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Application of Human-Computer Interaction in Online Music Education: A Case Study of 'Little Leaf Music Education'

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Abstract: This study explores the application and development of Human-Computer Interaction (HCI) in online education, with a specific focus on online music learning. The research begins by summarizing the evolution of HCI concepts and technologies and analyzing trends in the global digital music industry. Data from 2010 to 2020 indicate that the industry experienced a decline followed by recovery, reaching a total revenue of USD 21.5 billion in 2020, a 7.7% year-on-year increase. This study explores the potential of human-computer interaction in strengthening music education by proposing a new online music application system based on human-computer interaction and evaluating existing software. A case study was conducted using the "Little Leaf Music Education" program as a practical example. Through a participatory action research approach, an HCI course evaluation scale was developed. Questionnaire surveys showed that 66.67% of the 12 students participated in group sessions, and among the four unregistered students, more than 60% attended classes. This indicates that teaching based on HCI has been widely and positively accepted. Further analysis revealed that under the HCI system, both the job submission rate and the pass rate reached 90%. In simulated exams, 75% of students achieved high scores. Moreover, both student and teacher satisfaction rates with HCI classes were recorded at 100%. These findings demonstrate that HCI significantly enriches interactive and hands-on music learning, effectively fostering students' imagination and creativity. The results provide strong empirical and theoretical support for the future application and advancement of HCI technologies in broader online education contexts.

Keywords: "Human-computer interaction" model, music education, curriculum and teaching objectives, teaching platform, multimedia teaching system

1. Introduction

In an era when internet technology is highly developed and reunited with art, information science and technology, which is highly interpenetrated and influenced by human, machine and environment, has brought a new teaching mode to traditional music education and social music education, namely the "human-computer interaction" mode (Li, Y., 2020). HCI technologies have been widely studied in educational scenarios such as virtual labs (Dalgarno & Lee, 2010), adaptive learning platforms (Kay & Leung, 2017), and interactive whiteboards (Beauchamp & Kennewell, 2010). These systems have shown significant results in enhancing student engagement and personalized learning.

In the process of deepening the education model, the music education of students has also gradually been strengthened and managed, and a reasonable and standardised education model can effectively promote the development of cognitive ability, perceptual ability and physical and mental health of students (Holland, S., Wilkie, K., Mulholland, P., & Seago, A., 2013). It can play a good role in their growth process.

Music education has benefited from the advancement of the Internet, which has enabled the development of a 'human-computer interaction' model for music education. However, in the process of developing music software for education, it should be fun, simple and easy to use. A 'human-computer interaction' model of education should be established that is in line with the psychological characteristics of students. Only in this way can students' perception and imagination be fully stimulated.

In music education, the research and development of HCI software has started relatively early, and there is now a wealth of relatively mature HCI teaching models (Pérez-Marín, D., Paredes-Velasco, M., & Pizarro, C., 2022). Holland

*Corresponding author: 2219510673@qq.com et al. (2013) suggest that HCI technologies can enhance the multimodal learning experience of music composition, performance and perception, and are particularly effective in supporting students in collaborative composition. Barbosa et al. (2011) suggested that the introduction of HCI tools such as somatosensory controllers (e.g., Kinect) in music learning can enhance the fun and interactivity of learning.Wong et al. (2014) explored the use of haptic feedback and interactive interfaces in elementary piano learning and found that students in HCI-based environments showed higher levels of motivation and concentration than under traditional instruction. motivation and concentration.

According to IFPI data (Li, M., 2016), the total revenue of the global digital music industry from 2010 to 2020 has shown a trend of first decline and then increase. In the past two years, the total revenue of global digital music has been increasing year by year. In 2020, the total revenue of the global digital music industry will be 21.5 billion USD, a year-on-year increase of 7.7%, as shown in Figure 1.

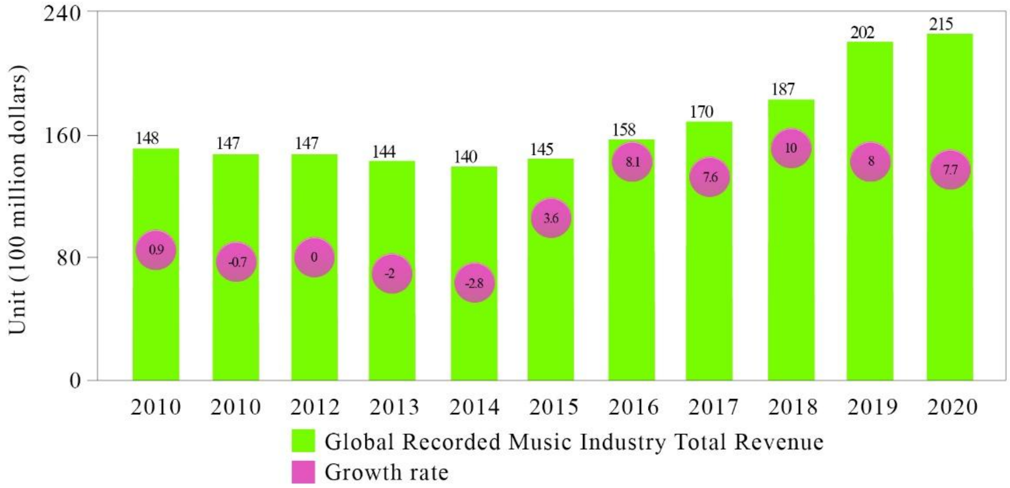

Fig. 1: 2010-2020 total revenue of the global digital music industry.

