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# Culturally Sustaining Math Word Problem Instruction with Hip-Hop Story Schemas

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# Culturally Sustaining Math Word Problem Instruction with Hip-Hop Story Schemas

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## ABSTRACT

On August 11, 2023, Hip-Hop celebrated its 50th anniversary. In honor of this milestone, we share an activity that is designed to harness the power and art of Hip-Hop to support learning in mathematics for students with and without exceptionalities. Using a vignette, we examine why culturally sustaining practices are pivotal to learning and how teachers can collaborate with middle-school students to strengthen an evidence-based practice such as schema-based instruction by honoring the funds of knowledge that students possess. The activity includes (a) the creation of culturally relevant word problems in mathematics, (b) schema-based instruction for solving additive-type word problems, and (c) the development of Hip-Hop rhymes to communicate problem-solving math schemas. Schema-based instruction supports students' mathematical reasoning and word-problem solving by teaching students to identify underlying problem structures and reasons for addition/subtraction or multiplication/division and is an evidence-based practice for supporting word problem solving skills for students with exceptionalities. Herein we provide a practitioner-ready guide for implementing these activities so that educators may replicate or adapt them to meet their students' needs. Although we focus on schema-based instruction, the Hip-Hop pedagogical tools shared could be applied to enhance instruction in other academic areas.

*Keywords:* Hip-Hop, schema-based instruction, additive word problems, mathematics, inclusive education, culturally sustaining practices

## INTRODUCTION

August 11th, 2023 marked the 50th anniversary of Hip-Hop as a culture. Hip-Hop has cemented itself as a global pop culture powerhouse over the past half century (Polfuss, 2022), but only more recently has solidified itself in education. As a vehicle for education through a culturally inclusive lens, Hip-Hop has proven to be beneficial for students with multiple intersectional identities and backgrounds (Hunter et al., 2023). It is opportunities to invite students to *connect with the content* by illuminating their *realities and experiences* in a culturally meaningful way that guides our approach to instructional design and community partnerships.

In this article, we celebrate Hip-Hop in education and share how it can be used to promote student achievement, artistic and self-expression, and belonging in mathematics. To achieve this, we outline how educators can approach evidence-based math instruction on word problems through Hip-Hop. First, we acknowledge current practice, next we share a review of literature anchoring a potential solution, and finally we outline a plan educators can use to replicate or adapt this activity for use with their students. Information shared in this article is informed by inclusive theoretical frameworks, empirical research, and insights from our own experiences in community partnerships (woven through the vignette).

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## The Problem

*Ms. Prescott*, a *third-grade teacher in a small urban school district, is using the district's mathematics curriculum to teach her students how to solve word problems. She finds the word problem instruction embedded in the lessons to be generic and preserve monocultural pedagogy. She notices the word problems are often not relevant to students in her community. Ms. Prescott knows that solving word problems can be especially difficult for students and plans to supplement her current instruction by teaching students a strategy to approach math word problems. Ms. Prescott wants to ensure her instruction is culturally inclusive and builds on her students' strengths and interests.*

In this scenario, Ms. Prescott recognizes a need to change to her instruction to better support her students' learning to solve word problems. Many students experience instructional barriers to learning in mathematics. According to data from National Assessment of Educational Progress (NAEP), only 45% of students without disabilities and 17% of students with disabilities performed at or above proficient on the 2019 mathematics assessment (National Center for Education Statistics [NCES], 2020). Furthermore, students who are culturally and linguistically diverse (CLD) comprise nearly 86% of students with disabilities (Freeman-Green et al., 2021). We view these outcomes as an indicator that the current educational system is not meeting learning needs of students, rather than seeing them as failure of students to learn mathematics.

Ms. Prescott also recognizes that her district's math curriculum is not culturally or linguistically inclusive for her students. Indeed, mathematics instruction in the US traditionally caters to White, western pedagogies, examples, and materials. Marshall (2023) critiqued the lack of culturally sustaining pedagogies that are specific to mathematics. Fortunately for her students, Ms. Prescott is invested in taking action to remove this learning barrier for her students.

## LITERATURE REVIEW

### Potential Solutions

*Ms. Prescott reads research about effective instructional approaches to teach word problems. She also learns more about inclusive pedagogical approaches that emphasize her students' cultural and linguistic identities. Ultimately, she decides to use Hip-Hop pedagogy to teach her students about word problem schemas. She wants to make sure her Hip-Hop schema instruction is authentic, relevant, and meaningful for her students.*

Like Ms. Prescott, we believe students have beautiful things to share from their lived experiences, interests, cultures, and perspectives. It is important to elevate their voices in mathematics learning experiences. We also believe that students have the right to receive instruction that is grounded in what science tells us about how students learn and honors learning differences. We recognize that students bring a wealth of knowledge into their learning, coupled with an understanding that math instruction should be relevant, inclusive, and evidence-based.

