Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 3962 – 3975
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4518

# A Comparative Study on Music Curriculum Design in Universities based on AR technology: A Survey of 10 Undergraduate Colleges in Nanjing

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**Abstract**

*During the past few decades, there has been a huge increase in the usage of technological devices like mobile phones, which are now an indispensable part of our everyday lives. AR-based applications for smartphones and tablets have proven to be a game-changer in a number of fields, most notably education. Currently, Nanjing's college music programmes are undergoing a fast development. Universities are currently experiencing innovation and a reform of their teaching methods in the field of music education. Improving music education in higher education institutions has emerged as a crucial concern for the music Students in Nanjing's undergraduate institutions.An analysis of how AR technology has affected the evolution of music curricula in undergraduate institutions in Nanjing through comparisons. Pre- and post-tests were used to evaluate the cultural understanding and motivation for the study of music of both groups. An Overview of Ten Nanjing Bachelor Colleges. Through the use of augmented reality technology, the experimental team introduced undergraduates' students to a range of cultural contexts, practices, and norms.The results show that as compared to the control group, the experimental group, which received AR-based training, had noticeably greater levels of intercultural competency and motivation for music learning.Quantitative data analysis revealed that AR-based training increased undergrad participants' involvement, motivation, and understanding of culture. This study provides insights into prospective patterns and paths that AR technology could take in learning, giving readers a preview of future advances. This comprehensive viewpoint provides teachers, scholars, and professionals with significant insights into the instructional implications, technological characteristics, and practical issues of AR. Increasing the development of music education in institutions of higher learning can play an obvious role in helping to grow the influence.*

**Keywords:** *AR Technology, Music Curriculum, Pedagogical Implications, AI, Music Learning, Motivation, Nanjing, Experimental Group, Qualitative Data Analysis, Cultural Scenarios, Music Education, Educational Sector.*

## Introduction

University music is a significant component of the professional art curriculum, but it also affects the emphasis and level of student learning [1]. The current state of university music education is a reflection of the poor quality of instruction, limited by teachers, resources, and other factors. The course work is not sufficiently challenging [1, 2]. The reform of music education at universities is essential because of the disinterest of students in studying and other issues. The instructor serves as the primary source of instruction in the conventional teaching model. The pupils are studying in the object location within the classroom [2, 3]. There is little connection between teachers and students, little classroom engagement, and ineffective cultivation of students' critical thinking and innovative skills. With the speed at which technological advancement is developing, [3], university music departments are using hybrid teaching strategies that combine in-person and online instruction. Among these, the cloud classroom emphasizes students' creative thinking and initiative in a classroom teaching environment and has become an innovative technology that helps teachers complete the effective classroom teaching mode [3]. It also has the flexibility of traditional blackboard teaching and allows for teacher-student, student, or human-computer interactions. Aesthetic education includes music instruction, which helps students develop their aesthetic sensibilities and establish a proper aesthetic perspective as well as a diverse skill set that satisfies the demands of contemporary society [4, 5]. By experimentation with the system of coding used in the content evaluation of 102 music school majors, it was attempted to determine the qualities of musical performances that aid in young musicians' engagement with music. It was discovered that music education places a strong

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emphasis on virtues, values, and accomplishments, and that traits associated with intrinsic motivation were present in stories about activities driven by external variables [5].

Applications utilizing Augmented Reality (AR) have garnered significant interest and attention across a wide range of industries, including healthcare, education, automation, e-commerce, travel, interior design, architecture, and construction, in addition to entertainment. With the aid of several AR-based applications, more interactive teaching and learning techniques have replaced traditional educational approaches and classroom settings [5]. In medical & healthcare fields, Augmented Reality (AR) makes it feasible to study human beings interactively and allows surgeons to practice medical procedures on a virtual body before doing them on real patients. Educational content can be explored through a range of media [5]. Students often learn through interactions with teachers and peers, who employ non-interactive media like video, notebooks, & photos along with conventional interaction in person to understand the instructional topic. The use of technology has been actively involved in educational and learning endeavours during the past few years, [5, 6], offering opportunities for learning through immersive simulations and educational video games. Using Augmented Reality (AR) technology in educational mediums can improve the quality of the content taught. AR integrates virtual information into the user's physical environment and enables users to interact with every part of their bodies of the virtual content [6]. The Augmented Reality (AR) experience can be investigated using web-based and smartphone-based applications that enable users to record instructional information with their smartphones' cameras and webcams and view its augmentation on a screen similar to a projectors or monitor. Some intriguing benefits of utilizing AR in education were noted [6, 7].