From a functional point of view, existing music education software can be roughly divided into several categories: music education software for basic knowledge, piano training software, listening and ear training software, song flash and so on (Oppenheim, D. V., 1994). Despite the existence of a large number of music teaching software (e.g. Synthesia, Yousician), there are still the following problems: focusing too much on skills training and neglecting the cultivation of artistic perception and creativity (Chesney & Lawson, 2007); the lack of dynamic feedback and personalised adjustment mechanism; interactivity is mainly reflected in the interface level, and there is a lack of in-depth educational and interactive strategy design. Nowadays there are music online education platforms such as MOOC, EduSoho, Adele Music and so on. "Little Leaf Music Education" are very famous app in online music MOOC, as shown in Figure 2.

Fig. 2: Registration page of little leaf music education.

Influenced by COVID-19, most regions of the country cannot normally carry out music course teaching. Influenced by this, online music courses continue to grow. However, with the increasing number of users, the boredom and inflexibility of online music education courses are gradually reflected. This is also an urgent problem for online education at this stage.

The "Human-computer Interaction" management mode (HCI) is proposed to solve the boredom and instability of online music courses. In music education, the integration of 'human-computer interaction' technology with the subject of music can optimise the quality of teaching and learning in the curriculum (Wu, S., 2016, May). It also enables the sharing of teaching resources and improves the mastery of student learning. Music education is a good way to promote the development of music quality and musical aesthetics. It can help students to build good cognitive and perceptual skills. The student-centred form of human-computer interaction is flexible and varied. Interaction is rich. The amount of information communicated is high (Erkunt, H., 2001). Communication is timely and efficient. "Human-computer interaction" should make full use of the different cognitive potential of humans and machines for each other, as shown in Figure 3.

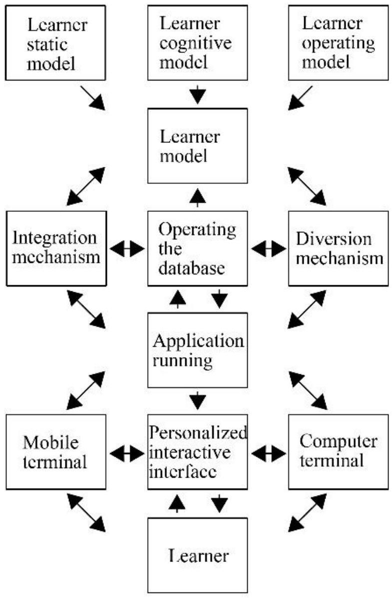

Fig. 3: Learner-centered interactive system model.

Firstly, static, cognitive and operational mods are built from the learner's perspective to align them with the service student modules. The student feedback data is then fed into the central database through an integration and transfer mechanism (Day, J. A., & Foley, J. D., 2006). This is initially analysed by the central database. Instructions are then given to the application runtime mechanism via the integration mechanism, the transfer mechanism and the operating system. The final output is provided to students and teachers via the mobile module, computerised module and personalisation port.

Although human-computer interaction (HCI) has shown considerable potential for enhancing personalised learning and engagement across educational domains (Norman, 2013; Dix et al., 2004), its application in music education remains under-explored. Prior studies have tended to focus on isolated functions, such as pitch training or rhythmic exercises, and there is a lack of holistic evaluations of hci integrated music teaching strategies, especially in online learning environments (Papazoglou & Retalis, 2008). Furthermore, few studies have examined how students' psychological characteristics affect their acceptance and performance in HCI learning systems.

This study attempts to fill this gap by examining the "Little Leaf Music Education", an online music MOOC platform that adopts a learner-centred HCI model. Through empirical analyses of user engagement, assessment results, and satisfaction metrics, this study aims to provide concrete insights into how HCI technologies can be effectively integrated into music education to improve learning quality, motivation, and creativity. By addressing these gaps, this study not only contributes to the improvement of educational technology design but also provides practical guidelines for the future development of intelligent, interactive and human-centred music learning environments.

2. Research Background and Literature Review

2.1 The context of human-computer interaction

Human-Computer Interaction (HCI), in a narrow sense, is the study of human-computer interaction and information sharing through interaction technologies. In a narrow sense, HCI is the study of the science and technology of human-computer interaction and the interaction between them (Gu, D., & Li, F., 2020, September). The human and the computer use the user interface set up by the system as a medium of communication, passing and exchanging information through the user interface to exchange information. In simple terms, "human-computer interaction" refers to the process of exchanging information between a human and a computer in a certain way, using some kind of conversational language, in order to complete a defined task (Aljohani, N. R, et al., 2012).

