

Analysis of AI-generated Music Applications in Primary Schools under the STEAM Education System

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Abstract

As a refinement of STEM (science, technology, engineering, and mathematics), STEAM (science, technology, engineering, arts, and mathematics) is considered a more comprehensive and practical pedagogy. However, in China's educational environment, without the combination of test-oriented content, such methodology is hard to apply and popularize. Therefore, how to integrate more STEAM elements into the classroom while still meeting the assessment objectives of the exams needs to be considered further. Besides, to meet the iterative requirement of STEAM design, integrating advanced technology elements, especially AI, is an unavoidable trend. With a focus on music in the arts section of STEAM, our research is mainly intended to discuss the validity and practicality of using AI to generate songs that can help both Chinese primary school teachers to make innovations in class content and students to memorize certain knowledge points. Drawing on findings in the previous literature on STEAM education concerning AI music, the impact of nursery rhymes, and related AI platforms, this study collects knowledge points that are appropriate for primary school students and produces AI-generated songs. Then we discuss how these songs can be integrated into the STEAM system. The study assumes that AI-generated knowledge memory songs are actionable and have a good potential for further development. These songs could have a significant positive impact on primary school students' knowledge memory and also stimulate teachers' interest in adapting more technology elements in their teaching to make teaching more creative. Keywords: STEM, STEAM, teaching methodology, AI-generated song.

1. Background

1.1. STEAM

Unlike traditional approaches to teaching and learning, which isolate subjects from each other and emphasise outcomes-based assessment (Taylor, P. C. 2016), STEM groups the knowledge and techniques needed to understand and transform the world across four broad subject categories, Science, Technology, Engineering, and Mathematics. However, this model is deficient in terms of a creative mindset, and this may be the most prominent defect of such classification (Sochacka, et al. 2016). With the addition of one further step, art is added to STEM, thus creating STEAM, including romantic and creative elements to the originally "tried and true" subject combination. Compared with STEM, STEAM plays a more important role in breaking down the brick walls of the classroom

and the real world, because art itself is a poetic reflection of the real world (Education Closet, 2019).

In addition to the obvious benefits of STEAM, there is also an often overlooked influence on the teaching community. Most importantly, it can reduce the pressure on teachers to develop courses alone and promote the formation of an atmosphere of positive and innovative communication among teachers (Belbase, 2022). In one example, however, according to the research done by Anisimova, et al. (2020) at the Faculties of Mathematics, Natural Sciences, Engineering, and Technology of the Yelabuga Institute of Kazan Federal University, only a third of all teachers are willing to propose new STEAM teaching programs, and other teachers are either willing to improve existing programs or use them directly (See Figure 1). Meanwhile, the development of advanced technology, es-

pecially that of AI, has put increasingly stringent requirements on teachers' creativity (Lavicza, et al. 2022). If teachers themselves are not creative or willing to become more creative, how can they ask students to be so?

Nevertheless, western countries such as the United States are still actively responding to STEAM and trying to incorporate it into general knowledge courses (Li, et al. 2022). Such attempts will encounter greater difficulties in the special context of China's education status quo, as Chinese teachers' time and willingness to invest in STEAM, especially those who teach in middle schools, are much lower than that of primary and university teachers under the pressure of "the mountain of the final exam" (Land, 2013) (see Figure. 2). Additionally, close communication between teachers of different subjects is more difficult (Park, 2022). Till now, existing STEAM design research, focusing as it does on China's status quo, is still in the minority. Therefore, the general problems facing STEAM may be more serious in China (Salas-Pilco, 2021).

Generally speaking, the problems faced by STEAM are shown below (see Figure 3). For China in particular, insufficient teamwork and team composition, difficulties in independent research and development, single course content, and insufficient validation of course effectiveness comprise the main problems in the promotion of STEAM education (Wang, et al. 2018).

Considering all the factors above, the focus of our research is on music teaching in the arts. As mentioned earlier, combining STEAM with AI technology may be a major heading in STEAM creativity. However, based on current test-oriented pedagogy in China, teachers may find it impossible to adopt the STEAM model completely in their classrooms. Therefore, allowing for the traditional model may be a better way for teachers to incorporate the STEAM model.

