

# A SOFTWARE TOOL TO GREATLY REDUCE THE INSTRUCTIONAL TIME NEEDED TO IMPLEMENT THE SCIENCE GENIUS RAP PROGRAMME

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## ABSTRACT

Urban youth of color from low socioeconomic status are generally known to be less engaged in STEM in the United States. On the other hand, the same demographic is usually engaged in hip-hop culture and rap music. Emdin et al. (2016) have introduced a 12-week teaching model through a hip-hop based science programme which encourages students to come up with hip-hop songs by connecting their everyday life to scientific concepts. This method has shown considerable promise: students have used it mainly as a way of disclosing their emotion while learning scientific concepts at the same time. However, the length of this programme could dissuade teachers from adopting this method. In this work, we introduce a software tool to facilitate the same process and achieve many of its outcomes all within a single instructional period, i.e., an hour.

## INTRODUCTION

As reported by Hossain and Robinson (2012), USA is falling behind other countries in terms of student performance in math and science. Furthermore, marginalized groups of students (e.g., African-American) interest in Science, Technology, Engineering and Mathematics (STEM) subjects has decreased and is projected to stay low during the coming years (Munce and Fraser, 2012). Generally, it is believed that urban youth of color are less likely to engage in STEM (Blustein et al., 2013) and they are less likely to be provided with mental health care in comparison with White and more affluent youth (Holm-Hansen, 2006). In addition to these issues, there is a growing trend in secondary school teaching that

has put great emphasis on standardized test preparation, therefore limiting in-class time for creative and collaborative activities.

To address these issues, Emdin et. al. (2016) introduced a teaching/learning model of a hip-hop based science programme. They call their model and an intervention programme born from it **Science Genius Rap**. They have suggested that we must consider a model for teaching that reflects the culture of young people and give them opportunity to express their emotions. Since urban youth of color are usually engaged in hip-hop culture, Emdin et. al. (2016) focused on the use of a hip-hop based science programme in urban classrooms. They argued that if urban youth of color can use hip-hop as a way of expressing their emotions and frustrations (e.g., hating school), hip-hop based interventions can be a tool for STEM teaching and learning. This method also moves away from the test-based teaching and learning and puts more emphasis on 21st century skills such as collaboration and creativity.

In this project, we build on the work by Emdin et. al. (2016), implementing a software tool to facilitate the same teaching/learning process. We aim to get urban youth of color with low socioeconomic status (SES) more interested in STEM while reducing the amount of time required for Emdin et. al. (2016) programme (12 weeks) to one hour. We believe this enables and encourages more teachers to integrate this method into their curriculum.

## BACKGROUND

In their study, Emdin et. al. (2016) introduced a hip-hop-themed science programme to serve as an intervention for disengaged youth in science classes through rap. Their programme involved writing and performing science-themed raps and taking part in a “battle” to perform their songs. The programme was implemented in ten urban public high schools where most of the participants were of Latino/a and African-American descent. Data for this qualitative study was collected via one-on-one interviews with students and analyzing the lyrics from students’ raps. They found three themes that emerged from data analysis: “1) students disclosed emotion through the hip-hop-based intervention; 2) students acquired substantial knowledge of content through the hip-hop-based intervention as evidenced through the lyrical content of their raps; 3) students used emotion and science content to reframe their science identity/perceptions of science through the hip-hop-based intervention” (p. 313). Although this was a valuable study with some reasonable outcomes, there are still a few concerns that we have tried to address in this work.

## CONCERNS

There are a few concerns that we have identified in the Science Genius Rap programme that are of particular interest to us.

1. It can be argued that since the programme draws heavily from hip-hop culture and rap music it is *fundamentally* not scalable in its current form.

