Implementing Mathematical Rap in Your Classroom

Rodney Andres Perez, *El Rancho High School, Mathematics Teacher*

Abstract: *Accessing cultural funds of knowledge using hip-hop can increase engagement and can be implemented in the classroom at various levels. This paper provides a framework for implementing mathematical rap in mathematics classrooms. Real classroom examples are provided to illustrate use-cases and student products.*

Keywords: *culturally responsive pedagogy, culturally relevant pedagogy, edutainment, funds of knowledge, hip-hopness, student engagement, student motivation*

Introduction

Hip-hop has been extremely influential in the development of United States culture. Learning a new dance move or singing a great hook has been a daily routine for many. However, since its inception into mainstream, there has been little association between the educational system in the United States and hip-hop. One of my favorite rappers, The Nortorious B.I.G., had an opening line that dedicated an entire album to teachers who told him that he'd "never amount to nothin'" (*Juicy*, The Notorious B.I.G., 1994). I received this message as a call to action for change in our education system—e.g., shifting to culturally responsive pedagogy which resonates with students' identities (An, Zhang, Tillman, Lesser, Siemssen, & Tinajero, 2016; Gay, 2002). In particular, it is important for teachers to consider that:

> While hip-hopness, or the expression of a hip-hop identity, is perceived as anti-establishment (in this case anti-school), urban minoritized youth are simply making sense of the phenomena that we all experience from their own unique perspective (Flores, 2000, as cited by Emdin and Lee, 2012, p. 12)

This led me to wonder, *how do we bridge the gap between hip-hop culture and education?*

Rationale

Hip-hop's popularity can be used in the classroom to bolster instruction. At the California Mathematics Council-South Conference in 2017, I had the opportunity to attend the presentation *Music, Math, Rigor, Excitement, and Empowerment* facilitated by LaMar Queen, co-founder of Music Notes and proponent of using mathematical raps to engage students and access mathematical content. During the session, Queen explained that hip-hop is our youth's culture. He cited Emdin and Lee (2012), noting that "[r]ap is the easiest form of hip hop for our youth to access." In a world of competing attention with mobile devices, Queen encouraged his session-goers to engage students by accessing their funds of knowledge (Aguirre & Zavala, 2013). In support of this viewpoint,

Queen pointed to the success of edutainment at reaching young learners. Bringing the world of entertainment into the educational sector (Christensson, 2019), programming such as *School House Rock* illustrates the effectiveness of such an approach. This was clearly evidenced as Queen engaged us in an impromptu call and response:

QUEEN Conjunction junction . . .

ATTENDEES . . . what's your function!

The expressiveness and creativity of music are what captivate me as a listener and lyricist. Hip-hop is potentially more influential in youth culture and can leverage learning mathematics.

The Four Levels of Implementation

The following are four levels for implementing rap in mathematics classrooms based on depth of understanding mathematical content and level of pedagogical implementation.

- **Level 1** leverages hip-hop to introduce rudimentary ideas, create a safe and inviting classroom environment, build relationships with students, and manage classroom transitions.
- **Level 2** focuses on decontextualizing and interpreting mathematical lyrics.
- **Level 3** implementation requires students to partake in the creative and iterative process for learning mathematics through fashioning their own raps.
- **Level 4** builds habits of academic collaboration through engaging students in the peer-review process to verify shared content knowledge.

Levels 1 and 2 represent foundational steps for implementing mathematical rap in classrooms since these levels are predicated on more teacher-centered implementations than subsequent levels. Level 3 and 4 are more student-centered, focusing on student-driven activities as learners become more proficient at connecting their own raps to mathematical content.
These levels were not designed for sequential execution but rather a framework to implement mathematical rap at various degrees of authenticity. Each level is discussed further in detail by stating applications for mathematical rap, examples in the classroom, and its justification for its implementation.

Level 1: Affective Domain

Teachers using mathematical rap at the first level of the framework do so for the following reasons:

- ✓ Intrigue—increase interest in mathematical content;
- ✓ Musical cues—use music to transition between tasks;
- ✓ Mood—lower affective filter and increase positive emotions;
- ✓ Memorization—use repetition and mnemonic devices.