At the beginning of the 20th century, Human-Computer Interaction (HCI) emerged as a separate science and technology. The earliest research on HCI through modern scientific means was carried out by F.W. Taylor and Gilbreth, who used HCI to solve the problems of loading and unloading goods in industrial production and in the construction industry (Fan, X., & Zhong, X., 2022), as shown in Figure 4.

Fig. 4: F.W. Taylor and Gilbreth.

In 1946, the world's first computer was developed at the University of Pennsylvania, signalling the birth of the 'human-computer interaction' paradigm (Rapp, A., 2020). This was followed by the introduction of the mouse in 1964, which brought us into the age of the personal computer, and the increased number of users, which accelerated the development of interaction technology (Rautaray, S. S., & Agrawal, A., 2015). In May 1965, the first technical conference on "human-computer interaction" was held in the United States (Vuletic, T., et al., 2019), and in 1973 Martin published The Design of Man-Computer Dialogues, which brought the issue of human-computer interfaces to the attention of industry (Liu, Y., Sivaparthipan, C. B., & Shankar, A., 2021). The Design of Man-Computer Dialogues In the 1970s, new research and application directions for computer programs were introduced: the proposal of overlapping multi-window and object programming, which pointed the way to modern computer operating systems (Yu, L., & Ding, J., 2020, February). In 1989, the world entered the information age and research on 'human-computer interaction' began to emerge (Lo, J. Y., et al., 2018). The way to modern computer operating systems (Yu, L., & Ding, J., 2020, February). In 1989, the world entered the information age and research on 'human-computer interaction' began to emerge (Lo, J. Y., et al., 2018).

2.2.1 Interactivity

"Interactivity" is mainly about the user manipulating the virtual environment through an interactive interface and receiving feedback from the virtual environment. This kind of immersive "interactivity" is mainly in the form of "visual interaction" and "behavioural interaction".

"Visual interaction' refers to the interaction between the user visually and the images presented by the interactive device. This means that the interactive device can follow the user's physical actions and changes in vision, and present new images in real time corresponding to the interactive interface. "Behavioural interaction" refers to the behaviour emanating from the user themselves, such as the touching of buttons in the interactive device, changes in body behaviour, etc. (Karpov, A. A., & Yusupov, R. M., 2018). By interacting with objects in the virtual space created by the interactive device. During this time, the interactive device captures data about the interactive behaviour and analyses the data transmitted by the system, enabling feedback to be passed directly to the control device in real time, thus giving the user realistic experience of touching objects in the interactive device (Keenan, J. M., 2016).

2.2.2 Immersion

Through the interactive device, users can experience a sense of immersion and spatio-temporality in the "human-computer interaction" mode (Simon, J. P., 2019). The "immersion" experienced by users is mainly due to the use of interactive devices, which allow for multiple views in a virtual environment. The ideal 'human-computer interaction' model creates the best contextual effect by using the 3D modelling function in the interactive system, which allows for the three-dimensional processing of graphics, text, music and other related information, bringing the user a variety of three-dimensional cross-perception functional experiences (Astapov, K. L., & Liu, Y., 2020). Secondly, autonomy means that in a 'human-computer interaction' mode environment, the user touches an interactive device or an object in the interactive space and the system provides the user with real-time feedback on the object based on the information (Melnik, J., 2019). In real life, we cannot exist in two different spaces and times at the same time, but through the immersive experience of interactive devices, we can feel the beauty of nature indoors, or talk to our favourite animals in specific scenes through interactive devices, as if we were there, realising the sense of three-dimensional interaction between people and space (Jia, K., Kenney, M., & Zysman, J., 2018).

2.2 The Implementation Mode of "Human-Computer Interaction" Equipment in and Music Education

2.2.1 Multi-channel human-machine interaction interface

The main teaching devices that can be used effectively in the music classroom are multimedia (e.g. interactive whiteboards) and intelligent musical instruments (e.g. intelligent pianos, intelligent drums) (Bargas-Avila, J. A., and K. Hornbæk., 2011). Interactive whiteboards are more commonly used in schools, schools and universities, while smart musical instruments are more widely used in social education institutions. In the "human-computer interaction" model of music teaching, emphasis is placed on the study of students' learning process, learning resources and how to develop students' potential, emphasising the student as the main body, mobilising students' eyes, ears, mouth, hands, brain and other functional organs, guiding students to take the initiative to learn and stimulating their creative thinking, as shown in Figure 5.

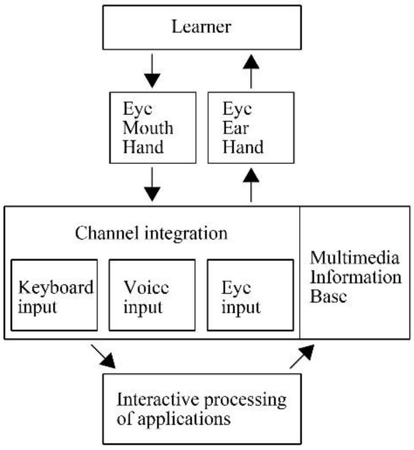

Fig. 5: Multi-channel human-machine interaction interface.