College students' emotions, aesthetic perception, and musical literacy can all be developed through music education in colleges. These days, [7], music education at higher education institutions can take advantage of the features of new the news media, like a lot of data and strong engagement, to provide better teaching properties and more teaching opportunities. In order to enhance the curriculum, it can also use additional media resources [7, 8]. Though most Chinese institutions have established an environment using new media for teaching music, there remain issues, including limited investment, [8], poor environment preparation, and teachers' incapacity to modify their lesson plans for the new medium. It must therefore be resolved in terms of financial commitment, teacher team development, content reform for music education, and, at the end, adjusting to the changing needs of society [8]. Digital and network technologies are combined in new media, which is a technologically advanced media form & environment. According to our belief, a majority of secondary students' music will become better the day that music instruction is reoriented [8, 9]. We cannot discuss the quality educational function of music education, or even just its innovative aspects, if our media does not collaborate and if it does not effectively lead the education sector. Students can now better acquire and understand music knowledge, [9, 10], but on the other hand, music education takes place within a digital media environment. Better appreciation of music can be consistently attained via feedback and communication between educators and students, since the impact of their interactions is greater. However, the new media also offers some socially innovative information and tools, which empowers educators and students to create higher-quality screening materials. This includes more resources for music auditions for schools and universities. Digital information allows students to access additional resources without being limited by time or location [9, 10]. This comprises the general arrangement of the learning environment as well as the synchronization of the two-way interactions between teaching and learning [11]. Figure 1 illustrates the categorization of music education in colleges and institutions [11, 12].

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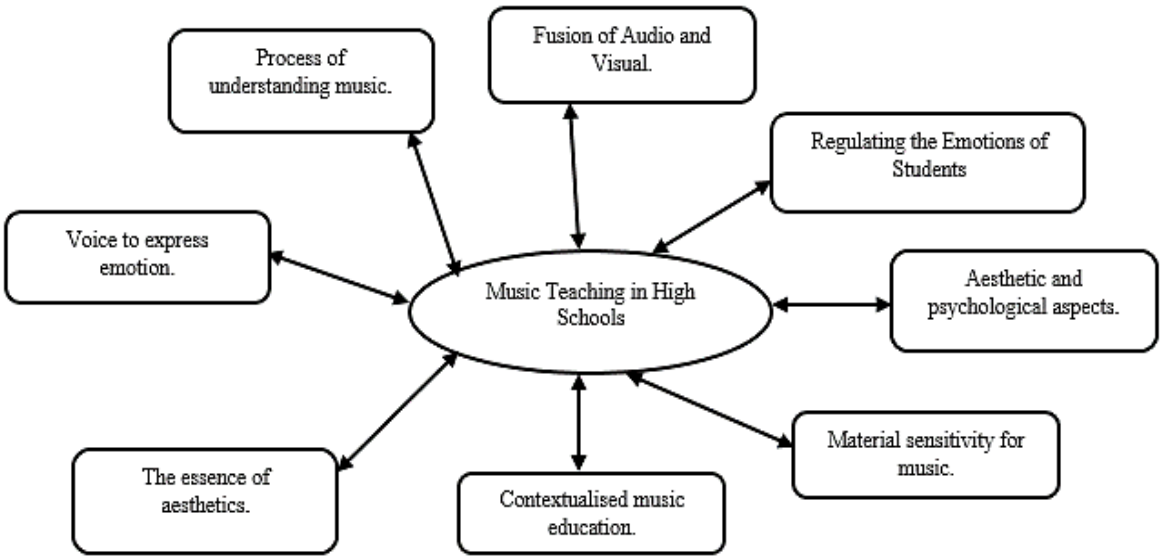


**Fig. 1** Classification of Music Instruction in Colleges and Universities. [12]

The rise in technological advances and mobile applications has led to a greater need for technology-enhanced learning [12]. In today's globalized world, traditional methods of teaching music may provide difficulties for undergraduate students as well as for students themselves, and they frequently fail to provide real-world experiences that might boost their interest and motivation [12, 13].

As a result, as technology develops, new opportunities for language acquisition arise, providing creative and captivating solutions to these problems. As a recently emerging innovative technology, Augmented Reality (AR) has shown to be a useful tool for boosting motivation and electronic language acquisition. Subsequently, [13, 14], Augmented Reality (AR) is considered a three-dimensional technology that smoothly combines the real and virtual worlds in order to improve undergraduate students' comprehension of the real world through simulated objects [15, 16]. Because contextualized learning helps students make sense of and apply what they have learned to achieve knowledge internalization—particularly in the context of the music learner—using Augmented Reality (AR) in contextualized education promotes successful learning because it blends virtual or real environments [16].