Examples of Level 1 Work

- Every year, I start my class with a lie (or, more precisely, an aspiration): *I am a ghostwriter for rap artists.* When students don't believe me, I rap, which leaves them in disbelief. That's when I know I have them hooked. Across the school, students know my alter-ego as Algo+Rhythm. I use rap as motivation to access mathematical content. There are plenty of resources online to support students in this work—*Flocabulary* (`https://www.flocabulary.com/`), *Music Notes Online* (`https://www.musicnotesonline.com/`, and *YouTube* (`https://www.youtube.com/`) are but a few of many web resources that allow students to explore mathematical content in unique contextualized perspectives. At Level 1, mathematical raps can be used as an anticipatory set to start your lessons.

- Teachers can also use mathematical rap to transition between tasks. This is another example of a Level 1 implementation. The sound and rhythm of music can be used to create an atmosphere conducive to student engagement in a variety of topics. For example, teachers are encouraged to play lo-fi (i.e., Low Fidelity) hip-hop during individual work time. The percussive sounds and slow and somber style of this music is well-suited for quiet study. On the other hand, upbeat instrumentals inspire students to move around and talk while they collaborate on group activities.

- Music helps create a positive, safe environment for learning. Students can request songs during independent study on certain days of the week to improve their mood (so as long it's not distracting nor explicit, of course). This gives students a voice of choice in dictating the type of environment in which they learn.

Rap or hooks allow students to memorize big ideas of mathematical processes and concepts. For example, when students learn to transform parabolic functions from their algebraic equations, the mantra demonstrated in Table 1 is quite effective with my students. Although the mantra isn't mathematically precise—after all, it does not account for non-positive scale factors—it is useful as a visual introduction in developing an intuition for the effects leading coefficients have on the graphs of quadratic equations. Moreover, the mantra opens opportunities for discussion about non-positive scale factors. *Can you or your students think of a mantra for non-positive scale factors?*

Justification

According to An et al. (2012), preservice teachers marked *student motivation* as the most prevalent incentive to teach music-themed mathematics. Music is naturally a vehicle for entertainment and self-expression, and hip-hop is a genre that enthralls the largest youth audience. As stated by Edmin and Lee (2012), when science teachers bring hip-hop into their instruction, students express interest and involvement in ways that are commonly found in hip-hop cyphers, including head-bobbing and hand-bouncing, moves previously absent from school classrooms.

Moreover, the increase in positive mood from music increases the likelihood that students will internalize concepts and facts. Wesson (2019) suggests that experiences that elicit stronger emotions generate stronger memories, and consequently, learning experiences become more stable and lasting.

Music also engages areas of the brain that are involved with focus, making predictions, and memory (Baker, 2007). Music lowers the affective filter as it relaxes and lowers stress that may inhibit learning (Vos, 1999).

Table 1: *Parabolic Transformation Mantra*

We say . . .	**We show . . .**
When a is greater than 1, stretch your arms to the sun.	
When a is less than 1, show 'em your big ol' guns.	

Level 2: Building Mathematical Language and Meaning

Teachers using mathematical rap at the second level engage their students in the following ways:

- ✓ Annotation—teachers use rap when engaging students in note taking;
- ✓ Decontextualization—students deconstruct raps and their meaning;
- ✓ English Language Development—students contextualize stanzas in teacher-assigned listening exercises.

Example

Beyond using mathematical raps used as an anticipatory set, rap can be used to extend the mathematical depth of tasks. For instance, when implementing mathematical rap as the foundation of mathematical inquiry or review, teachers may:

(a) have the mathematical rap prepared by printing the rap with a graph paper overlay beside the rap as a graphic organizer;

(b) include fill-in-the-blanks in the rap for students to focus on their listening skills;

(c) have students verify with each other in pairs or groups; and

(d) discuss the rap as a whole class.

Students can interpret and annotate expressions in multiple representations. Figure 1 illustrates an excerpt from one of my raps that illustrates inverse functions. Note that the numbers labeled in the figure represent the different representations described in the rap.

