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FUSING STEM CONTENT WITH HIP HOP AND ELECTRONIC MUSIC TO CREATE EDUCATIONAL SONGS

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Abstract:

Students spend countless hours learning through traditional lecture & textbook methods when studying STEM content (Ruiz-Gallardo, 2016). The purpose of this research was to generate audio samples and songs that explicate information about principles relating to biology and chemistry undergraduate courses. This procedure entailed examining the scientific concepts and mechanisms, devising engaging and educational song lyrics, collaborating with a musical producer, producing the songs using Ableton Live 10 and Maschine, and implementing post-production protocols. The entire creative process resulted in four electronically-produced songs: “Biochemical Romance,” “Transcription & Translation,” “DNA Replication,” and “Nucleophiles & Electrophiles.” These educational songs hold promise as an alternative teaching resource. Moreover, they may serve as medium for learning not just lower-division biology and chemistry, but upper-division material too. Furthermore, the creation of educational music may expand to cover content in other STEM-related fields such as physics, mathematics, and various engineering studies.

Keywords: STEM; music; educational; teaching resource

Introduction:

Traditional teaching techniques may not serve all learners (Gonzalez, 2014). As concluded by Gonzalez in her experiment that measures student success rates in an introductory biology course, the conventional lecture method has been proven over and over again to be the least effective teaching method in terms of student engagement and forward progression in the sciences. In her study, the “hybrid” method included an online lecture, laboratory exercise in lab, and 5-minute long video clips that showcase the lectures by expounding the most difficult 3 concepts. Moreover, her results indicated that there was a higher percentage of success rates, or percentage of A, B, and C grades, when students utilized the hybrid method as opposed to the lecture approach (Gonzalez, 2014). To understand why lecturing does not serve students well, we must closely examine the effects of passive and active learning.

Through lectures, high school and college students are strained to passively receive the information. In this way, students are inhibited from engaging in the process of learning, which hampers the effectiveness of the lecture method. Furthermore, lectures typically have an excess of details, especially in the hard sciences, and that content is often received more quickly than a learner can digest and comprehend (Bernot, 2014). Information is retained more when students are actively participating in the course of learning as opposed to being passive recipients (Bernot,

2014). Engaging in the educational process through music is one form of active learning that promotes the retention of knowledge, further understanding of the concept or mechanism at hand, and motivation to keep learning (Governor, 2013). Governor's case study results indicated that the application of science-content songs engaged middle school students by stimulating personal and situational interest, and the music served as a mnemonic device for retaining essential scientific concepts (Governor, 2013).

Methods:

Audio Sample Development

Before conducting research, I had regular meetings with Dr. Rawlings, my faculty mentor. We discussed possible overarching themes and practical applications in research. Also, we examined biases in current practice and any other challenges that could occur over the course of the project. He provided validity to the systematic review.

Next, I compiled relevant research about science education, music and other forms of media serving as a learning device, and the effectiveness of learning STEM content through lecture slides, textbooks, and unconventional ways like song and lyrics. This project focused on fusing STEM content with hip hop and electronic music to generate four educational songs. Under the guidance assistance of Dr. Rawlings, a research proposal and project timeline was designed. After submission, funding was received from UROP.

My expertise in hip hop is validated by ten years of experience with songwriting, developing sophisticated rhyme patterns, using effecting literary devices in lyrics, and delivering dynamic vocals. Also, as a hip hop artist, I have published five different tracks on SoundCloud. My enthusiasm for biology and chemistry stemmed from taking AP Biology and AP Chemistry in high school. Using hip hop music as a means to educate scientific ideas made sense because in addition to the built foundation in hip hop artistry, I understood how to employ analogies, rhymes, metaphors, and a number of literary devices to effectively explain biology and chemistry concepts.

Much of the audio content promoting education of the sciences exhibit parodies of pre-existing songs, especially pop songs, or use pre-existing beats. For the last few years, I have developed original rap songs that use relatable analogies, narratives, and various literary devices to explain information in the sciences, predominantly biology and chemistry. Initially, I found an interest for writing poetry and song lyrics about ideas and concepts learned in academia, and then as my curiosity in biology and chemistry grew, I experimented with combining scientific concepts with hip hop lyricism. Some of the common topics that were emphasized by professors throughout my undergraduate career were enzymes-substrate interactions, DNA replication, transcription, translation, nucleophiles, and electrophiles. These are core concepts that are reviewed in many biology and chemistry lower and upper-division courses. After examining and studying this material from General Chemistry I & II, Principles of Biology, Genetics, Biochemistry I, and Organic Chemistry I & II, I began to construct 4 written songs. Respectively, the songs were about enzyme-substrate interactions, DNA replication, transcription/translation, and nucleophiles/electrophiles.

