AI's movements as part of a dynamic, co-creative process. The integration of AI into improvisation generates unique, unexpected movement possibilities, enriching the creative process by challenging traditional methods and fostering new forms of collaboration. The system facilitates bidirectional influence, wherein movements performed by dancers in front of the agent are recorded and stored in a database. The AI model is trained on this dancer-generated data, enhancing its capabilities and enabling it to function as a more informed and contextually responsive agent. This work, explained in the following subsections, extends the scope of what AI can contribute to dance spaces, setting the stage for even more intricate and responsive systems that balance human unpredictability with AI's adaptive capabilities.

4 Study Design

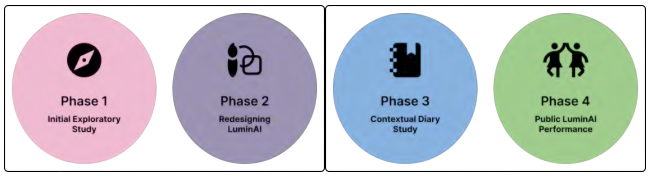


Figure 1: Study Design across four phases from initial exploratory study leading up to the public performance

The research unfolded in four phases per Figure 1: (1) initial exploratory study; (2) redesigning LuminAI; (3) contextual diary study; and (4): public performance, which contributed to one of the world's first collaborative improvised dance performance between humans and AI. This research was approved by our university's IRB before the study took place.

4.1 Phase 1: Preliminary Study

The preliminary study was conducted in a dance studio (outside of a class setting) that involved a 15-minute interaction session with LuminAI with **four dance students (D1-4)** and **one instructor (I)** from a Bachelor of Arts program in the Southwest United States. The dancers, all identified as female, had 12+ years of formal dance education across at least six dance forms, including Contemporary, Improvisation, Hip Hop, Ballet, Jazz, Musical Theater, Lyrical, African, Tap, Latin, and Senegalese. Recruitment was conducted through an open-call for dancers who had already studied modern improvisation.

We conducted 45-minute to 1-hour semi-structured interviews to gather in-depth insights into participants' experiences. The interviews focused on how dancers perceived movement output from LuminAI and how it impacted their creative expression in comparison to traditional dance settings. Participants were also encouraged to reflect on the challenges and limitations of the system, offering feedback on the interface design and suggesting future use cases for LuminAI in dance and movement improvisation. The interview data was analyzed by two researchers using open coding to identify recurring themes and extract design suggestions. Participants were also given printouts of LuminAI's interface to sketch ideas for further development.

4.2 Phase 2: Redesigning LuminAI

The learnings from the initial study, described in the results section, were synthesized to redesign LuminAI. Researchers collaborated with a real-time Unity visual developer to design a user interface on top of LuminAI's existing interface.

4.3 Phase 3: Contextual Diary Study

Phase three included curating a curriculum in collaboration with the same instructor that directly embedded LuminAI into a movement improvisation class setting. This phase also involved an iterative design cycle for LuminAI driven by researcher observations and ongoing user feedback across 13 class sessions (including an onboarding) in the second half of the semester while continuously improving the interface.

This phase involved **ten dancers (D1-D10)** between the ages of 18 to 26 and **one instructor (I)**. These dancers (nine identifying as female and one as male) were undergraduates pursuing majors in dance, theater, psychology and exercise sciences and had 4 to 18 years of professional dance and choreography experience across modern/contemporary, improvisation, jazz, tap, African/afrobeats, hip-hop, liturgical, lyrical, musical theater, acrobatic, ballroom, Latin: bachata, salsa, tango, heels, belly dance, Chinese folk, and flamenco among other dance forms. The students had also been involved in a dance performance between 1 to 10+ times in the past year. The instructor who self-identified as a female has 21 years of teaching experience. The instructor is a choreographer, filmmaker, and educator with expertise in dance technique, improvisation, pedagogy, and the integration of technology in dance.

Each one hour and 15 minute session included a class or rehearsal format. The class structure started with a 15-minute warm-up, including attendance, announcements, and physical exercises to prepare the dancers mentally and physically. Next, there was a 20–30-minute segment focused on introducing specific concepts like points, lines, and compositional devices. Dancers engaged in guided exercises to explore these ideas individually or with partners.

Afterward, dancers spent 30–35 minutes interacting with LuminAI, applying the concepts and exploring movement qualities like weight, time, and space. They refined their physical expressions through solo, duo, or group activities. The class ended with a 10–15-minute group activity where dancers collaborated to create, practice, or refine movement sequences inspired by LuminAI or the class theme.

The class concluded with a 10-minute reflection and journaling session, during which dancers document their experiences, insights, and areas for improvement, fostering a reflective learning process that reinforces the day's activities. This structure balanced physical preparation, conceptual exploration, creative interaction, and reflective practice, ensuring a comprehensive and dynamic learning experience.