Three main components anchor the proposed solution: (a) culturally and linguistically inclusive instruction and materials, (b) schema-based word problem solving strategy, and (c) meeting instructional needs of exceptional learners; with the Hip-Hop schema story lyric and beat creation representing the cumulative centerpiece of the activities.

### Culturally and Linguistically Inclusive Instruction and Materials

Culturally responsive math teaching may contribute to improved learning for students who are CLD and should include honoring the strengths and lived experiences of these learners (Abdulrahim & Orosco, 2020). Despite the recognized benefit of including culturally and linguistically sustaining practices in the mathematics classroom, there is still a lack of widespread practice (Anderson, 2021).

### *Hip-Hop to Support Student Learning*

Research has shown that Hip-Hop has the potential to enhance student learning (Kruse, 2016). Portfilio and Viola (2012) explained that Hip-Hop honors "the lived experiences of those historically marginalized from the mainstream educational institutions" (p. 11). Furthermore, Hammond (2020) advocated the use of Hip-Hop to access students' funds of knowledge and noted that it can apply to many learners "regardless of racial background or socioeconomic status" (p. 3-4). Hunter et al. (2023) reported that Hip-Hop based instruction provides an opportunity for teachers and students to go from culturally relevant (i.e., with tangential connections) to culturally responsive (i.e., incorporating cultural backgrounds) to culturally sustaining (i.e., allowing students to produce educational supports).

Hip-Hop can strengthen both art and STEM instruction for students with and without exceptionalities. Buffington and Day (2018) asserted that Hip-Hop education is a necessary component of art education because it is culturally sustaining. Additionally, Hip-Hop has been shown to have positive impacts on STEM education (e.g., Adjapong et al., 2021; Asamani, 2022; Lutes et al., 2021). For example, Lutes et al. (2021) demonstrated that a Hip-Hop based unit could improve math achievement for minority students.

### *Culturally Relevant Word Problems*

Solving word problems is a staple in math education. Students are presented with a short text that includes relevant information, presentation of a problem, and a task to solve that problem by applying mathematical reasoning and calculations. Duecker and Chitiyo (2023) underscored the need to engage CLD students by creating word problems that are meaningful to the students. To this end, Marshall (2023) highlighted the need for teachers to get to know students, families, and communities. Similarly, Duecker and Chitiyo (2023) noted procedures such as including culturally appropriate names, favorite athletes, preferred foods, and familiar geographical locations in word problems. As suggested by Duecker and Chitiyo (2023), we feel that the clear experts of this type of information are students from the community itself. Thus, by including middle-school students in the development of word problems for their peers, we propose that students can see what they care about reflected in the learning experience (Marshall, 2023).

## Schema-Based Instruction

Solving word problems is a complex task that is often challenging for many students. Schema-based instruction (SBI) is recognized as an evidence-based practice (EBP) that supports students' mathematical reasoning and word-problem solving (Peltier & Vannest, 2017; Yucesoy-Ozkan et al., 2022). SBI teaches students to identify underlying problem structures and reasons for addition/subtraction or multiplication/division. In SBI (Fuchs et al., 2021), word problems are classified as additive (i.e., addition or subtraction; see Hughes & Lembke, 2013a) or multiplicative schemas (i.e., multiplication or division; see Hughes & Lembke, 2013b). There are three main additive schemas: Combine, Change, and Compare (Powell & Fuchs, 2018). Each of these schemas is associated with an additive action. For Combine, groups or sets are brought together, or combined, to create a new set. Change involves an initial value or magnitude that is increased or decreased over time. For Compare, two (or more) values are compared with a difference between the two values. See Table 1 for explanation and examples.

**Table 1**

*Explanation of Types of Additive Schemas*

| Additive Schema Type | When it occurs | Example problem |
|---|---|---|
| Combine | When two (or more) discrete groups come together to form a total | Suri burrowed two animal books from the library. She borrowed three graphic novels. How many items did she borrow from the library? |
| Change | When there is a starting amount that increases or decreases. | Jonte collected 5 rocks on the playground. He had a hole in his pocket and 2 rocks fell out. How many rocks are left? |
| Compare | When a greater amount and a lesser amount are compared. | Store A sells Prime for $1.88. Store B sells Prime for $2.50. How much money would you save if you bought a bottle of Prime from Store A? |

## Relevance to Exceptional Learners

While SBI is beneficial for all students, research consistently demonstrates the benefits for students with learning and mathematics disabilities (Cook et al., 2020; Myers et al., 2022; Yucesoy-Ozkan et al., 2022). This is especially important when considering the various challenges word problems may present for students with exceptionalities, such as reading, organizing relevant and irrelevant information, creating a plan to solve the problem (e.g., select an operation), and calculating the solution. Students with exceptionalities may also experience differences with working memory, attention, comprehension, and receptive or expressive language. Elements of SBI support variations in student learning often experienced by students with exceptionalities.

