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TEACHING THROUGH EMOTIONS AND AVATARS: DESIGNING AFFECT-AWARE VIRTUAL WORLDS FOR PERFORMING ARTS EDUCATION USING LEGACY INTERNET OF THINGS GAMING DEVICES

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Abstract

This paper explores the innovative integration of affect-aware virtual worlds in performing arts education, leveraging legacy Internet of Things gaming devices (LIoTGDs) to enhance emotional engagement, and learning effectiveness. We introduce a unique framework that combines emotional intelligence theories, human-computer interaction (HCI), and technology-enhanced learning principles to create immersive, emotionally responsive educational environments. Utilising repurposed legacy IoT devices, this approach captures both emotional and physical inputs from users, enabling the development of avatars and virtual scenarios that facilitate dynamic and personalised learning experiences. We discuss the design considerations necessary for crafting user-centric, engaging interfaces and detail the technological challenges and solutions in integrating such devices. Additionally, the paper outlines specific applications in performing arts education, illustrating how these virtual worlds can simulate realistic performance scenarios, provide real-time feedback, and support the development of emotional expression and stage presence. We address implementation challenges, including hardware limitations, privacy concerns, and the interdisciplinary collaboration required to realise these environments. Finally, we highlight the potential broader implications and future directions for research in this field, emphasising the transformative impact of affect-aware technologies in educational settings. This study aims to contribute significantly to the academic discourse on merging technology and emotional intelligence to revolutionise educational practices in the performing arts and beyond.

Keywords: *Retro gaming, legacy computing, Internet of Things, affective computing, virtual worlds.*

INTRODUCTION

Performing arts, encompassing theatre, opera, ballet, entertainment shows, and dance, are transforming into a sector of the creative industries that integrates traditional skills with modern technology to appeal to global audiences [1]. This shift underscores the significance of emotional engagement, which is critical in activities that involve people's feelings and attention and is essential for evaluating learning based on emotional responses [2]. This concept of emotional engagement connects seamlessly with the evolution of virtual learning environments, where technology, particularly IoT gaming devices, plays a pivotal role. These technologies enhance educational experiences by making them more interactive and immersive, thus fostering deeper emotional connections and engagement, much like the transformative trends observed in the performing arts.

The evolution of virtual learning environments has transformed the educational landscape, offering immersive and interactive experiences for learners worldwide. The integration of Internet of Things (IoT) gaming devices has further enhanced these experiences, providing innovative and engaging ways to learn.

Virtual Learning Environments (VLEs)

VLEs have evolved significantly over the past two decades, from basic online courses to sophisticated, interactive platforms. These environments offer flexibility, accessibility, and personalised learning experiences, making education more inclusive and effective [3].

IoT Gaming Devices

IoT gaming devices, such as smartwatches, fitness trackers, and gaming consoles, have become increasingly popular in education. These devices offer real-time data analysis, interactive simulations, and collaborative tools, enabling learners to engage with complex concepts in a more interactive and immersive way [4]. The integration of IoT gaming devices in VLEs has shown promising results in enhancing educational experiences. Imagine a world where aspiring performers can hone their craft in virtual stages that react to their emotions. This is not science fiction, but the potential of affect-aware virtual worlds, poised to revolutionise performing arts education by offering personalised, emotionally responsive learning experiences.

These virtual environments will be equipped with sensors that can pick up on a learner's facial expressions, body language, and even vocal inflections. Using AI, the world can then adapt to their emotional state. A nervous actor delivering a monologue might see the virtual audience become restless, mirroring real-world anxieties. Mastering a scene of grief could trigger a virtual downpour, heightening the emotional impact.

Gone are the days of one-size-fits-all critiques. Affect-aware virtual worlds can provide tailored feedback based on the learner's emotional delivery. Did their voice tremble during a powerful moment? The environment could highlight that section for further practice.