The diary entries included: an emotion wheel to describe how the dancers felt about their interaction with LuminAI that day followed by questions regarding the role of LuminAI in challenging their improvisation, expressiveness and collaboration. Each question was accompanied with an open field for the dancers to add their thoughts. We also asked the dancers to share their pain points and describe if they adapted in any specific way in the class to overcome their problem. The students also completed two reflections - one halfway through the semester and one at the end, in either written or verbal forms that included questions such as: "Have your impressions of our dance & AI collaboration changed since it was first introduced to our classroom? Why or why not?", "How has interacting with LuminAI influenced your movement idea generation and emotional expressiveness? Can you share specific examples if/where LuminAI impacted your creative process?" and "Can you discuss the differences in your experience when interacting with LuminAI as a dance partner compared to a human partner, focusing on emotional and creative aspects?"

4.4 Analysis Methodology

We transcribed and analyzed the diary entries through open coding and thematic analysis to address the first research question. For the second question, we examined the creative environment, including interactions with LuminAI, peers, and the activity itself, using Kaufman's creativity subprocesses [9].

4.5 Analysis

Diary entries were extracted from Qualtrics, and verbal reflections were transcribed prior to analysis. We used thematic analysis to identify common themes from diary entries and reflections. Our thematic analysis approximated the codebook approach described by Braun and Clarke [18], in which researchers employ a structured coding framework, though the agreement among coders and inter-rater reliability are not typically considered quality indicators. Themes are usually established at the outset but can be refined or new ones generated through an inductive approach to data analysis [10].

We utilized an inductive process to generate themes by interpreting the data. Two authors engaged with the transcripts and identified codes (capturing single observations) within a collaborative document [10]. Then, we collaboratively grouped codes that reflected shared meaning into higher level themes. The process of grouping codes into themes was started asynchronously in a collaborative document, with calibration during weekly meetings. Disagreements between team members were resolved through group discussion. We identified 247 codes that were then organized into eight broad themes.

4.6 Positionality

We acknowledge that in thematic analysis, researchers' backgrounds and interpretative lenses play an important role in data analysis [14]. We provide context on the authors' backgrounds to aid the reader in interpreting our results. The first author is a human-computer interaction researcher with a background in professional dance. The second author holds a Ph.D. in human-computer interaction and has a background as a professional ballet dancer. The third author is a dance professor with 34 years of dance training and has previously worked with most of the students in the study. The last author holds a Ph.D. in computer science and engineering, has a background in computer science and cognitive science, and has over two decades of experience working on projects involving cognitive science, co-creative AI, museum/art installations, and educational media design.

5 Results

5.1 Phase 1: Preliminary Study

The preliminary study revealed key insights into participants' experiences with LuminAI, categorized into four overarching themes: Improv Practices, Interface Design, Applications of LuminAI, and Attitudes towards LuminAI, visualized in Figure 2. A total of 44 open and in vivo codes were identified, offering a nuanced understanding of the interaction between dancers and the AI tool. This subsection outlines the themes identified and considered for the redesign of the agent. However, not all recommended changes were implemented. Prioritization was based on the project requirements and the development process. The changes that were implemented are highlighted in the subsequent subsection.

In the theme of **Improvisation Practices**, participants highlighted

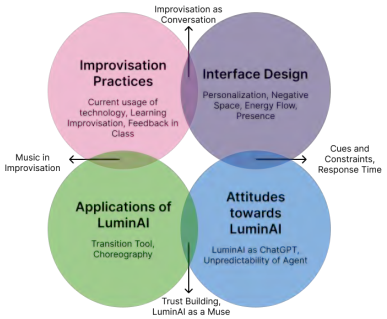


Figure 2: Themes and Codes generated by open coding after preliminary study: Improvisation Practices, Interface Design, Applications of LuminAI and Attitudes towards LuminAI

the role of feedback in dance, particularly regarding movement quality and anatomical positioning. While LuminAI's movements were sometimes perceived as unnatural, they often inspired creativity. Participants suggested the idea of technology reflecting individual style and preferences. One participant noted, *"It made me think of 'Just Dance... how each mode had a motive like high energy or slower movements"* (D1).

Under **Interface Design**, the importance of physicality and movement analysis also emerged, with dancers interested in how AI could analyze body positioning and offer tailored feedback. They emphasized the need for the AI to adapt to different levels of expertise and individual physical capabilities. Dancers envisioned AI tracking data like tempo and cadence, similar to how they currently use devices like phones for choreography reviews. Participants also explored spatial awareness and environmental interaction, proposing that LuminAI could reflect frequent movements through visual cues, such as color changes, to enhance spatial understanding. The instructor suggested, *"If I'm working in a particular area a lot, does it start to turn a different color, like a mood ring?"* (I).