1.2. AI-generated Music

At present, AI methods of music generation include three main aspects: evolutionary computation, conceptual blending, and deep learning (Kaliakatsos-Papakostas, 2020). Besides, current AI music software or platforms include Jambot, MidiNet, DeepBach, and others. Most of them have been developed by big enterprises such as Google, Amazon, and Sony (Civit, 2022). Based on research done by Conklin (2003), the current production of AI music is essentially limited to popular methods that randomly sample from history-based models. Furthermore, existing AI methods of music generation learn from a single database, and musical style is similarly con-

strained. Not only are these music materials not very suitable for the teaching environment of Chinese primary schools, but there are also substantial technical requirements for teachers (Louie, 2020). Therefore, here we focus on how to generate songs more feasibly with AI to help ordinary teachers integrate STEAM elements in the process of teaching general knowledge courses.

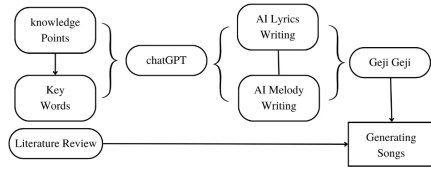
1.3. Nursery Rhymes

Cases examined by Bertrand Namukasa (2020) show that it is reasonable to use nursery rhymes to help children become interested in otherwise uninteresting knowledge points. However, in the current Chinese primary school teaching environment, on the one hand, the recitation method will be frequently used to enhance students' memory of knowledge points. On the other hand, some advanced educators and students often hold negative views of it. In fact, too much time without exercise can cause physical performance to decline, and too much time without memory can cause the brain to become sluggish. Memorising knowledge is as much a recommended means of keeping the brain flexible as exercising is to keep physically healthy (Hoque, 2018).

Over time, nursery rhymes have always been an integral part of childhood education at home and at school (Kenney, 2005). Positive effects include language impact, cognitive impact, and physical impact as well as social-emotional impact (Is, W). For our research especially, nursery rhymes play an important role in helping children memorise knowledge points; as the saying goes "a song that sticks in my head" (Long, 2020). Therefore, from the perspective of reviving nursery rhymes and helping nursery rhymes work more significantly in children's learning, our research will focus closely on the generation of nursery rhymes that can help memory.

1.4. chatGPT

As an AI language model, chatGPT can integrate resources according to users' instructions and generate the answers that users need. It is a very cutting-edge and cross-era technology that was launched in December 2022. It is now widely used in diverse areas including education (Mhlanga, D. 2023). As a summary of the "wisdom of the crowd" (Bishop, 2023), it can be of good assistance to teachers, and it can be included as part of future education goals (Zhai, 2022). Therefore, we also include chatGPT in the AI assistance of lyric and melody generation.



2. Research Question and Objectives

The main question that our research attempts to answer is how can AI-generated songs contribute to STEAM classes in China and help children remember knowledge points better. To answer this question, we set up three goals in three dimensions respectively: on the theoretical level, we look for confirmation that AI-generated knowledge memory songs do have a positive effect on memory by reviewing the literature on nursery rhymes; on the practical level, we plan to make such songs through current AI software or platforms based on the specific knowledge of our majors, such as conservation of water and soil and food engineering; and on the research plan level, we discuss how these songs can be applied in the STEAM class together with the other four main factors in Chinese primary schools, especially those in rural areas.

3. Methodology and Research Process

Our two main research methods comprise a literature survey and experimentation.

- Literature survey method: we reviewed literature from STEAM (STEM, STEAM, art in STEAM, music in STEAM), AI platforms (AI music status quo, AI music generation, chatGPT), nursery rhymes (the role of the nursery rhyme, its effect on memorization).
- Experimental method: we used the AI platform chatGPT to generate lyrics and melody based on specific knowledge, Sonic Pi to generate written melody, and Geji Geji to sing the generated songs for us.