Numerous research has looked at AR's function in situations involving second and foreign languages. Examined the factors influencing the expectations of pre-service music teachers of languages on the integration of AR into their future language training [16, 17]. Teachers were trained on how to include AR discussions and activities in their language classes. According to survey results, instructors' desire to use Augmented Reality (AR) was most significantly predicted by their perception of the technology's usefulness [17]. The favourable conditions and simplicity of use, however, were the least significant components. In a similar vein, Numerous studies on Augmented Reality (AR) revealed that a significant portion of current research has concentrated on the advantages of AR in educational environments. The majority of research on AR focused on using AR to improve undergraduate students' vocabulary and speaking abilities [17, 18]. They also advise educators to create appropriate curriculum and learning resources in addition to augmented reality to help undergraduate pupils become more proficient language learners [18, 19].

*Use of Artificially Intelligent Music Software in Education*

As computer technology has advanced, a plethora of intelligent software for music has also emerged. This has improved the processing power of music data and expanded the range of musical information by allowing computers to perform all original music tasks that previously required synthesizers or music workers to process and edit. With the help of artificial intelligence, users of this type of strong music software can edit, modify, record, and perform a wide variety of musical elements [18]. The application of

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this new kind of music system in the classroom has tremendously aided in the advancement of music education. Since the implementation of the musical system in the teaching of music, there is now a platform for engagement and communication between professors and students. The way that music is taught has also evolved significantly. Students can first experience the music and the beauty of each note by using the new music system. Secondly, [19], students are free to practice any music that is taught in class. By practicing, the students will be able to comprehend the qualities and purposes of each musical element as well as the concepts the teacher covers in class. Lastly, by using this technique, teacher can also have the class perform in an ensemble and assess each student's level of musical understanding by hearing their performance. As an illustration, in a music lesson, the instructor might play a question, asking the student to play a response, or play a piece of music, ask the students to repeat or recreate it. Not only can students enjoy music more fully in this fashion, but they can also connect and converse with teachers. Students will transition from a passive to an active role in the classroom [18]. They will no more just listen to the instructor's explanations; instead, they will be able to experience and comprehend music through artificial intelligence systems, as well as understand and enjoy music that the teacher is unable to experience. Students can have a better understanding of the traits and purposes of each musical element as well as how these musical elements are constructed by using these artificially intelligent software.

AR has the potential to improve student motivation & the learning process. grouped augmented Reality (AR) technology into five categories for instructional usage. AR is applicable to discovery-based education as well. These kinds of apps are used in astronomy education, sites of historical significance, and museums [18, 19]. A user can engage among the objects of interest in these kinds of applications. AR can also be applied to object modelling applications, where a user sees visual feedback of images coming from various angles. With the help of these apps, users may also plot virtual things, discover their physical characteristics, and observe how two or more items interact [20]. The majority of these applications are found in architecture education. AR books are also utilised in education; however, they are printed as regular books. Instead, a webcam is used to create interactions and visual representations from the book. It is accomplished by specialist computer software, programmes and or websites made just for this purpose.

*AR and Music-Based Learning Techniques*

Expanding on previous research, a detailed examination of the parallels and divergences of AR- and music-based educational technologies reveals relationships, commonalities, and unique characteristics that greatly influence the learning process. Augmented Reality (AR) dynamically blends virtual and real-world environments to create a dynamic combination that improves perception via digital data. Conversely, [19, 20], music-based learning leverages the inherent attraction of gaming to propel learning initiatives.

On the other hand, gamification-based music-based learning takes advantage on games' inherent motivational power to promote learning. This method skilfully weaves instructional materials into the storylines of games, encouraging involvement, engagement, and skill improvement. This synergy is evident in AR-enhanced learning language games, [19], when interactive situations, linguistic obstacles, and actual-life situations coexist [20]. This combination fosters both a thorough command of the language and a knowledge of other cultures [20].

*Multicultural Proficiency in Language Acquisition*

Learning grammar norms and vocabulary is only one aspect of the process of learning in music education. Nowadays, as the world grows ever more interconnected, [20, 21], mastering a foreign language becomes a prerequisite for understanding and navigating a variety of cultural contexts. Beyond language ability, language and culture interact in complex ways that cut beyond national borders and show up in people's day-to-day interactions, [21, 22], habits, and communication styles. The idea of intercultural competence—a necessary skill that permits productive and culturally appropriate interaction with people from diverse cultural backgrounds—is the foundation of this connection [23].

Intercultural competency include sensitivity to culture, awareness, and flexibility in addition to linguistic proficiency. It plays a crucial role in fostering meaningful relationships and effective communications within

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the context of music learning [22, 23]. People find themselves constantly interacting with people from other cultures as the global environment continues to change—for various private, professional, or academic reasons. Through the development of intercultural competency, Music Learning students have the ability to understand and value cultural nuances, which improves the calibre and efficacy of their communication.

## Objectives of the Study

- Evaluate the current music curricula in the ten undergraduate institutions in Nanjing that have been chosen.
- Look into the present integration of AR technology into music curriculum.
- Determine the most effective methods for integrating augmented reality technology into music curricula through comparative study.
- Offer suggestions for curriculum developers, instructors, and legislators on how to successfully incorporate augmented reality technology into music education.