The design of LuminAI's interface also shaped the **dancer's attitudes towards LuminAI**. Technological interaction was influenced by the tool's unpredictability of movements, with participants expressing a desire for more human-like visual representations of the AI agent. There was feedback on improving motion tracking capabilities, as current limitations in movement detection affected their engagement with the tool. Finally, participants viewed LuminAI applied in the studio as a **potential partner in overcoming creative blocks, stimulating new ideas, and aiding in improvisation.** They envisioned its role in dance studios and performance settings, considering it a valuable tool for partnered improvisation in education and professional dance.

In summary, the findings highlight the potential for co-creative AI tools like LuminAI to enhance creativity, performance, and dance education, while also uncovering areas for improvement in personalization and technological capabilities.

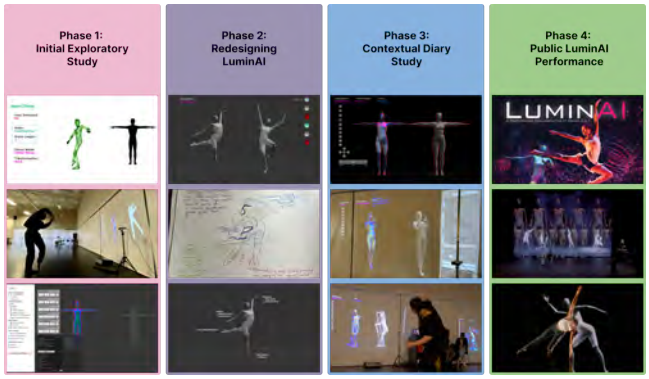


Figure 3: Evolution of agent design and fidelity across the four phases

5.2 Phase 2: Redesign of the agent

This subsection includes preliminary design recommendations that were generated from the exploratory study and implemented on LuminAI's interface to support co-creation and creative exploration. The redesigned agent was then introduced in a movement improvisation class, results from which are discussed in the following subsections. The evolution of agent design is visualized in figure 3.

5.2.1 Visual Grounding and Energy Flow Depiction. Participants emphasized the importance of visually grounding LuminAI to enhance its presence and improve the perception of movement dynamics. Feedback highlighted the need for a virtual "floor" to better reflect anatomical positioning and differentiate between grounded and elevated movements. Additionally, participants preferred visual representations that felt smoother and more human-like over abstract, particle-based designs. *"I think of the floating aspect of the agent and feel like a floor needs to be there. So then it can differentiate between one leg on the floor, one leg held up."* - D3. We subsequently introduced a virtual floor within LuminAI's interface to orient the human dancer and help them find stable balances with anatomical positioning. On another topic, D4 mentioned, "*I really liked when it switched its coloration to a smooth look because it rounded it out a lot, which made it more human. The dots feel very dissipating and fleeting versus the smooth skin which has curves and edges.*" We therefore redesigned the AI's appearance to include smooth, flowing visual elements that reflect energy flow and movement dynamics, making the interaction more engaging and relatable.

5.2.2 Tempo Synchronization and Transparency. Participants noted challenges with the AI's movement responses, citing a lack of synchronization and abrupt tempo shifts that disrupted their improvisational flow. Transparency in how LuminAI tracks and interprets movement was also identified as crucial for building trust and improving usability. *"Sometimes it felt kind of scattered because it would do a movement super fast. And I was like, okay, that was a lot of information all coming at once versus it moving at the same cadence and speed that I was moving prior. So having that match up will improve movement response."* - D4. We offered speed options on the interface to allow dancers to fine tune the agent to better match their cadence, creating a smoother and more synchronized interaction to ensure the AI's responses were intuitive and aligned with the user's flow.

5.2.3 Personalization through Profile Features. Participants expressed a strong desire for tailored interactions, emphasizing the value of tracking individual movements and styles. A proposed profile feature would allow users to store and revisit their movements, fostering adaptability to their unique expertise and physical capabilities. *"Having that match up will improve movement response... also, it'd be amazing to revisit movements I've worked on."* – I. Our team developed a tagging system within the classroom version of LuminAI to personalize interactions. Dancers' names were tagged during their interactions, and their movements were saved in the database. Future work would include a full profile feature to store user-specific data, enabling long-term personalization, and adaptability for each dancer to train individual avatars in their own likeness.

5.2.4 Spatial Awareness through Visual Cues. Participants envisioned LuminAI using spatial cues to enhance environmental interaction. For example, the system could visually reflect frequent movements by changing colors in specific areas, aiding spatial awareness and creative exploration. *"If I'm working in a particular area a lot, does it start to turn a different color, like a mood ring?"* - I. We explored integrating color-based visual cues to indicate spatial patterns, though this feature was reserved for future iterations due to development constraints.