- While this is true to some extent, we argue that the basis in hip-hop culture is appropriate for the target demographic, urban youth of color and low SES.
  - Songs that convey the emotional reality of the daily lives of youth are part of the musical heritage of cultures world-wide. Thus, we believe that the core pedagogy of the programme is transferrable to other cultures and ethnicities by incorporating different styles of music.
2. There could be a concern about if the materials learned through this process constitute “real” science or if the method merely gets students to play with words.
    - While this can be measured by following students’ performance in standardized tests, we argue that interpreting the world and one’s life through a scientific lens is, in fact, science.
    - What’s more, it is students “doing science” at the “highest” levels in Bloom’s taxonomy (Bloom, 1956).
  3. The final concern is that since this programme is, as designed, 12 weeks in length and demands substantial implementation support from teachers, it is not *practically* scalable.
    - This is the main concern that we have tried to address in our work by designing a software tool to facilitate the process.
    - We aim to achieve the same level of quality in science-themed raps and the same level of self-expression through our method despite the substantially reduced instruction time/teacher effort invested.

Based on the mentioned concerns, the research question that we have tried to answer in this work is: can we scale the 12-week-long Science Genius rap programme down to just 1 hour while still gaining all or most of the benefits (e.g., emotional disclosure, content acquisition, reframing students’ perception of science) with a software tool that actively facilitates lyric composition while simultaneously emphasising visual presentation and interactive performance.

## OBJECTIVE

We want to get urban youth of color from low socioeconomic status more interested in STEM by getting them to use hip hop to interpret the world around them using a scientific lens. We have seen this be possible with Science Genius rap battles, but it takes a long time. Typical instructional time allocated for science in US high school offers four 45 minute instructional periods per week over a 14-week semester. The Science Genius programme consumes one instructional period per week for 12 weeks per semester. Thus, the Science Genius programme takes about 20% of the total instructional time allocated to high school science (in the semester in which the programme operates). This is substantial and its implications on the programme’s scalability is enormous. In this project, we designed and implemented a prototype software tool to facilitate lyric composition and performance with the stated goal of enabling students to compose and perform high-quality science-themed raps in just one hour.

As a crucial next step, we hope to evaluate this tool with students in science classes in the target demographics to explore key differences in the results obtained with the 12-week Science Genius

programme and our 1-hour software-enabled process and better understand the trade-offs students and teachers make between the two.

## DESIGN AND IMPLEMENTATION

We designed our software tool to follow the overall process of the Science Genius Rap programme as described in Emdin et. al. (2016). Naturally, our goal of condensing the time to compose and perform a science-themed rap from 12 weeks into just a single hour motivates some necessary deviations from the specifics of the Science Genius programme. The tool is implemented as an add-on for SMART Notebook®, instructional software that is used in millions of K-12 classrooms in the U.S. and world-wide, including urban public and charter schools serving our target demographic. Add-ons for SMART Notebook® are developed in HTML, CSS, and JavaScript.

The process of using our software tool is split into two sub-processes: one for the teacher, and one for the students.

### TEACHER PROCESS

The overall process of using our software tool starts with the teacher, since it is they who makes the conscious decision to implement a science-themed rap battle in one of their instructional periods. As part of their before-class prep (which may be done immediately prior to the class or even days/weeks beforehand) the teacher uses our software tool to set a few things up. First, and most importantly, the teacher defines one or more keywords that they want the students to use in their lyrics. Although students are free to use other scientific terms or concepts in their lyrics, this word list scaffolds students with a well-defined scope and starting point for their raps. Teachers may provide a brief description or definition to facilitate student recall and comprehension but ideally students should be encouraged in class to look up the words and do deeper research on their own. Using the SMART Notebook® software teachers start with a template notebook file that provides:

1. instructions for the teacher on how to plan their lesson;
2. a motivational video from Professor Emdin to show students that introduces them to science-themed rap battles and inspires them with raps composed and performed by other students like them; and,
3. a table of 5-10 keyword/definition pairs for the teacher to fill out beforehand.

The file with the filled-out keyword table can then be circulated to students in class (or beforehand) via whatever digital distribution means the class already uses e.g., their learning management system (LMS), cloud storage, or email.