## Literature Review

(Shadiev, R., 2022) [24] With an emphasis on studies on cross-cultural education released within the previous five years, we examined articles on automated by computers language acquisition. We looked into the following areas: (1) the theoretical framework—theory, hypothesis, model, or framework—that served as the basis for the studies; (2) participant technologies; (3) the languages and cultures the studies examined; (4) the methodological aspects of the reviewed studies; and (5) the findings published by the researchers. Our findings indicated that the most widely applied theoretical underpinnings were social constructivism, sociocultural theory, and Byram's intercultural communication competence model. The participants used Facebook, Skype, email, and discussion boards on a regular basis. The most widely used language was Music, and American culture was given greater emphasis than any other civilization.

(Lu, K., Pang, F., 2023) [25] In higher education, asynchronously online learning has become increasingly popular, particularly in light of the current COVID-19 epidemic. In the area of higher education, however, not much research has been done on how to keep students' intention to use asynchronous online courses continuously. In order to determine the factors that impact on students' continuous usage of the planned asynchronously online courses, this study integrated four important variables (intrinsic motivation, external inspiration, awareness of multiple sources of information, or cognitive engagement) into the Technology Acceptance Model (TAM). In order to learn more about the continual use intention of asynchronous distance learning programmes, a survey comprising 325 college students was administered.

(Wang, N., Chen, X., 2016) [26] An increasing number of applications for mobile devices are being created for Mobile Learning (M-Learning) as it has shown growing effects on online education. This study proposes a novel mobile-optimized application structure for M-Learning that integrates the remote laboratories into a mobile learning setting using the Ionic framework. Remote experiment applications can leverage a shared codebase to launch native-like apps on a variety of mobile platforms, including iOS, Android, Microsoft Windows Mobile, or Blackberry, which was thanks to this mobility-optimized application architecture. An inventive remote network proportional–integral–derivative controlling experiment has been effectively developed using this fresh application architecture in order to showcase the efficacy of the suggested new architecture for M-Learning. Testing bed for Baidu mobile cloud validates the performance.

(Zhai, X. S., Chu, X. Y., 2023) [27] Education equity has garnered substantial concern among educators and has emerged as a vital environmentally friendly aim on a global scale. Although virtual teaching community have become a viable tool for reducing educational disparities by exchanging information and resources, more research is still needed to fully understand how to foster deep individual collaboration. With its sophisticated behaviour interaction features, Metaverse has demonstrated its ability to foster close

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interpersonal cooperation and communication. It's still unclear, though, how to use Met averse to improve educational equity. This paper intends to close this gap by reviewing the idea behind Met averse, its educational uses, and how it has evolved to include pedagogical interaction inside online learning communities.

(Hendricks, A. 2012) [28] A decreasing number of students are applying to Charleston Southern University's church music degree programme, which consisted which is modelled after a traditional/classical degree in religious music from Europe. In May 2011, the final two students to pursue this degree received their diplomas. The administration urged the music departments to research current job marketplaces and other schools' worship leadership training programmes before they graduated. The goal of this project is to create a worship leadership degree that will fulfil the university's mandate of providing churches with ministry leaders who have received the necessary training.

(Ge, T., & Darcy, O. 2022) [29] The proposal is for an interactively remote multimedia educational system that uses Virtual Reality (VR) technology to enhance the intelligence and interaction between humans and machines capabilities. Virtually realistic data from a remote multimedia education system is reconstructed by using quick picture region segmentation technology and fuzzy control parameters. Through the use of the deformation model, regional scheduling and information fusion are accomplished. The web-based remote media education system's background server and user interface are designed using the B/S architecture. Utilising an embedded ARM9TDMI as its central microprocessor, the learning system's software design is realised and interaction remote multimedia instructional data is processed.

(Mao, Y., Xia, T., Hu, F., 2024) [30] The sedentary and low-activity lifestyle that many students nowadays lead has a significant negative influence on the mental and physical well-being of the university community. University green spaces, or GSs, are crucial for promoting physical activity and improving students' health. However, earlier research focused on evaluating campuses as a whole, ignoring the variety of spatial conditions that exist within the campus environment. As a result, the primary emphasis of this study was the residential environment for youth in universities. It also constructed a framework with a broad variety of GSs exposure measurements that were both subjective and objective. Through innovative combination of spatial analysis, deep machine learning, and Unmanned Aerial Vehicle (UAV) technology, a systematic, objective structure was created to provide exposure assessment ranging from 2D (GSs areas), 2.5D (GSs visibility), and 3D (GSs volume). The frequency, duration, and estimated quantity of visits among GSs were among the subjective exposure indicators.