The implemented changes were tested in the classroom version of LuminAI during the diary study, visualized in Figure 4. These updates were introduced to better align LuminAI's capabilities with dancers' needs and preferences. The findings from the diary study will further inform future iterations, deepening the integration of co-creative AI tools into the dance studio. Learnings and insights from the course curriculum's application are described in the following subsection.

5.3 Phase 3: Contextual Diary Study

We applied open coding in the analysis of journal entries across 13 class and rehearsal sessions, supplemented by two written reflections from dancers, and identified 247 unique codes. These codes were then organized into seven broad themes visualized in Figure 5 and discussed below that collectively illuminated several key insights about dancers' experiences with LuminAI.

5.3.1 Creative Exploration and Improvisation. This theme refers to how LuminAI pushed dancers to explore unfamiliar movements and expand their artistic boundaries. The tool inspired users to

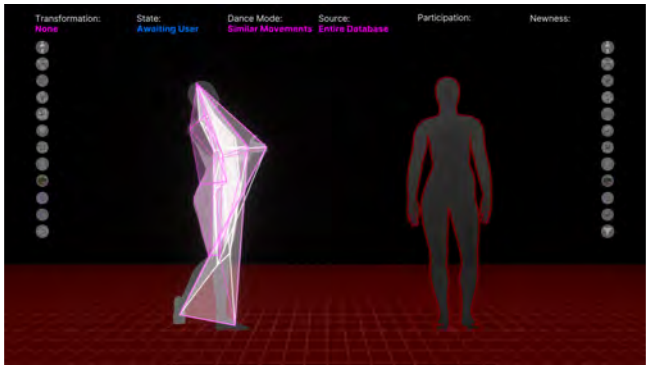


Figure 4: Final interface of LuminAI used by dancers in their classroom with toggle buttons for visualizations

Figure 5: 7 major themes identified from diary study along with their 23 sub themes

experiment with unconventional ideas and embrace challenges, fostering a sense of openness and creativity. By interacting with LuminAI, dancers enriched their improvisational language and cultivated new perspectives on artistic expression.

"These algorithms can emphasize and affect features such as style, mood, and technique. Not only do they underline artistic expression, but they ensure precision and creativity throughout the process." - D10

LuminAI also encouraged dancers to explore "impossible" movements that the AI could perform due to lack of physical limitations, leading to playful experimentation and deeper engagement with their craft. This theme highlights the tool's potential to serve as a catalyst for innovative ideas in both rehearsal and performance settings.

5.3.2 Collaboration and Partnership with Both Humans and AI. This theme indicates the interplay between dancers, their peers, the instructor and AI systems, focusing on how LuminAI supports co-creative dance practices. Participants highlighted the uniqueness

of LuminAI as a dance partner, emphasizing its ability to offer movement suggestions and act as a reflective tool for improving improvisation and self-expression. However, they noted differences in synergy compared to human-human partnerships.

"The role of AI has always been a tool. I never perceived it to be a replacement for real dancers or a virtual improvement of expression. It made me realize how many working parts of the body there are, and it made me more self-aware. It can show you your movement vocabulary while also showing you modified or new ways to move… Can I make it show me something different? I wanted to be very intentional about using it to improve my improvisation." - D4

5.3.3 Self-Awareness and Body Awareness. Self-awareness and body awareness refers to the dancers' growing understanding of their own movements, energy flow, and physical limitations while interacting with LuminAI. The system encouraged dancers to expand their movement vocabulary and adapt the AI's suggestions to align with their styles. Participants described how LuminAI fostered critical thinking about spatial relationships, movement quality, slowing down movements and energy use. This awareness extended to understanding effective use of negative space and emphasized simplicity, guiding dancers back to fundamental movement principles.

"I saw its usefulness as a tool and changed my perspective from 'limited' to 'simple.' Sometimes we overcomplicate things as dancers when it comes to improvisation. During the semester, I felt that the main theme was 'going back to basics.' Rooting myself in the movement—AI helped me accomplish that." - D4

"It influenced the movement generation. I really enjoyed the exercise where we embodied the avatar's movement, learning what it had created. This challenged our timing and capabilities, as the avatar often makes choices that are jerky or static, and it also creates impossible shapes with its body – it can be interesting and fun to try to embody the impossible." - I

The insights from this study **suggest that AI tools like LuminAI can support long-term engagement by fostering physical awareness and self-awareness among dancers.** The tool currently operates independently of music, but participants suggested adding rhythm and timing to improve synchronization and movement dynamics.

5.3.4 Journey in Perceptions and Acceptance of AI. Participants described a journey in their perceptions of AI, evolving from initial skepticism to curiosity and acceptance. Over time, they began to see LuminAI as a creative partner rather than a mere tool. This shift was driven by the system's ability to encourage diverse movement variations and interdisciplinary integration.