Conversely, a learner struggling with stage presence could be presented with a progressively larger virtual audience, building confidence in a safe space. Performing arts are all about understanding and conveying emotions. These worlds can create scenarios where one can interact with virtual characters programmed with various emotional states. By observing the character's reactions to their performance, individual can learn to read emotional cues and tailor their performance accordingly. Traditional performance spaces can be intimidating. Affect-aware virtual worlds offer a safe haven for experimentation.

Table 1. Features of Legacy IoT Gaming Devices

#	Feature	IoT example
1.	Interactive Simulations	IoT devices enable learners to participate in interactive simulations, making complex concepts more accessible and engaging.
2	Real-time Feedback	IoT devices provide immediate feedback, allowing learners to track their progress and adjust their learning strategies accordingly.
3.	Collaborative Learning	IoT devices facilitate collaborative learning experiences, enabling learners to work together on projects and share resources.

Learners can try out bold choices, fail without judgment, and learn from their emotional responses in a controlled environment. This fosters creativity and a willingness to take risks, crucial for developing a compelling stage presence.

BACKGROUND

The burgeoning field of affect-aware virtual worlds for performing arts education offers exciting possibilities for revolutionising traditional teaching methods. This review sheds light on the background considerations, the limitations of traditional performing arts education, the role of emotional intelligence, the potential of avatars and virtual worlds, and the repurposing of legacy IoT gaming devices for educational purposes.

A. Understanding Technology Adoption in Educational Settings

The successful implementation of affect-aware virtual worlds hinges on user acceptance within the performing arts education landscape. There is ease of use, usefulness, and social influence on technology adoption within educational contexts [5]. This framework offers a valuable tool to evaluate user acceptance of affect-aware virtual worlds by both learners and educators in performing arts education.

B. Blended Learning and its Advantages in Arts Education

Performing arts education has traditionally relied on instructor-led methods, often lacking the ability to cater to individual learner needs [6]. There is effectiveness in the use of blended learning approaches in arts education [7]. This research highlights the advantages of combining traditional methods with technology-based instruction, such as virtual worlds. This research provides valuable insights into integrating virtual worlds seamlessly into existing performing arts curricula, potentially creating a more engaging and personalised learning experience for learners [8].

C. Challenges and Opportunities in the Digital Transformation of Performing Arts Education

Traditional performing arts education often faces limitations in providing individualised feedback and creating realistic performance environments. The need for innovative solutions such as affect-aware virtual worlds in education has been highlighted [9]. These virtual environments can provide a safe space for learners to practice and receive personalised feedback on aspects like emotional expression and stage presence, which can be difficult to achieve in traditional settings.

The digital transformation of performing arts education presents both opportunities and challenges. The need for educational technologies that cater specifically to the unique needs of various performing arts disciplines, such as dance, music, and theatre has been considered [10]. Affect-aware virtual worlds, tailored to the specific requirements of each discipline, have the potential to address these needs and enhance the learning experience for learners. For instance, dance instructors can utilise virtual environments to provide real-time feedback on movement technique and posture, while music educators can leverage these platforms to offer personalised guidance on stage presence and performance anxiety.

D. The Role of Emotional Intelligence in Learning Outcomes

Emotional intelligence plays a demonstrably significant role in learner learning outcomes. A meta-analysis suggests that emotional intelligence is a crucial factor influencing academic achievement [11]. Learners with higher emotional intelligence tend to exhibit better self-regulation, motivation, and social skills, all of which are important for success in performing arts education. Emotional learning specifically within the context of performing arts education has been considered [12]. By incorporating features that encourage learners to identify and manage their emotions during performances, such as virtual audiences that react dynamically based on the learner's performance, these virtual environments can contribute significantly to the development of well-rounded performers [13].

E. Immersive Learning through Avatars and Virtual Worlds

Virtual worlds offer the potential for immersive learning experiences that can significantly enhance learner engagement and knowledge retention. Virtual worlds can be used to create engaging and interactive learning environments where learners can explore different performance scenarios and receive immediate feedback [14]. This immersive quality can be particularly beneficial in performing arts education, as it allows learners to practice in realistic settings and experiment with different approaches without the pressure of a live performance. For instance, a virtual world designed for theatre education could simulate various stage.