(Chris Zhao, Y., 2022) [31] Users' scenario-based engagement is enhanced by the library's immersive technological information practices. However, there is a dearth of research on user interaction with immersive technology in the context of healthcare libraries. In this pilot study, interviews and on-the-job observations were conducted with seventeen medical school undergraduates who had utilised virtual reality technologies at the medical libraries. Immersion technology and medical students have a relationship that both limits and supports their information habits. This was examined through the affordance viewpoint.

(Ho, W. C. 2014) [32] This study aims to investigate the perspectives and practices of Chinese primary school music teachers about the impact of contemporary music on students' learning of music curriculum. The goal of the study is to investigate how primary-level music teachers may successfully manage and lessen the negative impact of popular music on the standard of school musical education as a whole. In order to develop effective suggestions and tactics for teachers to guarantee that the learning outcomes of their students' music classes closely align with the curriculum standards, this study aims to investigate these issues. This study, which involved primary-level instructors from six Zhengzhou city districts, employed a qualitative research methodology.

(Xiaoman, Z. 2006) [33] The reliability and conformance of curriculum functions have been used to define moral education as well as principles instruction during China's recent reform of the curriculum. As a result, a brand-new educational idea founded on integral/complete curricular functions is developed. This text highlights how the curriculum reform focuses on ethical and values education in public schools by going over the curriculum's basic principles, the foundation of ethical and value education, the integrated

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curriculum establishing in instruction organisation, the inclusion of behavioural and psychological attitudes goals in the subject requirements, and instructional methods.

## Method

*Participants*

The subjects of the present comparison study were 10 undergraduate students who took part in a mandatory Institution Musical Group II course at a comprehensive interdisciplinary college situated in a suburban college in Nanjing. Enhancing their language proficiency in music was the primary objective of the programme [34]. According to their music linguistic scores from the yearly national university entrance exams in Nanjing, China these people were classified as intermediate level. The respondents, who were chosen from two distinct courses given by a teacher who remained independent of the researcher, had an overall age of 20.24 years (SD = 2.32). About 66% of those surveyed said they had some previous contact with augmented Reality (AR) technologies, mostly via recreational usage and exposure to smartphone programmes or games. The participants were split into the experimental group (n = 8) and the control group (n = 2) using a quasi-experimental approach [34].

An independent-sample t-test was used with the participants' results from a recent collegiate music language skills exam in order to guarantee comparison among the groups. According to the results, t (45) = -2.65, p = 0.261, learners across the two classes showed similar levels of skill in the music language. Eight students in the experimental group willingly consented to participate in semi-structured interviews after the intervention was administered.

*The Instruments*

*Intercultural Communicative Competence (ICC)*

The Inter Culture Conversation Efficiency measurements a valid and trustworthy instrument, was employed in both groups to assess respondents' culturally proficiency. Twenty questions on a five-point Likert scale, ranging in rating from "strongly disapprove" to "strongly agree," comprise this assessment [34, 35]. The survey was divided into six distinct subscales: identity regular consumption, message abilities, interactive respect, behaviour flexibility, interactions repose, and management of interactions. Together, these subscales include a number of cultural competency-related elements.

*Behaviour Driven by a Music Learning*

This study assessed participants' willingness to acquire music as a second language using the Motivation Moral Behaviour Scale, a recognised assessment tool in the field.

*Interview that is Semi-Structured*

To gain a thorough understanding of the thoughts, experiences, and opinions of participants on the AR language training App and its effects on cultural awareness and musical instruction, interviews with semi-structured questions were employed. Participants were able to elaborate on their experiences with the app and individual viewpoints were thoroughly examined thanks to this qualitative study technique.

*AR Language-Learning Application*

An augmented reality language learning app that was expressly made for the study was employed in this one. The app was created by a team of proficient engineers and instructional designers in collaboration with language instruction experts. It included augmented reality technology to provide undergraduate students with an interesting and interactive language learning experience. This software was developed to provide immersive language exercises, scavenger hunts, quizzes, cultural challenges, and rich cultural information in order to enhance language learning and intercultural proficiency. To produce a comprehensive and

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engaging learning experience, the following elements were thoughtfully incorporated into the smart development of the programme:

- *Culturally Immersive Content*: The application has carefully selected a diverse range of culturally enhanced written material, including interactive role-playing games, virtual tours of well-known cultural sites, and multimedia presentations highlighting customs and behaviours from other cultures.

- *Engaging Language Practices*: A range of interactive language lessons designed to improve bachelor students' language skills were available for them to get involved in.

- *Tests and Evaluations*: In addition to language proficiency, the application included tests and evaluations on intercultural understanding [35].

- *Cultural Difficulties*: Students in undergraduate courses had a stronger awareness of interactions between cultures dynamics as a result of these hurdles, which pushed them to explore the complex cultural characteristics of what language they were learning.