"I am still skeptical about the avatar's movement, but it serves as creative inspiration to move my body in ways I haven't considered before." - D6

"It grew on me once I saw the avatar creating different shapes for me to play with. I also enjoyed the different effects attached to the avatar, including the grid design, thermal-like coloring, and the graphic one." - D6

Participants noted that LuminAI helped them fine-tune their movements and develop a deeper connection with their bodies, particularly during rehearsals and performances. The tool's visualizations, envisioned in Figure 6, such as geometric designs and energy flow representations, were particularly well-received for their ability to inspire creative decision-making.

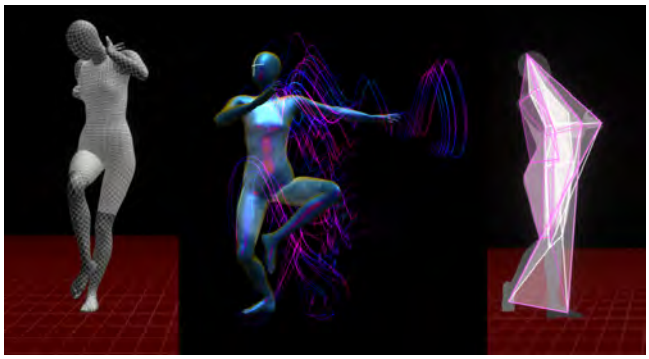


Figure 6: Agent visualizations for dancers to use: Gridlines, Motion Delay Energy Flow Visualization, Geometric shapes

5.3.5 Challenges and Limitations of LuminAI. Despite its strengths in creative exploration and self-awareness, LuminAI faced challenges with tracking accuracy and limited movement range, highlighting the need for improved body-tracking technology. Participants often experienced glitches, inaccurate movement detection, and restricted movement choices due to the system's limitations. Previous Motion Capture suits [74] also suffered from issues like high cost, fragility, and flammability. As D5 noted, *"It would sometimes glitch, not picking up my movements correctly...the AI would stutter during the response process"*. These technical issues disrupted interaction and limited dancers' ability to express complex movements.

Although LuminAI aimed to inspire creative exploration, its lack of human-like qualities made it difficult for dancers to engage emotionally. The instructor elaborated on this limitation, stating, *"LuminAI does not compare to improvising with a real partner at this point. It is a challenge to identify cause and effect between what you offer and what is offered back. Since there is no eye contact, breath sounds, or ability to move throughout space, much of the excitement that occurs with a real partner is not created through the avatar. The element of risk that exists between two partners is not present either – risk of being embarrassed, or the risk of genuinely having a connected experience, risk of running into each other, or the risk/opportunity of making physical contact."* This lack of physicality and spontaneity diminished the sense of connection that dancers typically experience during partnered improvisation.

To unlock LuminAI's full potential, improvements in body tracking, movement repertoire, and the development of features fostering collaboration and connection are needed. Enhancing these aspects will help LuminAI become a more effective tool for dance education and creative exploration.

5.3.6 Learning and Skill Improvement. LuminAI served as a powerful tool for dancers to break away from habitual patterns. The system prompted a reduction in repetitive movements by challenging participants to step outside their comfort zones, enabling dancers to rediscover the fundamentals of their practice. This theme of "back to basics" emerged as a significant point of reflection for

many participants, who found that LuminAI's unique interaction style encouraged simplicity and precision over complexity.
For instance, D2 reflected, *"LuminAI allowed me to draw awareness from how I result in doing the same movements over and over again, and I kind of result in a lot of turns and a lot of leg things and, and never really stationary. So it forced me to be stationary when I did my dancing."* This observation highlights the system's capacity to disrupt established habits and encourage dancers to explore unfamiliar dynamics in their improvisation.
Participants discovered the value of simplicity as a foundation for accuracy and creativity. The system's feedback often led dancers to engage with complex human movements in a more intentional and mindful manner, fostering an environment where simplicity became a pathway to deeper artistic exploration. LuminAI also presented movement challenges that required heightened awareness and adaptability. This interplay between simplicity and complexity allowed dancers to refine their skills while expanding their creative boundaries, marking a significant contribution to their overall learning and skill improvement journey.