The concrete technical route is shown in the figure below:

Throughout the whole process, we tried many AI platforms such as a web version of an automatic song lyrics generator. We fed it with key-words such as “conservation of water and soil”, or “environmental protection”, but it turned out that

it could not generate the lyrics we needed as there were no such songs in the present music library. On the contrary, it only generated lyrics on the topic of romantic relationships. Besides, there is also no AI platform that can achieve the generation of lyrics and their corresponding melody at the same time. Therefore, we turned to chatGPT and found that it could not only generate the lyrics of certain knowledge but also a corresponding melody in the form of a brief spectrum. After achieving that, we were able to resort to AI melody software such as Sonic Pi to play the generated melody. Finally, Geji Geji was chosen to sing the song that we generated as an example. The process of generating melody and lyrics is shown below:

Instruction 1: Please write four lyrics from the perspective of water and soil conservation for primary school students to memorize and emphasize the importance of environmental protection.

Feedback:

Verse 1:

Our land is precious, we must protect
Water and soil, we must respect
Planting trees, and flowers too
To keep our land, fresh and new

Chorus:

Let's protect, water and soil
Our environment, is worth the toil
Together we can make it right
Keep our land, shining bright

Verse 2:

Don't litter, or pollute the air
Nature's gifts, we must take care
Clean up trash, and recycle too
Our planet needs, me and you

Chorus:

Let's protect, water and soil
Our environment, is worth the toil
Together we can make it right
Keep our land, shining bright

Instruction 2: Please write the corresponding melody of the lyrics above.

(Verse)

4 4 5 5 6 6 5

4 4 5 5 6 6 5

6 7 1 1 6 6 5

4 4 5 5 6 6 5

(Chorus)

1 1 2 2 3 3 2

1 1 2 2 3 3 2

3 4 5 5 1 1 2

6 6 5 5 4 4 3

4. Results

The lyrics and songs generated by chatGPT were the best results we found, although sometimes they do not match perfectly and it is not possible to specify the rhythm.

The advantages of these songs are they are easy to generate: as long as you can use chatGPT you can freely generate as many songs as you like, which is ideal for teaching practice in primary schools and for allowing students to experiment with this kind of generation. The melodies are simple and easy to sing, which gives teachers and students an immediate sense of achievement. In addition, given the limitations of chatGPT's knowledge of a particular subject, this type of introductory knowledge generation is a good way to avoid its weaknesses.

The drawback is that the songs can only be used for creative teaching purposes and it is difficult to extract any artistic value or innovation from them. In addition, chatGPT is not an accessible AI platform for everyone, and it is difficult to match the generated melodies to the lyrics without a basic knowledge of music.

5. Conclusion and Discussion

5.1. Conclusion

- **STEAM Education** Through the integration and analysis of material found in the literature, this study elaborates on the main teaching concepts and teaching methods of STEAM education in detail.

- a. The application of STEAM education in classroom teaching can improve the enthusiasm of teachers and students and promote the all-round development of students.
- b. Art plays an important role in STEAM education, and STEAM has many advantages over STEM. It is mainly reflected in improving students' innovative thinking and interdisciplinary thinking.
- c. At present, some regions in China have begun to introduce the STEAM education concept, but there are still problems of small coverage and low popularity. Most of the regions that have carried out STEAM education take STEAM as a form of extracurricular expansion, mainly in the form of innovation competitions, but the application in the classroom is still very lacking.

- **AI lyrics**

This study uses ChatGPT as lyric generation software for the purpose of knowledge

dissemination and optimizes the lyrics generated by ChatGPT by continuously refining the conditions given to ChatGPT. It has proved the feasibility of AI lyrics, but at this stage, there are still some problems such as less adaptive software, and the quality of lyrics is not up to standard.

This study collected and tried some AI arranger software on the internet, and analyzed the advantages and disadvantages of each type of software. Taking Sonic Pi as an example, an attempt was made to edit music without professional knowledge, which verified the feasibility of AI-generated music. However, the music melody generated is simple and has a low degree of completion. Through the software GejiGeji, we generated some simple AI songs. We found that the songs have only basic lyrics and melody, and lack rhythmic changes and rich accompaniment, which makes it hard to be applied to educational practice.