- *Treasure Hunts:* The programme created engaging scavenger hunts inside the augmented reality setting, fusing language study with exploring of the actual world. Finding cultural monuments and artefacts was a task assigned to undergraduate students, which reinforced the learning of languages through real-world, context-driven encounters.

*The Procedure*

Two groups of volunteers were used in this study: the unmanaged grouping or the group of individuals taking part in the experiment. The experiment group used an Augmented Reality (AR) the study of languages app as an action, while the control group provided traditional training without the use of the technology known as AR. Every group began the language acquisition adventure with activities and tactics that matched their individual learning styles, while under the guidance of the same experienced teacher.

*Data Interpretation*

Utilising qualitative as well as quantitative analysis methods, the impact of the technology of augmented reality on intercultural competencies and music education excitement was evaluated. The quantitative findings were summarised using descriptive statistical techniques, which revealed details about the respondents' degrees of cultural competence and their desire to learn music. Matched samples the t-test have been used to examine changes within each group prior to and after the intervention was administered in order to assess the effectiveness of the AR language instruction app compared with traditional training methods. A one-way ANCOVA was conducted to evaluate interpersonal skills and enthusiasm for the study of music between the control and experimental groups. The pre-test scores were utilised as covariates in this analysis. The semi-structured conversations yielded qualitative data that was analysed using content evaluation, offering valuable insights into the perspectives and experiences of the people who participated. This comprehensive approach made it possible to evaluate the impact of Augmented Reality (AR) technology on multicultural competence and motivation for music education.

## Results

An analysis of how AR technology has affected the evolution of music curricula in undergrad colleges in Nanjing through comparisons. Pre- and post-tests were used to evaluate the intercultural competency and motivation for music learning of both groups. An Examination of Ten Undergraduate Universities in Nanjing.

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*Results of Quantitative*

The descriptive statistics for the two study variables—music learning and intercultural communicative competence (ICC)—are shown in Table 1. Table 1 shows that the experimental group's pre-test ICC mean score (M = 2.69, SD = 0.79) was marginally higher than that of the control group (M = 2.79, SD = 0.79). Comparing to the pre-test, the mean score for the experimental group (M = 3.79, SD = 0.67) increased during the post-test. The average rating of the control sample increased in a similar manner (M = 3.79, SD = 0.97). In terms of the acquisition of music, the experimental group performed somewhat better on the pre-test, with an average score of 2.49 (SD = 0.64), compared to 3.79 (SD = 0.64) for the control group. The group doing the experiment outperformed the control group on the motivation post-test, with a mean score of 3.79 (SD = 0.79) compared to 3.76 (SD = 0.79) for the former.

**Table 1.** Descriptive Statistical Analysis.

| | Groups | N | Mean | Std. dev. | Std. error mean |
|---|---|---|---|---|---|
| *Pre. Icc* | Experimental | 8 | 2.79598 | 0.07959 | 0.87966 |
| | Controls | 2 | 2.95979 | 0.64959 | 0.07959 |
| *Post. Icc* | Experimental | 8 | 3.64985 | 0.54968 | 0.49659 |
| | Controls | 2 | 3.64895 | 0.96785 | 0.97864 |
| *Pre. Music Learning* | Experimental | 8 | 3.89796 | 0.39867 | 0.98687 |
| | Controls | 2 | 2.59679 | 0.32189 | 0.64724 |
| *Post. Music Learning* | Experimental | 8 | 2.49678 | 0.64896 | 0.98768 |
| | Controls | 2 | 2.48967 | 0.97860 | 0.97869 |

Table 2 presents the results of the t-test for paired samples that was used to assess the differences in motivation and cultural awareness between both the experimental and control groups both before and after the intervention.

**Table 2.** Paired Samples Are Used To Assess Motivated And Cultural Competence.

| Group | Pairing | M | Std. dev. | *t* | df | Sig.(2-tailed) | Cohen's d |
|---|---|---|---|---|---|---|---|
| **Exp.** | *Pre. Icc* | -0.89768 | 0.09490 | -5.798 | 8 | 0.000 | 0.59 |
| | *Post. Icc* | -0.54968 | 0.00796 | -38.959 | 2 | 0.000 | 0.97 |
| **Exp.** | *Pre. Music Learning* | -0.97896 | 0.54968 | -3.896 | 8 | 0.000 | 0.69 |
| | *Post. Music Learning* | -0.79689 | 0.97896 | -2.896 | 2 | 0.009 | 0.64 |
| **Controls** | *Pre. Icc* | -0.97869 | 0.64289 | -0.896 | 8 | 0.008 | 0.89 |
| | *Post. Icc* | -0.97899 | 0.89647 | -04.195 | 2 | 0.009 | 0.64 |
| **Controls** | *Pre. Music Learning* | -0.97896 | 0.97809 | -2.989 | 8 | 0.009 | 0.58 |
| | *Post. Music Learning* | -0.97866 | 0.64896 | -07.549 | 2 | 0.039 | 0.89 |