5.3.7 Applications and Future Outlook. Participants envisioned diverse applications for LuminAI, ranging from dance education and performance to STEAM fields and injury prevention. They also suggested that future iterations of LuminAI could serve as a teaching tool, warm-up partner, and choreographic aid, underscoring its potential to become an integral part of creative and educational practices in the arts.
Participants emphasized the potential for AI to bridge the gap between STEM and the arts, inspiring future generations to explore interdisciplinary approaches. *"AI has expanded my view on dance through an anatomical and physiological lens. I feel as though this dance collaboration will inspire me to show my future students how STEM and the arts can come together despite the many misconceptions spread out there. Dance remains very human to me and AI can somewhat bring out the human-like mechanics behind how our body moves."* - D6

5.4 Impact on Creative Sub-Processes

Participants' journal and written reflection data was subject to another round of coding to identify how LuminAI in the classroom impacted creativity among dancers. The creative process is multifaceted, encompassing both cognitive and emotional dimensions that contribute to the **generation** of novel and useful ideas. Building on the second research question, this study aims to deepen our understanding of how creativity emerges within complex and interactive environments. We examined the subprocesses outlined by Boldt and Kaufman [9], which gave us a structured framework for understanding how dancers navigate and regulate their creative process while improvising with LuminAI. We start with generation relating to divergent thinking tasks, which is highlighted in most creative processes [1, 55, 65, 76]. In our context, the dancers actively generated multiple movement options during improvisation to see how LuminAI interacts with their creativity. *"LuminAI influenced my movement idea, and emotional expressiveness"* - D2

The second subprocess is **elaboration**, which involves developing and adding details to preliminary ideas [28, 55, 65]. In this context, after an initial movement is mirrored by LuminAI, the user refines their movement by adding intricate movements or altering the speed and rhythm to explore how the AI adapts. The dancer elaborates on initial ideas, building on the interaction to deepen the complexity of the creative dialogue. D1 elaborated on the visualizations of the geometric tool *"I really like the geometric tool and it helped me make different decisions than what I normally would."*

When dancers incorporate culturally rooted movements, like traditional jazz or hip-hop, into their performance and observe how LuminAI interprets them, it falls under **association**, where one reflects on instances where one establishes connections between their creative work and external memories and knowledge structures [1, 55, 65]. This subprocess is evident when the dancer draws upon external knowledge or memories to enrich the creative exchange with the AI. Association can also be with peers in a classroom. *"I applied my background in majorette and hip hop on the avatar to create more meaningful shapes and movements"* - D6

At some point during creative work, individuals must decide which of their generated ideas to select and execute [13, 55, 64, 76, 79]. The dancer uses **selection** as a creative subprocess to choose specific movements that best enhance the collaboration to produce the most compelling interaction with LuminAI and incorporates it into a performance sequence. We recognized multiple overlaps, making it evident that the dancers engaged with multiple creative sub-processes at same time. For instance, *"It challenged my ability to not do things that I usually do when I improv because I tend to do movements that I'm familiar with"* - D9 falls under selection, as the student was choosing to avoid familiar movements. At the same instance, the student was reorienting their approach to improvisation, by employing the **Anchoring** subprocess, where the participant orients themselves by acknowledging, establishing, or refining goal(s) or constraint(s) related to their work [1, 55, 64, 65, 76, 79]. The same quote also highlights the creative metacognition subprocess as the dancer is reflecting on habitual patterns and strategies. **Creative Metacognition** encompasses the use of metacognition both in the creative process and toward the creative product, as well as understanding the right times to be creative [41, 43]. In this context, the dancer reflects on how their previous movements influenced LuminAIs behavior and plans how to steer future interactions. The dancer monitors their creative process and strategically adjusts their approach to maximize the co-creative potential of LuminAI.

Similarly, the following quote by D9 shows usage of Creative Metacognition and Evaluation as the participant critiques the AI's limitations and reflects on how these impact their creative process. *"I think I would maybe change the way the AI picks up the movement, because sometimes it processes what we're doing really slowly. And I think it's used to having one speed and as a dancer, speeds vary when I'm moving. So I can do a movement really slow, but then do something really, really fast. And the AI has a hard time computing or processing what I'm doing. So I think that's what I would work on, maybe just having more speed options for that."* Creativity involves examining and **evaluating** emergent ideas and work, and several creative process models [1, 55, 64, 79]. Here the dancer assesses whether LuminAI's responses align with their desired aesthetic or emotional tone, adjusting their movements if the interaction feels off. This subprocess occurs as the dancer critiques and evaluates the outcomes of their improvisational choices in collaboration with the AI.

Synthesizing these insights, we observe that dancers engage with multiple creative sub-processes - often simultaneously, rather than linearly. LuminAI acts as a catalyst, prompting dancers to reflect on their habitual patterns, refine their movements, and make intentional creative decisions. The interplay between the AI and the dancer fosters a dynamic co-creative process where improvisation becomes a site for deep exploration, self-awareness, and adaptation. This study underscores the fluid and recursive nature of creativity, illustrating how AI-driven interactions can enhance human creative expression in dance.

6 Discussion

Movement improvisation is a multi-faceted creative process, and this study underscores its profound implications for the design of co-creative AI systems like LuminAI. Our findings illustrate the transformative potential of AI as both a partner and a reflective tool in dance, offering opportunities for creative exploration, heightened self-awareness, and skill refinement. At the same time, the study highlights the challenges and design considerations necessary to fully realize AI's role in dance education and performance.