Justification

Students can deconstruct and decontextualize mathematical rap lyrics, stanzas, and lines to develop and reinforce mathematical concepts and retain content knowledge through repetition and song. Analyzing mathematical raps supports emergent multilingual students by helping them to decontextualizing texts (i.e., Mathematical Practice 2) while developing skills to identify literary

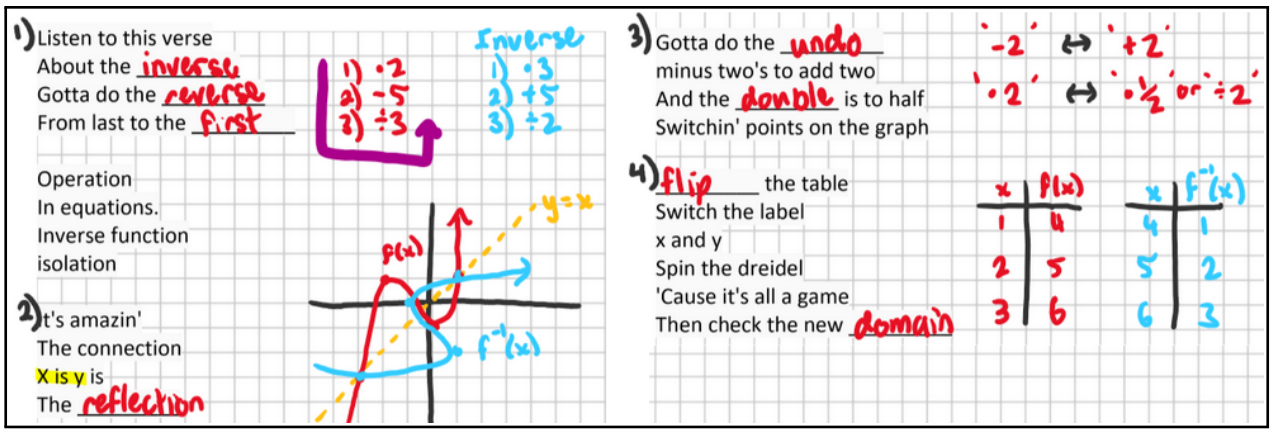

Fig. 1: *Mathematical rap decontextualized.*

devices such as motifs, metaphors, similes, and idioms. When collaborating in pairs and groups, students use raps to engage in mathematical argumentation (i.e. Mathematical Practice 3) to support their interpretations of specific lines within the rap. Raps reinforce the building of mathematical vocabulary through students' interpretations and annotations. Students engage in mathematical discourse as they discuss raps and contextualize lyrics through their pictorial, graphical, and algebraic representations. In this manner, connections between mathematical representations are supported and contextualized.

Lykins's (2015) research dictates that repetition is a valuable teaching strategy. Through rereads of the rap, An et al. (2016) suggests that students can internalize knowledge, memorize, and retrieve facts. Mathematical raps also facilitate students' comprehension of mathematics concepts through real-life application and interdisciplinary connection. While conventional re-reading activities typically result in short-term memory acquisition, connections fostered by mathematical raps encourage the building of long-term memories.

Level 3: Mathematical Expression

Teachers using mathematical rap at the third level engage their students in activities such as:

- ✓ Creation—students create their own rap;
- ✓ Memorization—students commit lyrics to memory as they rehearse their performances;
- ✓ Performance—as students perform their rap, they share content knowledge with peers in a highly motivating context.

Example

The first time I had students create their own mathematical raps, I was amazed by the creativity and the sense of self-efficacy the activity generated. Students who typically expressed a dislike of math or claimed they "couldn't do math" successfully demonstrated knowledge of mathematics on their own terms. In general, I've found that students want to learn. *They want to be heard*. To tap into this natural inclination for learning, teachers need to give their students channels to access content knowledge through their funds of knowledge (Aguirre & Zavala, 2013).

When I launched the rap activity for the first time, I provided students with a rubric and guidelines (see Appendix). As the guidlines suggest, I provided students with a word bank of mathematical

vocabulary to be used in their creations. I required students to describe the process of solving an inequality of their own creation and to explain the process of graphing the inequality on a number line. Some students needed extra support. I gave some sentence frames and starters if they needed them (e.g., "Solving inequalities is just like equations . . . "). Although a number of the students' raps contained mathematical errors, the activity was worthwhile because it encourages students to see mathematics as a process and it provided me with greater insight into their mathematical understandings (and misunderstandings) than typical worksheet activities. Moreover, the errors served as teachable moments that facilitated student revision—not unlike work that students engage in as they draft essays in their English Language Arts classes.