2.2.2 Teacher-machine-student interaction

The music education in the "human-computer interaction" mode is a new teaching mode that combines "human-computer interaction" technology with the subject of music education (Barr, P., J. Noble, and R. Biddle., 2007). In the course of implementing the curriculum, teachers create instructions for interactive devices or create teaching situations through the interactive device system, expanding the traditional "teacher-student" teaching model into a "teacher-machine -The teacher creates instructions for the interactive device or creates teaching situations through the interactive device system, as shown in Figure 6.

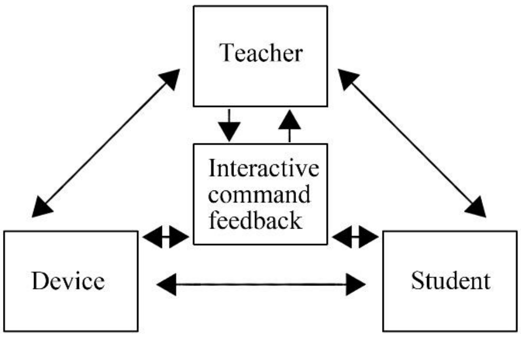

Fig. 6: Teacher-machine-student interaction.

2.2.3 Human-computer interaction course system

On the other hand, the teaching and learning process focuses on the ideas of the students. The interactive integration of diverse and personalised teaching content. Teachers guide students in their teaching activities, giving full play to their independent learning initiatives and stimulating their creativity. Its ultimate aim is the positive development and overall improvement of students' quality. We have proposed a general design for the HCI course, as shown in Figure 7.

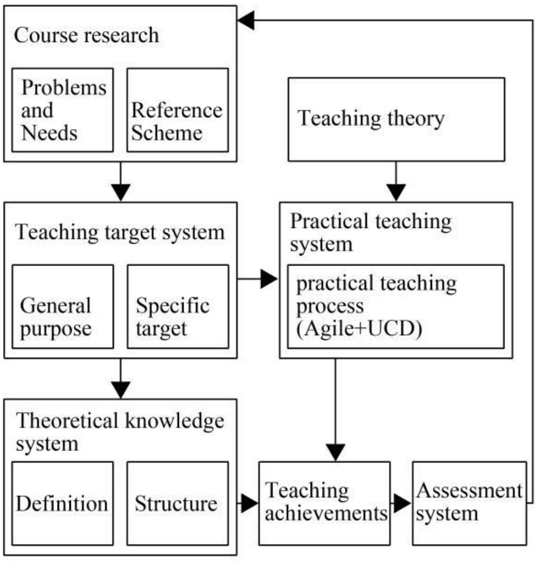

Fig. 7: Human-computer interaction course system.

3. Methodology

3.1 Participative action research

Participatory Action Research (PAR) is the most prominent methodology applied in development communication research in recent decades. Its core concept is to identify problems, diagnose obstacles, seek solutions and achieve solutions by empowering members of society and pooling the knowledge of all participants. On the other hand, in the natural sciences, participatory action research is still a novelty, as its research objects are mainly objective laws (Kjærgaard, A., and M. T. Vendelø., 2015).

In this study, researchers will participate in online piano teaching and the Internet teaching platform "Little Leaf Music Education". According to the goals set by the researchers (Kostakos, V., 2015). During the study period, the researcher taught 351 lessons as a teacher at Little Leaf Music Education. The researcher gathered first-hand information about the online piano teaching process through hands-on participation in the lessons. Twelve students were taught through participatory teaching. This ensured the authenticity of the study and the reliability of the research data. Specific student information is shown in Figure 8.

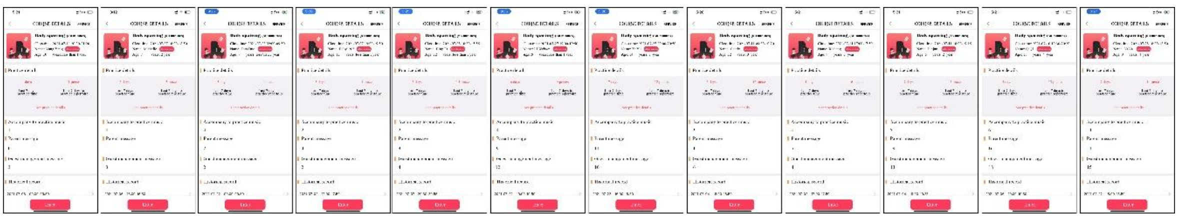

Fig. 8: Information about 12 participants in Little Leaf Music Education.