6.1 Revisiting the Results

The dancers' experiences with LuminAI reveal a dynamic learning process, highlighting the interaction between technology and movement. Initially skeptical about its ability to capture the nuances of human movement, participants grew more accepting as curiosity developed. Over time, they recognized LuminAI's potential to challenge habitual movements, inspire improvisation, and offer fresh perspectives on spatial relationships and movement quality.

Participants highlighted the system's ability to prompt self-awareness and body awareness, encouraging them to reflect on their movement vocabulary and simplify complex improvisational patterns. Many found value in LuminAI's ability to "go back to basics," fostering a renewed focus on foundational techniques. Simultaneously, the system's unpredictable and sometimes "impossible" movements sparked creative exploration, pushing dancers to embody new shapes and rhythms. This dual dynamic of reflection and experimentation was central to the participants' journey, reshaping their perceptions of both AI and their own artistic practices.

However, the study also brought to light limitations. Technical issues such as motion-tracking inaccuracies, glitches, and constrained movement choices often interrupted the flow of interaction. These challenges underscored the need for better tracking quality, more nuanced movement generation, and greater system responsiveness. Participants also noted the absence of emotional expressiveness and real-time risk—qualities intrinsic to human-human partnerships—which limited LuminAI's ability to replicate the richness of traditional improvisational dynamics.

6.2 Design Recommendations from Dancers

A significant takeaway from the study was the feedback from dancers on the interface design and system functionality of LuminAI. Participants provided specific suggestions to improve both usability and creative potential. They emphasized the need for a more intuitive user interface, with clearer visual cues to guide interactions, as well as additions to the avatar's visual design, suggesting the inclusion of more playful and expressive elements to boost engagement and focus.

The dancers also stressed the importance of accurate motion tracking and quality assessment of movement. They noted that the technology should be capable of capturing subtle nuances in human movement such as hand and feet articulation to ensure smooth, responsive interactions. Additionally, participants called for the integration of playfulness and temporal elements, such as rhythm and timing, to help dancers synchronize their movements and enhance their connection to the system. Finally, the inclusion of human-like expressions, such as breath-like movements or emotional cues, was highlighted as a way to make the AI's movements feel more dynamic and relatable, fostering a deeper sense of engagement.

6.3 Working to Engage with Creative Subprocesses

Co-creative AI tools could prioritize fluency by generating diverse, unexpected responses that spark dancers' creativity. Algorithms should encourage exploration, offering varied movement suggestions to inspire divergent thinking. Machine learning models can analyze broad input data to produce surprising outputs, prompting further experimentation. Adjustable parameters like speed and shape complexity would allow dancers to refine their movements and deepen the creative process. Visual tools, such as geometric visualizations, can also serve as inspiration.

The AI could recognize and incorporate culturally or personally meaningful movements, helping dancers blend their backgrounds into creativity. Train the AI to respect and interpret various dance forms or styles in its responses. Allow users to input context, like dance styles or inspirations, for personalized interactions.

Co-creative tools could help dancers select movements that align with their goals or challenge habits. Provide real-time feedback and movement visualizations to aid in evaluation. Include options to save preferred movements for later exploration. The AI could assist dancers in setting and adjusting goals or constraints, refining their approach. It would offer goal-setting features, allowing dancers to define themes or limits, with the AI adapting to fit those parameters.

The AI could enable dancers to critique and adjust its responses to ensure alignment with their creative vision. Incorporate evaluation, real-time feedback loops where dancers can adjust parameters like responsiveness, speed, or sensitivity. Allow users to report limitations or suggest improvements for enhanced co-creativity.

Lastly, tools could foster reflective thinking - creative metacognition - by allowing dancers to monitor and adapt creative strategies. Providing feedback mechanisms, such as movement analysis or playback can be built to help dancers reflect on how their actions influence the AI's behavior. Encourage iterative experimentation by highlighting how changes in input impact the output.

Overall, bringing LuminAI to life by introducing it to a dance classroom promotes including the following in a co-creative AI tool:

- **Adaptability:** Co-creative tools must adapt to varying skill levels, styles, and creative preferences, enabling both novices and professionals to engage meaningfully.

- **Transparency:** Clearly show how the AI processes input and generates responses to build trust and foster creative collaboration.
- **Interactivity:** Provide intuitive and responsive interfaces that facilitate a seamless exchange of ideas between human and AI.
- **Customization:** Allow dancers to personalize the interaction to align with their artistic goals and aesthetic preferences.

6.4 Implications for Future Design

A key finding was how LuminAI encouraged dancers to break free from habitual movements, emphasizing simplicity, accuracy, and movement quality over complexity [78]. This highlighted AI's potential to foster both technical growth and artistic reflection. The system's real-time movement suggestions also created a dynamic space for creative exploration, pushing dancers to experiment with new shapes and rhythms. A central theme emerged around balancing human agency with machine responsiveness, emphasizing the need for design solutions that enhance this synergy while preserving creative autonomy.