F. Avatars and Embodiment in Learning

The use of avatars in virtual worlds can further enhance the learning experience by fostering a sense of embodiment. Avatars have the potential to provide embodied learning experiences that can improve learner motivation and learning outcomes [15]. Learners interacting with virtual worlds through avatars can develop a stronger emotional connection to the learning environment and the characters they portray. This can be particularly valuable in performing arts education, where embodying a character is a crucial aspect of the learning process.

A virtual world designed for theatre education could simulate various stage settings, allowing learners to practice delivering lines and embodying characters in front of virtual audiences [16]. By utilising avatars that reflect their physical movements and emotional states through facial expressions, learners can gain valuable insights into their stage presence and emotional communication [17]. This embodied learning experience can lead to improved performance skills such as cognitive control, self-confidence, and a deeper understanding of character development [18].

G. Repurposing Legacy IoT Gaming Devices for Educational Purposes

Legacy gaming devices, such as heart rate monitors or motion controllers, hold promise for repurposing in educational settings. Robertson et al. explored the potential of these devices to capture user data that can be used to personalise learning experiences. This data, including physiological responses and body movements, can be leveraged by affect-aware virtual worlds to tailor the learning environment and provide feedback specific to each learner's emotional state and physical performance.

Physiological data from gaming devices can be used to assess user engagement and emotional state [19]. Heart rate, skin conductance, and other physiological measures can be used to gauge a user's emotional response to a virtual environment [20]. This concept is directly relevant to the development of affect-aware virtual worlds for performing arts education. By analysing physiological data captured from legacy IoT gaming devices, these virtual environments can provide instructors with valuable insights into learners' emotional states during performances. This information can then be used to offer personalised feedback and support, ultimately leading to improved performance skills and emotional regulation. Data can be combined with other forms of user input, such as facial recognition and voice analysis, to create a more comprehensive picture of the learner's emotional response. This holistic approach can be leveraged by affect-aware virtual worlds to provide real-time feedback on aspects like stage presence, emotional expression, and performance anxiety. Instructors can then utilise this data to tailor their teaching approaches and offer personalised support to each learner. The IoT gaming devices for educational purposes presents not only exciting possibilities but also challenges.

Hardware limitations and potential privacy concerns surrounding user data collection and analysis need to be addressed. Additionally, successful implementation requires interdisciplinary collaboration between educators, technologists, and game designers to ensure the development of virtual worlds that are both pedagogically sound and engaging for learners. Emotions have a role in cognitive development and social interactions [21]. Biofeedback has been effect in game-based learning, demonstrating its potential to improve user engagement, learning outcomes, and emotional regulation [22].

DESIGN CONSIDERATIONS

This section presents a discussion on the design considerations for creating affect-aware virtual worlds, including technology integration, emotion recognition, and their application to performing arts education.

A. Technology Integration

The integration of legacy IoT gaming devices into contemporary virtual worlds represents a fascinating yet challenging endeavor. As technology evolves, the vast potential of virtual worlds for gaming and beyond becomes increasingly evident. Legacy IoT gaming devices, which were innovative in their time, now face compatibility and functionality issues in these advanced environments [23, 24].

Legacy IoT gaming devices refer to older generation gaming hardware and peripherals that were designed with limited connectivity and processing capabilities compared to modern standards [23, 24]. These devices often include outdated communication protocols, limited hardware interfaces, and lack support for current software frameworks.

B. Emotion Recognition

Emotion detection and analysis through IoT devices has gained significant traction in recent years, leveraging the advancement in sensors and machine learning algorithms to interpret physiological signals [25]. The field focuses on recognising human emotions by collecting and analysing data from various sources such as heart rate, facial expressions, and other physiological signals [26].