The results of the t-test using paired samples showed that the cross-cultural ability of the experimental group increased significantly from pre-intervention (M = 2.96, SD = 0.79) to post-intervention (M = 3.78, SD = 0.78), t (2) = -26.8, $p < 0.001$. The Cohen's d = 0.46 indicated that this change had an acceptable effect size. Cohen's d = 0.78 indicates a strong impact size. Similarly, the experimental group showed a

Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 3962 – 3975
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4518

substantial rise in motivation score from pre-intervention (M = 86.8, SD = 0.89) to post-intervention (M = 3.89, SD = 0.43), t (2) = −39.56, p < 0.001.

The pairs of samples t-test revealed a statistically significant increase in interpersonal skills in the control group between before intervention (M = 2.85, SD = 0.74), and post-intervention (M = 3.51, SD = 0.78), with t (8) = −6.75, p = 0.005. Cohen's d = 0.25 suggested that this alteration had an acceptable effect size. Additionally, the control groups showed a significant increase in motivational ratings from pre-intervention (M = 3.07, SD = 0.79) to post-intervention (M = 3.49, SD = 0.49), with an average moderate to moderate effect size, Cohen's d = 0.27, and t (8) = −2.47, p = 0.278.

These results imply that after the intervention, intercultural skills and drive increased in the control as well as the experimental groups. In contrast to the control group, the experimental group showed greater average variations in both cultural competency & motivation. ANCOVA was performed to investigate the differences between the groups.

The findings of the ANCOVA performed to look at the way the AR-based instructions affected ICC are shown in Table 3. The findings showed that the group variable had a statistically significant effect on the ICC scores [F (1, 23) = 5.78, p = 0.27, ηp2 = 0.244]. With a moderate effect size, this ηp2 value indicates that the Group variables (i.e., the variable that is independent) accounts for about 11.8% of the variance in ICC scores. After adjusting for pre-test ICC scores, this result highlights an important variance in ICC scores comparing both the control and the experimental groups. To be more precise, the group conducting the experiment showed a higher ICC increase than the control group.

**Table 3.** Results of ANCOVA For ICC Rankings

| **Sources** | **Type II sum of squares** | **df** | **Mean squ.** | **f** | **Sig.** | **Partiality squ.** |
|---|---|---|---|---|---|---|
| *Pre. ICC* | 4.896 | 1 | 4.198 | 7.896 | 0.008 | 0.189 |
| *Grouping* | 3.695 | 1 | 3.609 | 8.968 | 0.009 | 0.118 |
| *Error* | 26.4895 | 44 | 3.489 | | | |

In a similar vein, Table 4 shows the findings of the ANCOVA study carried out for assessing how the AR affected the Music Training grades. A substantial influence was observed on the Music Learning scores [F (1, 23) = 18.265, p < 0.001, ηp2 = 0.245] according to the study. The ηp2 value, which is approximately 28.9%, indicates a significant impact size. After adjusting for the pre-test Music Education scores, this result shows an important distinction in Music Education scores between the control and experimental populations. When compared to the controls company, the experimental group's Music Learning scores were noticeably higher, demonstrating the tremendous benefits of utilising AR technology in language learning contexts.

**Table 4.** Results of the ANCOVA for the Music Performance Ratings

| Sources | Type II sum of squares | df | Mean squ. | F | Sig. | Partiality squ. |
|---|---|---|---|---|---|---|
| Pre. ICC | 6.989 | 1 | 6.496 | 49.897 | 0.002 | 0.796 |
| Grouping | 2.496 | 1 | 2.596 | 19.896 | 0.008 | 0.774 |
| Error | 6.895 | 44 | 0.389 | | | |

The ANCOVA analysis's overall findings are consistent with the prediction that AR-based training improved multicultural ability and musical training more than traditional instruction. The experimental group's ICC & Music Learning score was greater than the control groups, indicating potential benefits of utilising AR technology in language learning settings.