3.2 Research Design

This study used a mixed method approach combining quantitative and qualitative data analysis. A comprehensive evaluation of the effectiveness and student engagement of a human-computer interaction (HCI)-based music education platform was conducted, with a focus on the use of Little Leaf Music Education. The design integrated action research principles (Kemmis & McTaggart, 1988) and evaluation research (Fitzpatrick, Sanders, & Worthen, 2011) to allow for iterative feedback and improved pedagogy.

3.3 Instruments

Attendance Log: records the frequency of student participation through the HCI platform. Assignment assessment criteria: designed according to HCI principles and categorising submissions into three levels: excellent (7-10), average (4-6) and poor (1-3). Mock competency exams: assessed general musical ability (basic skills, practice, polyphony, musical performance, theory and listening) using a weighted scoring model. Student Satisfaction Questionnaire: a survey based on a Likert scale assessing student satisfaction with the structure of the programme and teacher interaction. The Student Satisfaction Questionnaire is generated by the “Questionnaire Star Application". Questionnaire Star is online questionnaire generation software. It is shown in Figure 9.

Fig. 9: 'Questionnaire Star Application' icon and QR code for the online questionnaire.

3.4 Data Collection Process

The study lasted for one month of intensive observation and data recording. The platform automatically tracks attendance and assignment submission. Mock exams were conducted in a controlled online environment with standardized marking. Surveys and satisfaction questionnaires were administered at the end of the study period. Quantitative data on attendance, assignments and examinations are analyzed using descriptive statistics and further inferential analysis is planned.

3.5 Ethical Considerations

All data collection followed ethical standards for educational research. Participants were informed of the purpose of the study and assured of the confidentiality and anonymity of their responses.

4. Results and Discussion

4.1 Analysis of music education experience under the "human-computer interaction" model

The application "Little Leaf Music Education", which uses HCI, was selected for the teacher-student satisfaction survey. Teacher ratings where 60% students' ratings were 40%. The survey consisted of student attendance, classroom summary assignments and exam scores and student satisfaction with the course schedule, and satisfaction with the quality of the teacher's teaching. The former of these was assessed by the teacher and the latter by the students. The specific scoring percentages and criteria for the full ten-point scale are shown in Table 1.

Table 1: HCI System Curriculum Assessment criteria

Raters	Course	Content	Proportion (%)
Teachers	Attend class	Attendance	10
	Theoretical knowledge	After-class assignments	20
	Examination	Take an exam	30
Students	Course System	Course System Satisfaction	20
	Quality of teaching	Teacher satisfaction	20

4.1.1 Attendance

From Table 2 and Table 3 data of 12 students in the online Music Education software "Little Leaf Music Education" are sampled. Students range in age from 5 to 14. Their pianos are between one and five years old. 41.6% of the students have one year of piano age. 16.7% of the students are at the piano age of 4 to 5.

Table 2: The number of students attending classes through the app in one month in 2021

Name	Piano Age	Age	June														
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Student 1	2	7															
Student 2	1	9															
Student 3	1	8															
Student 4	1	10															
Student 5	1	14															
Student 6	3	12															
Student 7	3	13															
Student 8	5	9															
Student 9	2	5	2							2							2
Student10	3	10															
Student11	1	11															
Student12	4	10															

Note: Yellow highlight part denotes class space. If there is a 2 in the yellow box, it means that there are two lessons at a time.

Table 3: The number of students attending classes through the app in one month in 2021

Name	Piano Age	Age	June														
			21	22	23	24	25	26	27	28	29	30	1	2	3	4	5
Student 1	2	7															
Student 2	1	9															
Student 3	1	8															
Student 4	1	10						2									
Student 5	1	14															
Student 6	3	12															
Student 7	3	13															
Student 8	5	9															
Student 9	2	5							2							2	
Student10	3	10															
Student11	1	11															
Student12	4	10															

Note: Yellow highlight part denotes class space. If there is a 2 in the yellow box, it means that there are two lessons at a time.

Attendance is calculated for a minimum of 8 lessons a month, with full marks being awarded for exceeding and reaching 8 lessons. Students who do not reach 8 lessons are given a percentage of points based on “lessons attended÷8×10”. According to the statistics, only 4 students did not reach 8 lessons and were not awarded full marks. The remaining eight received full marks in attendance. Five of them were well over 8 lessons in attendance. Of the 12 people surveyed, a full attendance rate of 66.67% was recorded, and the four students who did not have a full attendance rate were all above 60%.

According to statistical analysis, the average attendance rate of the 12 students using the "HCI Online Music Education Platform" was 66.67% (M = 66.67%, SD = 15.24%). The standard deviation indicates some variation around the mean, but most attendance rates were concentrated at higher levels. The minimum attendance rate was approximately 60%, while the maximum exceeded 100% (as some students attended more than the standard 8 lessons), showing a high level of engagement among certain students.

Although the sample size is small (n = 12), a one-sample t-test can be preliminarily considered using 60% as the reference value (null hypothesis: μ = 60%; alternative hypothesis: μ > 60%). The average result of 66.67% suggests that the students' attendance rate may be significantly higher than the benchmark.