Moving forward, I engaged instrumentalists and producers to collaborate with me to bring these written songs to life. Due to schedule conflicts and limited availability, the best option was to collaborate with a musically-trained, electronic producer to generate all four songs. The musical relationship between myself and the electronic producer, Shaun Ramos (artist name: S-Class), started in January of 2017. S-Class and I discussed the desired musical direction and style

for each song. Building a consensus for this project took one week. Once we fully understood the musical direction and creative research objective, him and I proceeded with the production process for “Biochemical Romance,” “Transcription & Translation,” “DNA Replication,” and “Nucleophiles & Electrophiles.”

S-Class produced the audio samples on two different digital audio workstations (DAWs)- Ableton Live 10 and Maschine. The songs were piece by piece structured together using pre-existing samples and MIDI (musical instrument digital interface) arrangements. The MIDI arrangements were sequenced by hand via mouse & keyboard, and they were also sequenced by playing notes on the production technology called Native Instruments Maschine MK2. During production, S-Class used several software synthesizers, including Massive, Monark, Serum, and Reaktor. Application of these production tools permitted S-Class to develop variations in musical genre and instrumentation within each song. He built the song beats in the order of “Biochemical Romance,” “DNA Replication,” “Transcription & Translation,” and then “Nucleophiles & Electrophiles.” I sat next to S-Class to provide him suggestions and constructive criticisms during the entire production process. It took 15 hours to complete each song beat. Upon completion of the four beats, I recorded my hip hop vocals. S-Class synchronized my vocals over each beat. Moreover, he constantly made sound revisions to enhance the overall quality of each song. Finally, he conducted post-production, which included mixing and mastering.

Results:

“Biochemical Romance”

This song is about how enzyme-substrate interactions work. Variation was achieved by turning on and off different instruments- lead synths, drums, bass, and bells. Hip hop was fused into EDM (electronic dance music) synthesizer arpeggios and neuro bass lines.



“DNA Replication”

This song is about the biological process of DNA replication. The mixture of R&B with West Coast hip hop leads into a future funk verse, which then transitions into a future bass chorus.



“Transcription & Translation”

This song is about the biological processes of transcription and translation. Variation was achieved by switching between three musical genres- house, hip hop, and trap. The house groove leads into a hip hop verse containing an FM synthesis square bass. From there, the song transitions into a trap bridge.



“Nucleophiles & Electrophiles”

This song is about the chemistry involved with nucleophiles and electrophiles. In this song, G-funk moves into a vaporwave-sounding chorus that features 1980s synthwave arpeggios and sound effects preluding to dark, experimental electronic sounds.



Implications, and Conclusions:

These audio samples hold promise for serving as an alternative teaching resource for students in biology and chemistry classes. This research lays the foundation for science education through entertainment mediums. Furthermore, educating scientific concepts through graphic animation and video may work complimentary to the scholastic music. In addition, this audio and visual-driven media could extend to cover topics in physics, mathematics, and many engineering fields.

Further experimentation between traditional learning methods and music education would provide more insight on how students learn best when studying biology and chemistry material. After sampling and experimentation, measuring the student success rates via scores on specific class assignments and exams would help figure out which studying methodology is more effective. The class assignments and exams would be designed to test on concepts reviewed in the educational songs. The test groups may be categorized based on studying methods- textbook, lecture, music, and hybrid methods.

The challenges with finding musicians is something that could not have been anticipated. The solution was selecting a musical producer that thoroughly understood the objective of the creative research. Shaun Ramos, or S-Class, carried out the sound design, production, mixing, and mastering while taking into account the educational purpose for each track. This collaboration led to the generation of four audio samples that aim to simplify content in the fields of biology and chemistry.

On a broader scope, the media content surrounding this research does not address material beyond basic, foundational biology and chemistry. The goal is to improve and progress the accessibility and learning of STEM-related topics, including material covered beyond the basics. Moreover, a greater understanding of the STEM-related fields embedded in the youth will lead to more critical-thinking and analytical minds, which will be source of solving the major problems that govern our society.

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