### STUDENT PROCESS

We tried to take the process that the students who have participated in the full 12-week programme and encapsulate it into a software tool that enables them to quickly and efficiently compose rap lyrics, choose a sound track, synchronize the lyrics with the sound track and create a companion multimedia

presentation (a SMART Notebook® file) to support their live performance. We have put special emphasis on the presentation stage to address some factors that matter to us.

- It is hard for the audience to grasp rap lyrics because the words are usually sung very fast. The companion multimedia presentation shows time-synchronized subtitles to address this issue.
- Supplementing the time-synchronized lyrics with related images or videos further reinforces the content of the rap lyrics in a visual-linguistic way.
- Crafting the visual presentation gives students (some of whom may have struggled with lyric composition) additional venues for creative self-reveal/self-expression.

The software tool guides students through the steps of building their song and performance.

#### STEP 1 – CHOOSE THE SOUND TRACK

As the first step in the software tool, the students need to choose the sound track against which their rap will be performed. In our implementation four different tracks are available by default covering a variety of different sub-genres, moods and beats (i.e., beats/minute). The sound track is vitally important as it not only sets the tone of the lyrics it also provides the foundational structure of the rap: how the words flow, how concepts will be broken apart, and how energy/movement is built up from one verse to the next.

#### STEP 2 – WRITE THE LYRICS

This is arguably the most important, most challenging, and most time-intensive portion of the entire student process. Care must be taken to scaffold students without biasing them into formulaic modes of expression. Our software tool seeks to stimulate student thinking and support student writing, but we expect much of the actual composition to occur in students' heads aided by simply pen and paper.

The SMART Notebook® file circulated to students includes three prompts to stimulate students thinking about their rap.

1. *“What’s the most important thing going on in your life right now?”* [Students are encouraged to write a sentence or two in response.]
2. *“How do feel about it?”* [Students are shown a standardized list of positive and negative feelings words and encouraged to pick 1-3 words from the list that resonate with them (Center for Nonviolent Communication, 2005)]
3. *“What personifies (represents) you and the things affecting you right now?”* [Students are shown the keywords/definitions provided by their teacher and are invited to pick 1-3 that resonate with them.]

At the conclusion of the three prompts, students are invited to try to tell a story about themselves and what’s going on in their life using science. A text area is provided in the software in which they may type their lyrics. As mentioned before, much of the work in coming up with the lyrics happens “in the air” and inside students’ heads. Some students may choose to *freestyle* (focusing on building rhymes without particular attention to subject matter or continuity between verses) alone or part of a *cypher* (group of rappers contributing lyrics in a circular one-after-another fashion). Others may choose to start with a

*hook* (catchy introductory verse) and use the beat of the sound track to help them iterate on additional verses. The software tool seeks to support the open and iterative nature of building rap lyrics with three specific features:

1. Each line of the rap they write is annotated with the count of syllables.
2. Each line of the rap is annotated with suggested words that rhyme with the last word of the previous line.
3. A search box provides easy access to a rhyming dictionary so that they can look up additional words as needed.

Teachers and students ultimately regulate how much time they spend on this step of the process but we have found in informal testing that 20-30 minutes is sufficient to compose a rap that is 8-10 *couplets* (pairs of rhyming verses that act as a unit) long. A rap of this length adequately fills out the 1-2 minute long sound tracks we provide by default and afford enough space for students to reveal themselves emotionally and convey meaningful scientific content.

#### STEP 3 – SYNCHRONIZE THE LYRICS TO THE SOUND TRACK

When students have finished entering all of their lyrics into the software tool, they proceed to the next step of the process. As mentioned earlier, rap lyrics are often hard to interpret; we expect this to be even harder when the raps use science vocabulary and concepts as integral components. In this step, students work by themselves to synchronize their lyrics to their chosen sound track. They start by beginning playback of their sound track and rehearsing their rap to the music. As they finish rapping each line in their lyrics, the student taps a button to annotate the end of the line with a time synchronization marker.

When all of the lines in the lyrics have time synchronized in this way, students can review and rehearse their timings. While the tool does not provide a simple way for students to “tweak” the timings of individual versus students can easily lay down new timings during any of their rehearsals.