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*Results of Qualitative*

A subset of the experiment group's participants participated in semi-structured interviews, from which topics and insights were also extracted as part of the qualitative examination [36]. They expressed excitement about the app's immersive and interactive features, which enhanced the fun and allure of language learning. One individual, for example, expressed,

*"When I could view and communicate with virtual worlds and characters, I was actually inspired to study. It increased the excitement of the entire procedure and piqued my interest."*

Additionally, each student's development of cultural knowledge was successfully promoted by the AR-based education. Students in undergraduate courses gained important insights into various social conventions, customs, and methods of communication through virtual chats with the culturally varied virtual characters [35, 36]. The encounter facilitated a greater understanding and appreciation of diverse cultures, as reported by the participants. One person talked about,

*"My viewpoint on ethnic diversity has changed as a result of my interactions with the virtual characters. My ability to modify my language and conduct in many cultural contexts has greatly enhanced my intercultural competency."*

A few users stated that the augmented reality software improved their capacity to use language proficiency and cultural awareness in everyday situations. Incorporating cultural obstacles and scavenger hunts inspired participants to investigate their surroundings and locate cultural sites or items [36]. This feature of the software assisted users in bridging the gap between their virtual and actual life experiences. As one of the participants said,

*"I became more aware of the cultural components around me as a result of the scavenger hunts. I began to see details in daily life that I hadn't seen before. I felt more a part of the culture and its language as a result."*

Additionally, it was found that the AR-based training gave participants a customised and flexible learning environment. Undergraduate learners were able to track their learning progression and monitor their academic achievement through the app's progress monitoring system. Students valued the app's immediate feedback because it allowed them to pinpoint their areas of weakness and adjust their study techniques accordingly. One participant highlighted, such as,

*"The constructive criticism feature of the programme made it easier for me to identify my ability to learn languages strengths and shortcomings. It inspired me to strengthen my areas of weakness and recognise my accomplishments along the way."*

These recurring themes and representative passages from the semi-structured interviews demonstrate how AR technology improves students' motivation, engagement, and cultural awareness in Music Learners. The idea that incorporating augmented reality technologies in instruction in languages substantially assists in the development of cultural competency and music learning motivation in undergraduate students studying music is further supported by the qualitative findings, which are consistent with the quantitative results.

## Discussion

Using a mixed-methods approach to data collection and analysis, this study looked into how using Augmented Reality (AR) could enhance music learners' enthusiasm to learn new languages and their capacity for cross-cultural communication. According to the preliminary quantitative findings, the AR-mediated class significantly improved the learners' intercultural proficiency, outperforming its non-AR counterpart in that domain. The outcomes in this domain align with the findings that bolstered the advantages of augmented reality on students' intercultural competency [36, 37]. This gain in proficiency may be partially explained by the special qualities of the AR environment. Because of the immersive nature of the AR classroom, students were prompted to engage in more active communication with their virtual peers, [37], which helped to foster an environment that was conducive to improving intercultural

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proficiency. In essence, the virtual exposure provided by the augmented reality course encouraged students to interact with others in novel ways, [38], potentially improving their intercultural competency.

The performance of AR-enabled learners differed significantly from that of their classmates without AR, [38, 39], according to the data. AR learners showed a higher level of self-management in managing their intercultural competencies [40]. This research raises concerns about how augmented reality might help to develop a setting that fosters the development of students' self-monitoring skills. These skills help students become more interculturally competent overall by allowing them to interact with cross-cultural content, adjust their responses, and work independently on cross-cultural projects.

## Conclusion

This study's investigation of AR applications across a number of educational fields shows how AR technology may improve educational outcomes for students. Because of the advantages and features of augmented reality applications, students are actively engaged in technology learning. These attributes help teachers communicate complex subjects more easily, which benefits both students and teachers. In addition to providing teacher preparation, the teaching support system for music courses can be utilised for in-the-moment student testing. This creates a theoretical foundation for music evaluation and, in turn, provides targeted, helpful suggestions for additional training.

The results indicated a variety of beneficial implications for education, particularly in the setting of music learners. Since the AR course aligns with contemporary notions of student-centeredness and significantly raises motivation for language learning and intercultural competency in Music Learners, it is advised to implement it in interactive Musical Learner cultural courses. Teachers, students, and music learners are suggested to use AR environments for communicative intercultural activities in order to increase the intercultural ability and inspiration of music learners.

There are a few significant limitations to be aware of, even if this study offers insightful information about how AR affects Chinese music learners' enthusiasm to learn music and their intercultural competency. First, undergraduate college students in China who were enrolled in a required music course made up the participant pool. It's possible that this particular group does not accurately reflect the range of music students learning languages across all age groups and skill levels. The results might not apply as broadly to other populations of music learners, such as adult students or those in other types of schools, and might be more relevant in comparable environments. University and college music professors can only accurately represent the significance of their creative contextual imparting knowledge by "teaching with pleasure" in accordance with the new curriculum and teaching philosophy of the twenty-first century. This investigation did not address long-term effects or the transfer of knowledge to real-life intercultural interactions. A long-term study that tracks participants' experiences and actions after the instructional phase might provide more in-depth understanding of the long-term effects of augmented reality-enhanced learning.

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Journal of Ecohumanism
2024
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DOI: https://doi.org/10.62754/joe.v3i7.4518
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2024
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