SBI may also support students who have not been identified with an exceptionality, but experience challenges learning math. Effective whole class instruction may reduce the need for more intensive interventions later on. Additionally, Reddig et al. (2023) posed that "culturally responsive pedagogy has been an answer to the overrepresentation of

diverse students in special education, poor achievement outcomes of CLD students" (Culturally Responsive Practices section). Thus, restructuring EBPs to be culturally inclusive has multiple benefits. This particular activity could benefit not only the middle-school students involved, but also the third-grade students with and without exceptionalities whose teachers could leverage the culturally sustaining word problems and the Hip-Hop schema stories for teaching additive schemas.

## ACTIONABLE STRATEGIES: A "HOW-TO" GUIDE FOR EDUCATORS

*Ms. Prescott wants to teach her students about SBI through Hip-Hop. She intends to (a) create lyrics that explain underlying structures (schemas) for word problems, (b) incorporate beats, movement, and the hand gestures that she read about in the research, and (c) use word problems to which her students can relate. To achieve this, Ms. Prescott knows she needs input from content experts and seeks help from older students in the community. Ms. Prescott calls upon the middle school math teacher, Mr. James, for help.*

*They devise a plan for Mr. James to teach his 6th grade students all about word problem schemas. His students will then create the lyrics and put their rhymes to a beat. He will also have his students write addition and subtraction word problems about topics that they find interesting and important.*

In our vignette, Ms. Prescott and Mr. James recognized students have funds of knowledge (Vélez-Ibáñez, 1988) and empowered students to use these funds of knowledge to revitalize mathematics instruction for youth in the community. Below we outline how to bring this vision to fruition.

### Step 1: Get Student Buy In

First, educators should explain to the middle-school students that they need their expertise to develop instructional materials for third-grade students in their community. Enlisting the help of local middle school students enhances the local cultural relevance of the mathematics instructional materials to be created. Sharing the intent to use the materials with third-grade students in the community provides an authentic purpose for the tasks. Next, present middle-school students with two tasks: creating culturally relevant word problems and developing Hip-Hop schema story songs that teach about additive schemas in mathematics.

### Step 2: Establish Foundational Knowledge

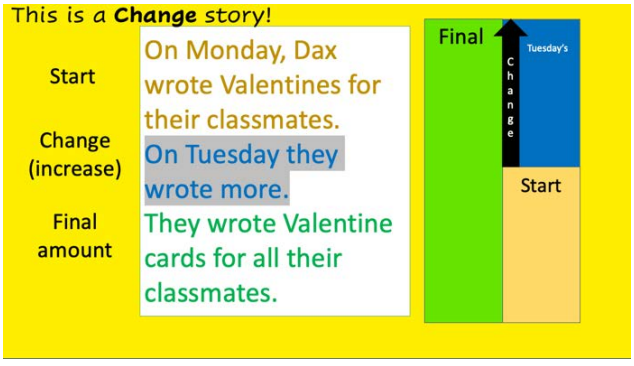
Middle-school students may or may not have received previous instruction on math story schemas, so we recommend reteaching and reviewing word problem structures. Students learn that we can teach elementary students a story strategy that can help them solve word problems more effectively. Start by providing an introduction to the story problem types (i.e., combine, compare, change problems). Explain to students that (a) we *combine* when different groups come together (i.e., addition), (b) we *change* when we increase or decrease from a starting value (i.e., either add or subtract depending on whether there is an increase or decrease from a starting value), and (c) we *compare* when we contrast two different numbers to see the difference between them (i.e., we subtract the lesser value from the greater value). Figures 1 and 2 provide examples of combine and change story problems that can be presented to the students.