#### STEP 4 – DESIGN THE VISUAL PRESENTATION AND PERFECT THE PERFORMANCE

When students are comfortable with their rehearsals and the timings for each verse, they move on to design their companion multimedia presentation. They start by entering a title for their rap song, picking a colour scheme and selecting a font. The software tool then auto-generates a baseline companion multimedia presentation that puts each line on its own page in the SMART Notebook® file. Each page may also contain randomly-preselected images or videos that are related to science keywords or feeling words that are semantically related to the lyrics on that page.

This file serves as a starting point for further creative refinement: they can delete or change the images/videos selected, add additional text or graphical elements, alter the layout, colours or typography, all using the standard page composition features of the SMART Notebook® software. We do not constrain students to the keywords as entered by their teacher. To support students - when they dive deeper into the science curriculum and incorporate science concepts, themes or vocabulary beyond

those provided by their teacher – the software tool provides a search box that lets students enter keywords to search for images (via Bing Image Search) and GIFs(via Giphy) to use in their presentation.

Screenshots of the whole process is available in Appendix 1.

#### STEP 5 – BATTLE!

Students send their completed multimedia presentations to their teacher using their class’s normal digital distribution mechanism (i.e., DropBox, LMS, or even USB flash drives). One by one, students perform their raps in front of their class. Usually, students perform their raps at the front of the class, in front of a SMART Board® interactive whiteboard that shows their particular companion multimedia presentation. When the performance begins, students press a button in the SMART Notebook® add-on that begins playback on their chosen sound track and advances through the pages in their presentation using the time synchronization markers they laid down in Step 3. At the teacher’s discretion, students may videorecord their performances alone (e.g., using a smartphone camera) to be sent to the teacher separately.

The instructions provided to teachers in the template SMART Notebook® file provided to them in their process includes a suggested simplified rubric to help teachers (and peers) evaluate students’ raps for the depth and accuracy of scientific content, emotionality of the composition or in its performance, and the creativity shown in the visual design of the companion multimedia presentations. At the teacher’s discretion, they may choose to follow up with a short quiz that more directly assesses student comprehension of the science curriculum (concepts and vocabulary) expected of them.

## DISCUSSION AND FUTURE WORK

In this document, we have reported on the design and implementation of a software tool to facilitate the Science Genius Rap programme to get urban youth of color from low socio-economic status more interested in science. We adopted the overall process from the work conducted by Emdin et. al. (2016) and built an add-on for SMART Notebook® software for this purpose. Our work is still very fresh: while we have run a limited number of pilots to test the feasibility of our approach this testing did not involve students from the target demographic and hence it is still an open question whether this approach will be effective for them. More work is needed; particularly, we are interested in determining which emotional and scholastic benefits of the 12 week programme are lost or impaired when the duration of the programme is so dramatically curtailed.

To facilitate this future work, all the source code and supporting materials for this project are available online under a permissive “open source” license. We encourage other researchers to explore the method in future studies.

## ACKNOWLEDGEMENTS

We would like to thank Dr. Christopher Emdin and Edmund Adjapong from Columbia University. We would also like to thank the staff at SMART Technologies who provided development assistance and feedback on early prototypes of our software tool.