Emotion detection techniques primarily involve the collection of physiological signals through IoT devices. These devices include wearable technology like smartwatches and fitness trackers, which measure heart rate variability, skin conductance, and temperature. Additionally, cameras and microphones integrated into IoT systems capture facial expressions and voice modulations, providing a comprehensive dataset for emotion analysis. The process begins with data acquisition, where sensors continuously monitor and transmit physiological signals to a central processing unit [27]. These raw signals are then pre-processed to remove noise and artifacts, ensuring that the data is clean and reliable for analysis [28].

C. Application to Performing Arts Education

The application of affect-aware technologies and virtual worlds in performing arts education holds transformative potential [29]. By integrating emotion detection and analysis through IoT devices into virtual learning environments, these technologies can simulate realistic performance scenarios, offer real-time feedback, and nurture the development of emotional expression and stage presence [30].

In performing arts education, emotional expression and stage presence are critical components of a learner's skill set [31]. Traditional teaching methods, which rely heavily on face-to-face interactions and subjective feedback from instructors can be supplemented and enriched by interactive systems, such as affect-aware virtual worlds [32]. These environments utilise IoT devices to monitor physiological signals such as heart rate, skin conductance, and facial expressions, providing data that can be analysed to gauge a learner's emotional state and performance quality [33].

By simulating performance scenarios in a virtual setting, learners can practice and refine their skills in a controlled, yet dynamic environment [34]. As learners perform, their physiological responses can be monitored in real-time, such as through EEG, allowing the system to provide immediate feedback on their emotional expression and stage presence [35]. This feedback can highlight areas of improvement, such as the need to project more confidence or to convey a particular emotion more effectively [36]. Real-time feedback is another crucial advantage of these technologies [37].

Despite the promising potential, there are challenges to implementing these technologies in performing arts education, such as the variability in physiological responses among individuals [38]. Factors such as stress, health conditions, and even daily fluctuations can affect the accuracy of emotion detection systems [39]. Therefore, it is essential to develop adaptive algorithms that can account for these variations and provide reliable feedback [40].

Privacy and data security are also critical concerns. The collection and analysis of sensitive physiological data necessitate robust security measures to protect learners' information. Ensuring that these systems comply with data protection regulations and obtaining informed consent from participants are paramount to maintaining ethical standards [41].

IMPLEMENTATION CHALLENGES

Implementing affect-aware technologies in educational settings, particularly in the realm of performing arts, presents a myriad of challenges that need to be meticulously addressed to ensure their efficacy and ethical deployment [42]. The integration of emotion detection systems through IoT devices, while promising, faces significant hurdles related to hardware limitations, privacy and ethical concerns, and the necessity for interdisciplinary collaboration [43].

One of the foremost challenges is the hardware limitations of legacy IoT devices [44]. Many educational institutions may rely on existing technology infrastructure that includes older IoT devices with limited processing power and outdated communication protocols [45]. These legacy devices often struggle to handle the advanced data processing and real-time analysis required for sophisticated emotion detection systems [46].

Despite the challenges, the potential benefits of integrating affect-aware technologies in performing arts education are substantial [47]. Real-time emotion tracking can provide invaluable feedback, allowing learners to refine their emotional expression and stage presence with unprecedented precision [48]. These systems can also foster a more personalised learning experience, adapting to the individual needs and emotional states of learners, thereby enhancing their engagement and motivation [49].

CONCLUSION

Virtual worlds can transcend geographical and physical limitations. Learners with disabilities can use avatars that allow them to perform without physical constraints. Additionally, these worlds can be programmed with diverse virtual audiences, allowing learners to practice performing for different cultures and backgrounds. Despite these challenges, affect-aware virtual worlds hold immense potential to revolutionise performing arts education. By personalising experiences, fostering emotional intelligence, and creating a space for safe exploration, they can empower the next generation of performers to truly connect with their audiences and captivate the stage. As technology evolves, we might soon see these virtual worlds become a vital training ground for the performing artists of tomorrow.

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