- **AI music applied to STEAM teaching**

AI-generated music has great potential and development prospects, and music, as a subset of art in STEAM, plays a very important role in promoting STEAM education. AI songs have the advantages of large output, high efficiency, and simple operation. After the technology is improved, different types of songs can be generated in batches to meet the teaching requirements of different disciplines. Therefore, both the development of AI music and its application in STEAM teaching classes may have a bright future.

5.2. Discussion

- **Result discussion:**

The main purpose of this study is to collect and analyze the existing AI lyrics software and explore the current situation and characteristics of AI songs. At the same time, through a comparative study of the development of STEAM education concepts in China and abroad, the feasibility and advantages of applying AI songs to primary school STEAM classes are analyzed. This study fulfilled its initial research objectives, and the research results are in line with expectations.

- **limitations:**

- Technical bottleneck

Through the analysis of various AI word-forming software, it was found that most AI

word-forming products cannot be worded according to the knowledge points, and there are problems such as words not expressing their meaning, and words having nothing to do with the knowledge points. Of many examples of AI lyric software, it appeared that ChatGDP could better meet the lyric requirements, but ChatGPT still has great limitations in generating lyrics. If very detailed instructions are required, it takes a long time to generate a complete lyric, which does not reflect well on the efficiency of AI lyrics. At the same time, ChatGPT has other problems such as a limited number of users and it has not been introduced in China.

In terms of composition, most music software still needs professional music knowledge to achieve full functionality. Cutting-edge technology breakthroughs are needed in how to better meet the needs of music writers and non-music teachers, and produce a more intelligent generation of music accompaniment.

- Promotion and application

At present, AI composition software still mainly serves the music production industry and has not really been popularized with the public and teachers without music knowledge. Research on the STEAM teaching concept and teaching methods is still relatively backward in China. Most teachers have been engaged in exam-oriented education for a long time and lack the learning and practical teaching experience concerning STEAM teaching concepts.

- Expansion

This innovative approach to teaching the combination of music and AI can also be extended to other STEAM subjects. Other art forms such as painting and dance could also possibly be closely integrated with AI.

- Further study

Conduct a more comprehensive and in-depth study of the existing music composition software, analyze which technologies may be helpful for the further development of AI-generated music, and which technologies have obvious shortcomings that need to be improved.

Go deep into the school classroom and conduct practical research. Learn more about the current situation of steam education and the needs of teachers and students for steam education.

6. Team Members and Roles

Our team consisted of five people: XU XINTONG (Morri), SUN XICHEN (Esther), TANG SHIJIA (Mike), CHEN SIYUAN (Dany) and YANG YUEMEI (Hedy). Our roles are shown in the figure below:

The Announcer					
	XU XINTONG	SUN XICHEN	TANG SHIJIA	CHEN SIYUAN	YANG YUEMEI
Role	The Initiator	The Driver	The Monitor	The Innovator	The Executor
Work Content	Provide expertise and skills in the advancement of the project.	Receive information, give timely feedback to the group and lead the team through each section.	Help the team to interact and communicate better during the group meetings.	Provide new ideas and creative thoughts during the dilemma.	Complete each task on time and positively cooperate with each team member.

Patent

The name of this AI-assisted lyric generation platform is "ChatGPT" developed and provided by OpenAI; the name of this AI-assisted score generation platform is "Sonic-pi" and it is developed and provided by Sam Aaronv and his team; the name of this AI synthesis song platform is "Gogi Gogi", which is developed and provided by the team of Kugou Music.

Author Contributions: Conceptualization: S.Y.C., S.J.T. and X.C.S.; methodology, validation, formal analysis: S.J.T., X.C.S. and X.T.X.; investigation, resources, data curation: X.C.S. and Y.M.Y.; writing—original draft preparation, visualization: S.Y.C., S.J.T., X.C.S., X.T.X. and Y.M.Y.; writing—review and editing, visualization, supervision: S.Y.C., X.C.S., X.T.X. and Y.M.Y.; Project administration: X.C.S. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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