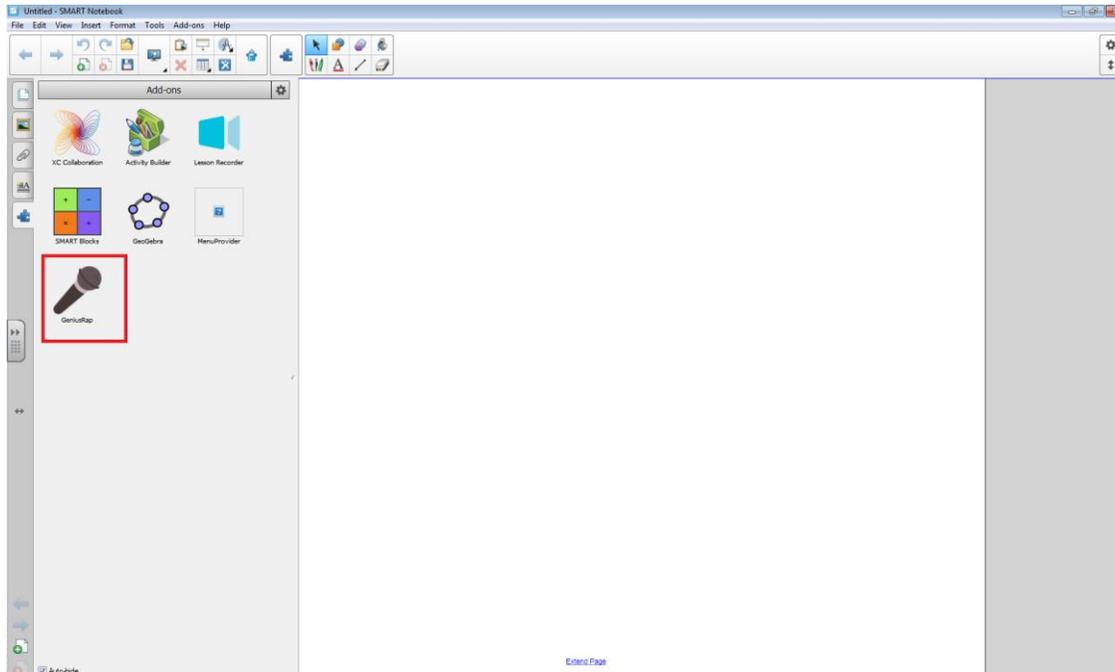
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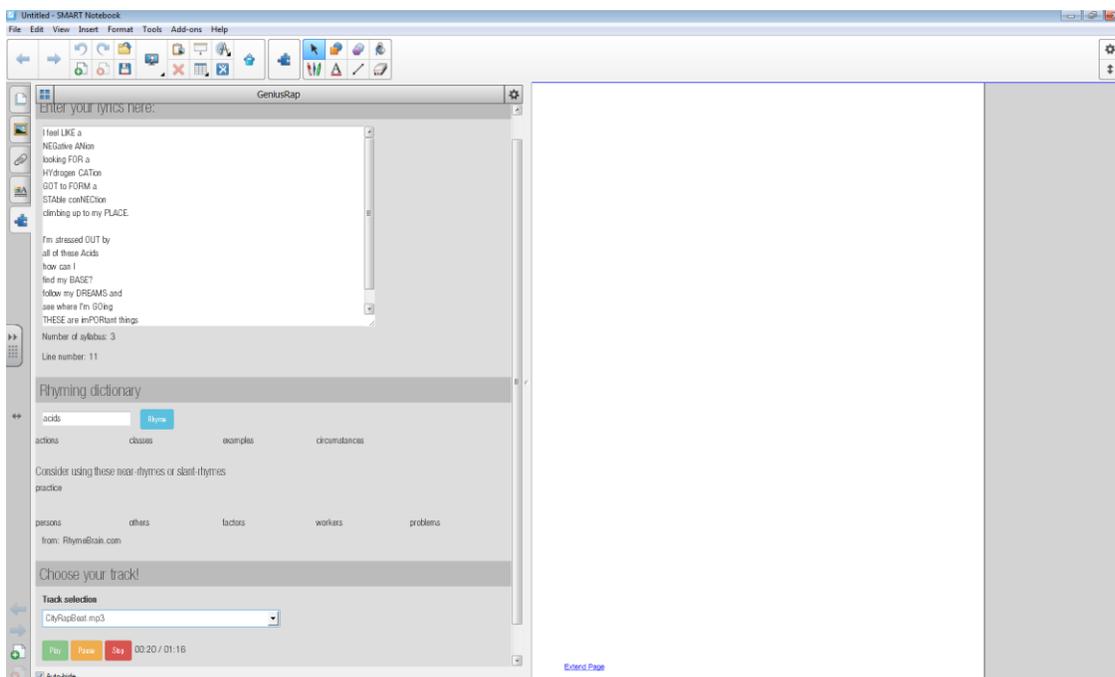
# APPENDIX

Here we have visually described the process of building the multimedia presentation in SMART Notebook software environment.