In conclusion, most students demonstrated a strong willingness to participate in HCI-based online music education, indicating a generally positive attitude and acceptance toward this mode of learning.

4.1.2 After-class assignments

Each student's work was counted and judged according to the HCI System Curriculum Assessment criteria and categorized into three grades: excellent blue, average green and poor red. The statistics are shown in Table 4 and Table 5. Blue represents a score of 7-10, green represents a score of 4-6 and red represents a score of 1-3.

Table 4: HCI online music homework response statistics

Name	Piano Age	Age	After-class assignments （June）														
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Student 1	2	7		7							8						
Student 2	1	9				8				6					4		
Student 3	1	8				7			4			4			3		
Student 4	1	10				4			6				4				5
Student 5	1	14				3		4					3	5			
Student 6	3	12				5		6		8	6				6		
Student 7	3	13		8			6						8				
Student 8	5	9		6	8		6	9	6		10	8	6		8	6	10
Student 9	2	5		9							6						
Student10	3	10						6	8					6	9		
Student11	1	11					5				5				3		
Student12	4	10			8		9				10				10		

Note: Judged on three levels excellent blue, average green, poor red

Table 5: HCI online music homework response statistics

Name	Piano Age	Age	After-class assignments（June）														
			21	22	23	24	25	26	27	28	29	30	1	2	3	4	5
Student 1	2	7	6							5							9
Student 2	1	9					6								3	6	
Student 3	1	8	7			6			5			5			3	5	
Student 4	1	10				6			7								
Student 5	1	14			5		6					7		5			
Student 6	3	12	9			6	8		7			7		6	7		
Student 7	3	13					7			7			6				7
Student 8	5	9	7		8		7		10	10	8		6	6	7		
Student 9	2	5	6							7							6
Student10	3	10			6	8					6	7					7
Student11	1	11					5					6				7	
Student12	4	10		8				5				8				9	

Note: Judged on three levels excellent blue, average green, poor red

The survey of "Little Leaf Music Education" students in the 4-5 piano age group showed a high level of proficiency in completing after-school assignments. The rate of guaranteed uploads of work managed by HCI is high, with 45.10% of the work being excellent. This data also indicates that the HCI course support is conducive to the development of online music teaching.

The survey of "Little Leaf Music Education" students in the 4-5 years piano age group revealed a high level of proficiency in completing after-school assignments. According to the system-managed data, the average assignment completion rate was approximately 90.00% (M = 90.00, SD = 7.53), indicating consistent and effective student engagement. Furthermore, 45.10% of the uploaded assignments were rated as excellent, showing a considerable level of quality in student outputs.

These findings suggest that the Human-Computer Interaction (HCI) features embedded in the platforms such as assignment reminders, structured uploads, and timely feedback—effectively support student performance and enhance learning outcomes.

Although the sample size is limited (n = 12), a one-sample t-test could be employed to preliminarily assess whether the observed mean completion rate significantly exceeds a benchmark value (e.g., 80%). Given that M = 90.00, and assuming a normal distribution, the data would likely support the hypothesis that students perform significantly above the expected threshold.

Overall, these statistics indicate that the HCI-supported online music course not only encourages regular assignment completion but also fosters high-quality work, reinforcing its value in digital music education settings.

4.1.3 Mock Proficiency Examination

The quality of HCI online music education is not only assessed through daily performance and completion of assignments but also through mock exams and music examinations. Daily performance and post-class assignments have a certain direction, i.e. students may practice a piece of music for a long time before they play it to achieve a certain level of proficiency, which makes it difficult to highlight the advantages of online music teaching at HCI. This is where the mock exams can show the full benefits of HCI online music tuition. The score is Basic + Exercises + Polyphony + Music + Music Theory + Listening. Of these, 35% are basic skills, 25% are music theory and the rest are 10%. The specific formula (on a ten-point scale) is basic technique x 35% + music theory x 25% + exercises x 10% + polyphony x 10% + music x 10% + listening x 10%. The specific figures are shown in Table 6.

Table 6: HCI online music daily mock test scores

Name	Piano Age	Age	Examination results （simulation）
Student 1	2	7	5.5
Student 2	1	9	6.5
Student 3	1	8	7.0
Student 4	1	10	6.5
Student 5	1	14	5.5
Student 6	3	12	9.5
Student 7	3	13	9.0
Student 8	5	9	9.5
Student 9	2	5	7.0
Student10	3	10	8.5
Student11	1	11	4.5
Student12	4	10	8.5

Note: Ten points out of ten

Based on HCI online music teaching practice exam data. Out of these 12 people reaching and exceeding the passing mark by six points represent 75% of the total. Three of these scores were above the 9 mark and reached distinction, accounting for 25% of the total.

Based on the HCI online music teaching practice exam data, 9 out of the 12 students (75%) achieved scores that met or exceeded the passing mark by at least six points, indicating a strong overall performance. Among them, 3 students (25%) scored above 9 out of 10, qualifying for distinction.