The insights from this study point to broader implications for the design of interactive systems in dance. First, the findings highlight the importance of designing for multi-layered collaborations, where AI systems can support not only one-on-one interactions but also group dynamics and collective creativity. Systems should consider integrating features that allow for delayed feedback, intermediary facilitation, and adaptability to diverse rehearsals and performances.

Second, the study emphasizes the potential of AI as a tool for reflective learning demonstrated by Kang et al [38]. By enabling dancers to critically examine their movements and expand their vocabulary, interactive systems like LuminAI can contribute to both skill development and artistic growth. However, achieving this potential requires addressing technical limitations, such as tracking errors and glitches, and incorporating features that enhance emotional expressiveness and real-time interaction.

The dancers' evolving relationship with LuminAI underscores the importance of fostering trust and empathy in human-AI partnerships. As participants grew more comfortable with the system, they began to see it not as a replacement for human collaborators but as a complementary tool that could enrich their creative practice. This shift highlights the need for designs that prioritize collaboration and mutual learning, bridging the gap between technology and the performative nuances of dance.

Finally, in reflecting on interface design, one of our primary takeaways is that while *LuminAI was designed for dancers, it was not fully utilized by them without a facilitator guiding the experience.* This finding suggests a need for delayed feedback mechanisms similarly found in [72, 73] or intermediary figures (e.g., instructors, researchers) to bridge the dancer-AI interaction effectively. Future systems should consider designs that foster not just one-on-one interactions but multi-layered collaborations, especially when multiple AI stations or many-to-many engagements are involved.

7 Conclusion and Future Work

As we navigate the intricate intersection of technology and dance through the lens of LuminAI, our study has unearthed invaluable insights that illuminate the future trajectory of research and development in interactive AI systems for improvisation dance. The improvisational classes culminated in the world's first collaborative improvised dance performance between humans and artificial intelligence. Visual documentation of this performance is presented in the accompanying Figure. 7

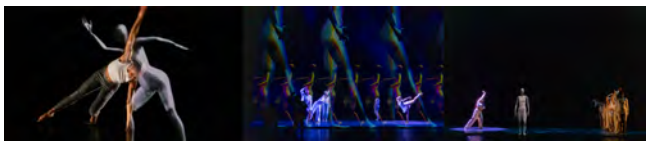


Figure 7: The world's first collaborative improvised dance performance between humans and artificial intelligence

Building upon the findings and design recommendations, several avenues for future work emerge. First, the implementation of the proposed design recommendations represents a tangible next step highlighted in the above sections. These steps prioritized design systems that carefully balance the roles of human and AI, enhance the fidelity of motion-tracking systems to minimize noise and improve real-time responsiveness, incorporating design elements that support or mimic the role of facilitators and including mechanisms that allow dancers to reflect on their interactions with the AI over time, enabling deeper learning and integration into their creative process.

Dancers treated their collaboration with LuminAI as a unique partnership, viewing the digital avatar as an active co-creator rather than a passive tool. LuminAI's unconventional movements became an expressive medium, allowing dancers to experiment with mimicry and adaptation, deepening their understanding of the AI's 'intentions.' Through one-on-one duets, dancers interpreted and responded to LuminAI's cues, fostering patience and mutual exploration. Advanced dancers found meaning in navigating LuminAI's movements without familiar cause-and-effect, focusing on embodiment and interaction. This co-authoring process created a sense of community and trust, empowering dancers to explore and express with both human peers and their adaptive AI partner. Participants' experiences over the semester highlight both the initial awe and the long-term value of the collaboration.

Future research will continue to explore LuminAI's potential in diverse dance styles and cultural contexts and exploration of the AI's movement, expanding the relevance of AI in performing arts. The co-creative AI tool can also venture into a delayed feedback loop, along with the concurrent feedback to potentially fit into a many-to-many social container of learning, instead of the current one-to-one interaction with a dancer.

Our findings point to new opportunities for AI to serve as a reflective tool, enhancing dancers' self-awareness and creative exploration. The study underscores the need for future AI systems in dance to balance responsiveness, interaction fidelity, and human-computer collaboration. Furthermore, findings highlight the role of

facilitators in bridging the gap between dancers and AI, offering pathways for designing more intuitive and collaborative systems that reimagine the future of dance. This paper synthesizes the outcomes of this collaborative journey, aiming to push the boundaries of human-computer interaction in the realm of dance.

Acknowledgments

We would like to thank Cassandra Naomi and Ramya Iyer for their help in development work on LuminAI; Manoj Deshpande for his help in data collection as well as all the dancers as part of the Kennesaw State University's Department of Dance. This project is funded by the National Science Foundation (CMII 2123597).

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