Students can select the Science Genius add-on from the list of Notebook add-ons:

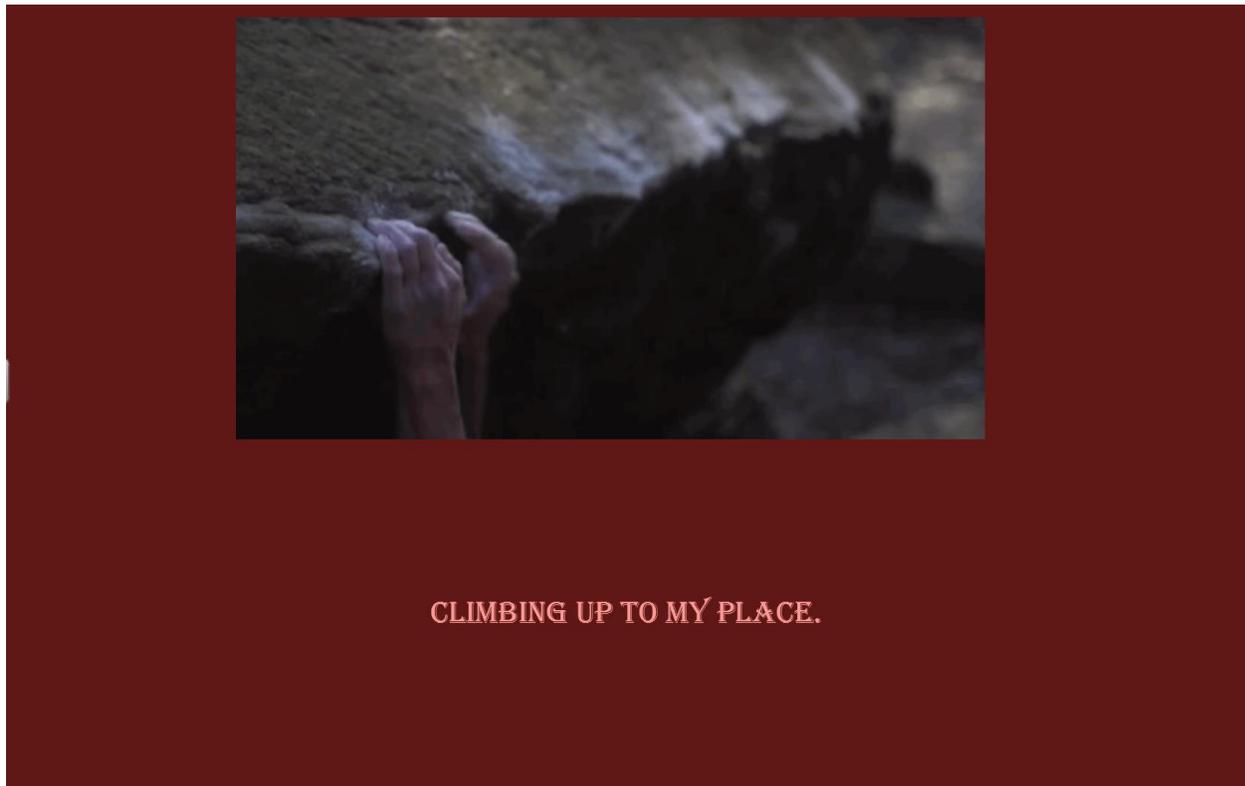


Thereafter, they will start writing their lyrics, while making use of the rhyming dictionary and syllabus count features. They can also choose their desired sound track.





The slides will be generated with random images.



Students can still search Bing or Giphy for more images to edit their slides. They can also play their presentation here or save it for later use.