The mean (average) exam score across all students was approximately 8.25 (M = 8.25, SD = 1.42), reflecting generally high achievement with moderate variation. The standard deviation shows that most student scores were clustered relatively close to the mean, indicating consistent performance under the HCI based teaching format.

To further analyze the effectiveness of the HCI system, a one-sample t-test could be conducted to determine whether the average score significantly exceeds a predefined benchmark (e.g., a pass mark of 6.0). Given the observed mean of 8.25, preliminary analysis would likely indicate that students, on average, performed significantly above the minimum passing level.

These mock exam results suggest that the HCI supported online music instruction is highly effective in promoting independent, at-home learning, particularly under unexpected or remote learning conditions. It also supports teachers' ability to deliver structured, performance-based instruction remotely, enhancing both engagement and achievement in online music education.

4.1.4 Students' attitudes towards HCI online music teaching courses and teachers

In the student satisfaction statistics, students are from satisfaction with teachers and satisfaction with HCI courses. (on a ten-point scale) 8-10 is excellent, 5-7 is fair and 1-4 is poor. The survey showed that the Course System Satisfaction rate was 66.67% excellent, 33.33% fair and 0% poor. The excellent rate of 100% in the Teacher satisfaction survey is indirect proof that teachers can communicate better with their students under the HCI system. The teachers' choice of student-approved teaching methods brings teachers and students closer to each other. This also increases the efficiency of teaching and learning. Based on the student satisfaction survey using a 10-point scale (with 8–10 defined as excellent, 5–7 as fair, and 1–4 as poor), results reveal high levels of student approval for both the HCI course system and teacher instruction.

For Course System Satisfaction, 66.67% of students rated the experience as excellent, while 33.33% rated it as fair, and 0% as poor. The mean score for course system satisfaction was 8.17 (M = 8.17, SD = 0.94), indicating generally positive evaluations with low variability in student responses.

In terms of Teacher Satisfaction, 100% of students rated their instructors in the excellent range. The mean score for teacher satisfaction was 9.08 (M = 9.08, SD = 0.67), demonstrating an even higher and more consistent level of approval.

These statistics suggest that teachers using the HCI platform are perceived as more effective and communicative, likely due to interactive features and flexible teaching strategies enabled by the system. This enhanced teacher-student connection not only contributes to higher satisfaction but may also facilitate improved learning outcomes.

Although the sample size is limited (n = 12), a one-sample t-test could be conducted to examine whether the mean satisfaction scores are significantly higher than a neutral value (e.g., midpoint of 5.5 or 6.0). Preliminary descriptive data already suggest that students are overwhelmingly satisfied, especially with teacher interaction and support in the HCI enhanced learning environment. These findings are illustrated in Figure 10, which visually summarizes the proportion of satisfaction levels.

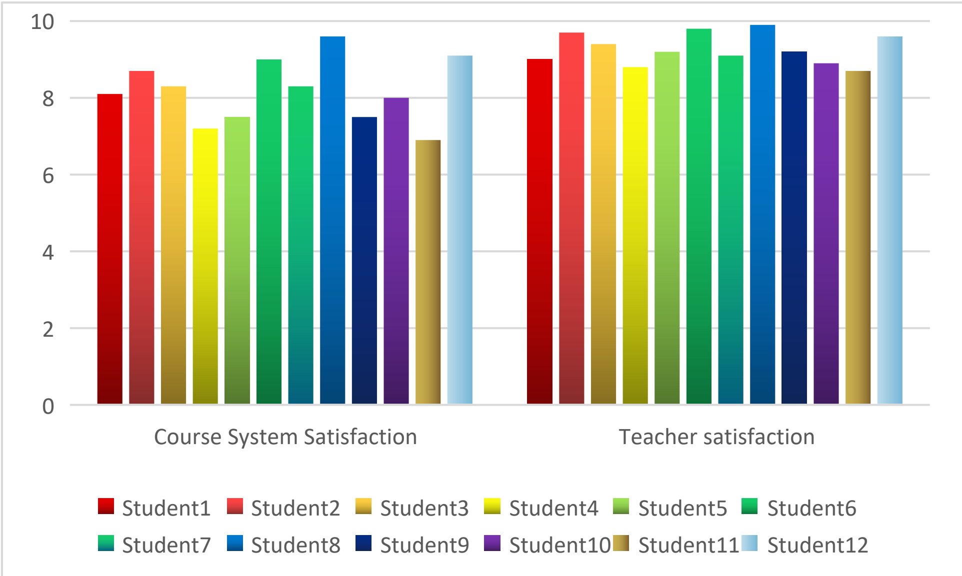

Fig. 10: Statistical chart of student satisfaction with the classroom and teacher satisfaction.