The following rap, *The Unequal Diss*, highlights one student's understanding of multi-step inequalities and their solution. The student author, Chris, used a literary devices learned in English class—metaphors, similes, personification, imagery—to illustrate his narrative and to write about mathematics.

The Unequal Diss

BY CHRIS

We are not equal,
I'm greater than you,
You less than my shoes,
I'm spittin' that heat,
You spittin' that at you,
Solving inequalities is just like equations,
Flip the symbol like a negative operation,
My bank numbers are mutation,
Police station giving me a citation,
These words are friction,
Science fiction multiplying the stitches,
Straight edge no trippin',
I'm sippin' on water,
$5 - x > 4$ the alligator mouth be open like a *scough* Door,
Subtract 5 from the left got negative one on the right,
Negative 1 is x and goes under to fight,
Then it divides,
Greater than gets scared and switches its sides,
$x < -1$ the symbol is open and x starts to run,
Graphing the number line you're already done,
You know I'm not dumb,
I do this for fun,
Step up to me you look like a duck

The following rap, *Untitled*, is another excerpt from the same course. Julian, the student author, had little mathematical efficacy, having repeated Integrated Math 1 twice before. Despite his lack of motivation for the class, Julian enjoyed the rap activity because it connected mathematics to his cultural identity. After Julian composed and presented his lyrics, he was noticeably more resilient in class—ultimately passing Integrated Math 1!

Untitled

BY JULIAN

This is not a rap battle,
Most of ya'll can't step to me.
Open your eyes,
and let you see the inequality.

10 plus $2x$
is greater than 3.
I don't think nothin' of it,
'cause math's not for me.

But I'll show you the steps.
This is what's next,
First you isolate the variable,
that's the x.

Then you take away 10,
and you do it again.
It's all simple if you listen
to these words, my friend.
I know you know that the tens
cancel out,
And all you're left with is
$2x$ and minus 7.

I didn't rhyme,
but I didn't have time.
But back to this man,
all you gotta do is divide.

And that's what's left.
Your answer's pretty simple.
10 is greater than
7 over 2, dude.

For our first rap activity, I collaborated with two other Integrated Math 1 teachers to build excitement and a sense of competition amongst our students. Each teacher implemented the same activity. Students had a week to prepare for their performance and were given at least ten minutes each class meeting to work on their creations as the rap battle drew near. We cleared off tables in my classroom to provide space for a cypher (i.e., an informal gathering commonly formed during rap battles) to form in the center. Students who had the *illest* bars were placed in our montage of mathematical rappers.

Justification

Kaplinsky (2016) and Shore (2017) emphasize the forgotten "fourth C" in Common Core—namely, creativity—as a means to engage students at higher levels (i.e., depths) of mathematical knowledge. Shore (2017) encourages teachers to provide their students with opportunities to create their own

problems. Such moves encourage students to take ownership of mathematics which, in turn, motivates students to persevere in problem solving (i.e., Mathematical Practice 1), incentivizing student access to content.

Pink (2010) identifies three factors that lead to better performance and personal satisfaction: autonomy, mastery, and purpose, noting that self-direction leads to engagement. By giving students options to be creative and to use their own voices, teachers provide students with the drive to achieve.

In the writing process, students address misconceptions orally and textually as they revise their piece. They continually practice and rehearse what they have written to ensure that their work makes sense semantically, syntactically, and mathematically. This iterative process reinforces content knowledge and language development. Students revisit their ideas countless times as they internalize mathematical concepts such as switching the inequality symbol when dividing by a negative. Prior to creating the rap, students learned the reason for inversion of the inequality symbol but continued to make mistakes. After the rap, none of our students made this mistake. The reinforcement of repetition inherent within the writing process resulting in learning gains for all students.

Writing and performing mathematical raps increases the use of language development and mathematical literacy and, thus, supports emergent multilingual students and Redesignated Fluent English Proficient (RFEP) students. Cross-disciplinary activities (e.g., English literature and mathematics) encourage students to create more conceptual connections and experiences than possible when content is taught in isolation (Boaler, 2014).

By involving teachers and other classes in the task, we continue to build and strengthen our personal learning community. Teachers modeled enthusiasm for hip-hop, and students reciprocated.

Level 4: Decontextualizing and Publishing

Teachers using mathematical rap at the fourth level engage their students in activities such as:

- ✓ Decontextualizing—Students critique other students' raps through the writing / peer-review process;
- ✓ Publishing—Teachers make student work and achievement public within the school community and beyond.

Example

After students engage in the writing process individually, they engage in peer-review. Students revise each other's mathematical raps and check if they are syntactically, semantically, and mathematically correct. This type of error analysis is inherently engaging since students argue and justify interpretations of each other's raps. For example, in his poem, *The Unequal Diss*, Chris stated that $x < -1$, which should be $x < 1$. During the peer-review process, students work out problems within the poems to verify that solutions within the work are correct. Likewise, Julian's rap, *Untitled*, includes a similar error in the last line. Note that "10 is greater than 7 over 2, dude" should read "x is less than negative 7 over 2, dude."

Justification

As students engage in Level 4 work, they continue to develop and hone their mathematical argumentation skills (i.e., Mathematical Practice 3) as they attend to precision (i.e., Mathematical Practice 6). In addition, they are encouraged to assess their own work, an important skill in subsequent coursework.

As students publish their work online, they broaden their personal learning networks and increase affirmation from their community, strengthening self-efficacy (Lalande, 2012; Clifford, 2013; Office of Educational Technology at the US Department of Education, 2013; Richardson, 2014; Moss, 2019). Moreover, students develop marketing skills and use metrics to make decisions to broaden their viewership.

Conclusion

The four levels discussed in this paper encourage students to see mathematics is a process. The levels scale by the degree of effort in pedagogical implementation for teachers and the degree of academic rigor for students. Level 1 activities use hip-hop to create a positive classroom environment through recall and choral responses. Level 2 activities engage students in decontextualization and synthesis. Level 3 activities encourage students to make sense of mathematics and create knowledge lyrically. Level 4 activities compel students to share and verify their knowledge with others. At each level, students connect hip-hop culture with their understanding of mathematics; however, activities at higher levels encourage students to access content knowledge with a deeper understanding than in preceding levels.

The incorporation of hip-hop culture in the classroom aligns with the core competencies that every young person should master before they finish high school (Wagner, 2014), namely:

1. Critical thinking and problem solving;
2. Collaboration across networks and leading by influence;
3. Agility and adaptability;
4. Initiative and entrepreneurship;
5. Effective oral and written communication;
6. Accessing and analyzing information;
7. Curiosity and imagination.

Through mathematical rap, students think critically, collaborate, adapt, market, develop written and oral communication, analyze and decontextualize information, and invent. Students become producers rather than consumers of knowledge. Rap encourages students to become more mathematical literate as they contemporaneously express their funds of knowledge. In addition, composing raps encourages students to connect literary devices from their writing classes in the mathematics classsrom (Aguirre & Zavala, 2013).

Emdin and Lee (2012) suggest that "teaching and learning is improved in the moments when students' motivation is enhanced by pedagogy that utilizes their hip-hopness as an integral part of instruction" (p. 19). I challenge educators to access funds of knowledge to teach in culturally responsive ways such as through rap. *Hip-hop is life. Hip-hop is fun. Now, hip-hop is math.*

References

Aguirre, J., & Zavala, M. (2013). *Making culturally responsive mathematics teaching explicit: a lesson analysis tool.* Pedagogies: An International Journal, DOI:10.1090/1554480X.2013.768518

An, S., Zhang, M., Tillman, D., Lesser, L., Siemssen, A., & Tinajero, J. (2016). *Learning to teach music-themed mathematics: an examination of preservice teachers' beliefs about developing and implementing interdisciplinary mathematics pedagogy.* Mathematics Teacher Education and Development, 18(1), 20-36.

Baker, M. (2007, Aug. 1). *Music moves brain to pay attention.* Stanford School of Medicine. https://med.stanford.edu/news/all-news/2007/07/music-moves-brain-to-pay-attention-stanford-study-finds.html

Boaler, J. (2014, Aug. 1). *From Stanford online's "how to learn math for teachers and parents": brain placticity [Video].* Youtube. https://youtu.be/pxru8H6XbR4

Clifford, M. (2013, Jan.). *20 tips for creating a professional learning network. Getting Smart.* https://www.gettingsmart.com/2013/01/20-tips-for-creating-a-professional-learning-network/

Christensson, P. (2019, December 4). *Edutainment Definition.* Retrieved 2020, May 3, from https://techterms.com

Emdin, C., & Lee, O. (2012). *Hip-hop, the "Obama effect," and urban science education.* Teachers College Record, 114(2).