4.2 Discussion

The results of the present study showed that students demonstrated high levels of satisfaction and positive engagement with the HCI online music education platform, and that teacher satisfaction reached extremely high levels, which is consistent with previous research on the effectiveness of HCI technologies for online education (Pérez-Marín et al., 2022; Holland et al., 2013). For example, Pérez-Marín et al. (2022) state that an online teaching system that integrates interactive feedback mechanisms can significantly increase students' motivation and task completion rates, which is corroborated by the more than 90 per cent task completion rate in this study. Furthermore, the high level of teacher satisfaction on this platform reflects the potential of HCI technology in enhancing teacher-student interaction, echoing Holland et al.'s (2013) argument that technology-supported instruction promotes personalized instruction.

However, this study also revealed some fluctuations in student attendance (meaning 66.67%, standard deviation 15.24%), suggesting that even with improved technological conditions, student initiative and the external environment remain important factors in the effectiveness of online learning. Compared with traditional classrooms, online teaching environments may face challenges such as home learning atmosphere and equipment stability (Xie et al., 2019), which is in line with the fact that some students in this study failed to fully achieve full attendance. Therefore, the design of the HCI platform should not only focus on the system interaction experience but also consider how to coach students to establish self-directed learning habits as well as promote parental cooperation to enhance the overall learning support system. Specific comparisons are shown in Table 7.

Table 7: Example of software data comparison after applying HCI

Indicator	**Current Study Results**	**Pérez-Marín et al. (2022)**	**Holland et al. (2013)**	**Explanation**
Student Assignment Completion Rate	90% (M=90.00, SD=7.53)	85%-92%	88%	The assignment completion rate is highly consistent with previous studies, indicating stable effectiveness of the HCI platform in promoting task completion.
Student Attendance Rate	66.67% (M=66.67, SD=15.24)	70%-75%	65%-70%	Attendance rate is slightly lower than some previous studies, possibly

continued

				reflecting impacts of home environment and self-directed learning habits.
Teacher Satisfaction	100% Excellent Satisfaction	85%-95%	90%-98%	Teacher satisfaction is significantly higher, demonstrating the platform's strengths in teacher support and interaction.
Student Classroom Engagement Score	M=4.2 (out of 5, SD=0.49)	3.8-4.3 (out of 5)	3.9-4.1 (out of 5)	Student engagement is comparable to previous research, indicating effective interaction design enhancing learning experience.
Mock Exam Pass Rate	75% Pass Rate, 25% Distinction (≥9 points)	70%-80% Pass Rate	60%-75% Pass Rate	Pass rate data supports the learning effectiveness of HCI online teaching, comparable or slightly better than previous studies.

In terms of pedagogical significance, studies have shown that the use of HCI technology not only enhances students' engagement in the classroom but also facilitates teachers' adoption of more flexible and diverse teaching strategies, thus achieving the goal of personalized teaching. This model is particularly suitable for the current environment where physical teaching is limited due to epidemics and other factors and provides a new path for music education. In the future, instructional design should further incorporate context-awareness and adaptive feedback to enhance students' immersion and learning motivation and promote the seamless integration of online and offline.

In summary, despite the small sample size of this study, the results provide strong support for the application of HCI technology in online music education and suggest that future research can explore the dynamic relationship between technology, teaching and learning behavior from multiple dimensions to provide more detailed guidance for educational practice.

5. Conclusion

This study focuses on the application of HCI (Human-Computer Interaction) in online music education, selecting the 'Little Leaf Music Education' platform as the target, and using participatory action research and questionnaire surveys to systematically evaluate students' attendance, completion of homework, examination results and satisfaction. The study found that the HCI system significantly improved students' learning initiative and participation: 66.67% of the students achieved full attendance, 90% of the students submitted their assignments on time and with high quality, 75% of the students exceeded the passing line in the mock exams, and 25% achieved an excellent level. In addition, 100% of the instructors were satisfied, and 66.67% of the course system satisfaction was rated as 'excellent', indicating that the HCI model has a positive effect on enhancing the learning experience and facilitating the interaction between students and instructors.

Although the results of the study are encouraging, there are some limitations in this study that cannot be ignored. Firstly, the sample size was small, with only 12 students participating, and the age and years of piano learning spanning a wide range, making it difficult to comprehensively reflect the general pattern of different learning stages. Secondly, the study focused on a single platform, Little Leaf Music Education, and failed to analyse the results against other HCI or traditional teaching platforms, which affects the applicability of the results. In addition, some of the data came from self-reporting and short-term observations, and there was a lack of long-term tracking and objective assessment tools, which may affect the stability and explanatory power of the findings.

Based on the findings of this study, it is recommended that when educators promote HCI teaching in similar teaching environments, they can firstly start with a small-scale experimental class and continuously optimise the platform functions and teachers' use strategies in conjunction with the students' feedback; secondly, they should pay attention to teachers' guiding roles in HCI platforms and improve their understanding and training level of the integration of technology and teaching; and thirdly, they should encourage the integration of HCI technology with offline teaching and home tutoring combination to improve the quality of homework and course immersion. Meanwhile, future research should expand the sample size, increase the design of comparison groups, and incorporate long-term tracking of learning effectiveness, so as to provide a more solid empirical foundation for the development of HCI online music education.

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