Flores, J. (2000). *From bomba to hip-hop: Puerto Rican culture and Latino identity.* New York: Columbia University Press.

Kaplinsky, R. (2015, Nov. 7). *Digging into depth of knowledge*. California Mathematics Council South 2015 56th Annual Conference, Palm Springs, CA, United States.

Lalande, M. (2012, Oct. 18). *What is a PLN – Marc-André Lalande's take.* Youtube. `https://youtu.be/hLLpWqp-owo`

Lykins, A. (2015). *Using repetition to make ideas stick.* Mathematics Teacher, 108(8), 622-625.

Moss, P. (2019, Nov. 24). *Why learning through social networks is the future.* TeachThought. https://teachthought.com/the-future-of-learning/learning-through-networks-is-the-future/

Office of Educational Technology at the US Department of Education. (2013, Sept. 18). *Connected educators.* Youtube. `https://youtu.be/K4Vd4JP_DB8`

Queen, L. (2017, Oct. 28). *Music, math, rigor, excitement, and empowerment. Proceedings of the California Mathematics Council South 2017 58th Annual Conference*. Palm Springs, California.

Richardson, W. (2014, Mar. 2). *Will Richardson – personal learning networks* [Video]. Youtube. `https://youtu.be/OMIG0xOySCc`

Shore, C. (2017, Oct. 28). The forgotten 4th c: Creativity in the math class [Conference session]. *Proceedings of the California Mathematics Council South 2017 58th Annual Conference.* Palm Springs, California.

The Notorious B.I.G. (1994), Juicy [Song]. *On Ready to Die* [Album]. Bad Boy Records.

Wagner, T. (2014, Jan. 17). Creating innovators. *TedxNYED*. https://www.youtube.com/watch?v=a3f7dP_l9xY

Wessen, K. (2019, June 10). Learning and memory: how do we remember and why do we often forget?. *Brain World Magazine*. https://brainworldmagazine.com/learning-memory-how-do-we-remember-and-why-do-we-often-forget/

Vos, J. (1999). *The Learning Revolution*. Network Education Press.

Rodney Andres Perez teaches Math I and III and is an Integrated Math Intervention Specialist at El Rancho High School in Pico Rivera, California. He is currently pursuing a Master of Science in Education with an Emphasis in Teaching Foundational Level Mathematics at California State University, Fullerton. Rodney aspires to bridge the connection between our education system and our community. He believes every student deserves equitable opportunity in education, which is key to their development into respectable and informed citizens.

APPENDIX: Assignment Guidelines and Scoring Rubric

Inequality Math Rap Guidelines

Criteria	**Recommended and Suggestions**	**Word bank**
● Needs all vocabulary words but can use variations ● Explain a process of solving the inequality algebraically and graphically ● Include an example of solving a single variable inequality ● Has at least two verses	● Hook (chorus) ● Has more than two verses ● Use at least one metaphor or simile ● Use sentence starter: "Inequalities are like equations…"	● Isolate ● Variable ● Inverse operation ● Boundary point ● Open ● Closed ● Number line ● Graph ● Great than (or equal to) ● Less than (or equal to) ● Inequality ● Symbol/sign

Inequality Math Rap Rubric

Style/Flow (3 pts. possible)	
3 pt.	Has charisma Has little to no mistakes in presentation Has literary devices (metaphors, similes, idioms, motifs, etc.)
2 pt.	A few mistakes while rapping/reading
1 pt.	Very little stage presence Poor word-choice
0 pt.	No presentation
Completeness (3 pts. possible)	
3 pt.	Has all criteria
2 pt.	Missing an element
1 pt.	Missing more than one element
0 pt.	None
Correctness (3 pts. possible)	
3 pt.	Math process and example is correct
2 pt.	Minor error(s)
1 pt.	Major conceptual error(s)
0 pt.	None