**Figure 1**

*Explanation of Introduction to Combine Problem Type*


**Figure 2**

*Example of a Change Problem Type*

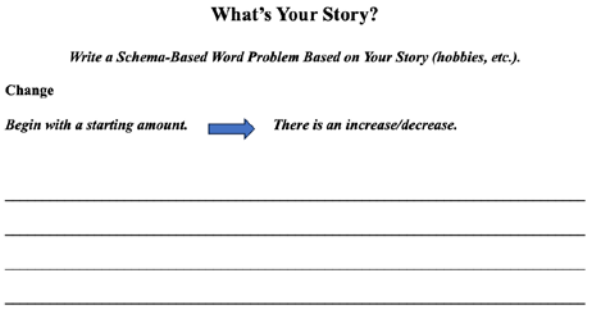



Once students understand the story problem types, they can brainstorm vocabulary to be used in their

Hip-Hop lyrics. Additionally, teachers could organize a word problem lottery where students are provided with a schema story visual aid (see Figure 3) and asked to create combine, change, and compare type problems that reflect the people, places, and activities that are meaningful to their lived experiences. The problems can be placed into a draw for a small prize.

**Figure 3**

*Example of Schema Story Visual Aid for Writing Culturally Relevant Word Problems*

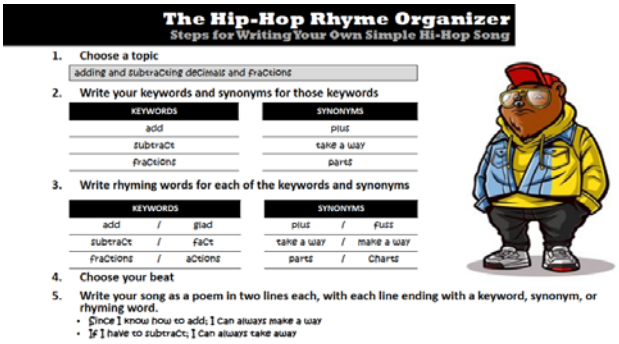



## Step 3: Write Hip-Hop Rhymes Using the Hip-Hop Rhyme Organizer

Once students understand the components of additive schemas, teachers can guide them in developing a Hip-Hop strategy song to be used to teach the story problem types to elementary students. We recommend teaching the students a framework for developing their Hip-Hop lyrics using the Hip-Hop Rhyme Organizer (see Figure 4). The first step is to choose a topic (e.g., combine, change, and compare-type problems). Second, students select keywords related to the topic and synonyms for each keyword. Please note that the word 'keyword' is used here to help students select words and word phrases that communicate critical parts of the underlying schema and is not being used in reference to the inefficient strategy to look for a specific term and decide the operation based on that word. Third, students write rhyming words for the keywords and synonyms. Fourth, students choose their beat. Students can be provided with digital files of beats from which they can choose. Fifth, students write their song as a poem in two lines each, with each line ending with a keyword, synonym, or rhyming word.

**Figure 4**

*Example of completed Hip-Hop Rhyme Organizer*




## Developing Hip-Hop Rhymes

Students work in groups to develop their Hip-Hop lyrics. Teachers may provide students with tablets, headphones, headset splitter cables, and access to backbeats. The headset splitter cables enable students to work in groups and listen simultaneously to the beat while developing their Hip-Hop lyrics.

## LESSONS LEARNED

*Everyone benefits from this plan. Ms. Prescott and Mr. James are able to learn more about their students and how to make math more culturally inclusive and locally relevant. Mr. James's 6th grade students are able to review (or learn about for the first time) math story schemas. By writing schema story lyrics and math word problems, they are authentically applying math and language arts skills. And most importantly, they are sharing their voice, creativity, and expertise with members of their community. Ms. Prescott's students benefit from learning about math story schemas and enjoy the Hip-Hop elements of movement, song, and dance.*

Implementing this practice will likely confirm what Ms. Prescott and Mr. James already knew to be true: Students have beautiful things to share. In elevating their voices, interests, and lived experiences in learning math, the teachers are privileged to see the amazing results of their students' work. Students are given the space to create word problems that reflect the people, places, and activities that are meaningful to their lived experiences. The lyrics for their Hip-Hop songs are likely to be original and creative. No group's Hip-Hop rhyme will be the same; each one presenting a unique perspective. Additionally, Ms. Prescott and Mr. James will see how culturally relevant activities can be integrated into their pedagogical practice in relation to a specific content area. We hope that this activity may provide other

practitioners with the tools to translate research into practice in their own classrooms.

We propose that this activity can benefit students by providing an opportunity to review important mathematics concepts. For middle-school students for whom SBI and comprehending word problems by identifying underlying structures and schemas is new, they can add this problem-solving strategy to their wheelhouse. Additionally, the chance to harness the power and art of Hip-Hop to support student engagement and elevate students' funds of knowledge is an enlightening experience. Finally, the target audience (third-grade students) of the word problems and Hip-Hop lyrics, will likely benefit from a math learning strategy that is not only grounded in research, but culturally sustaining and created by near-age peers who offer refreshing and youthful perspective to mathematics problem solving.

Strengthening SBI by leveraging Hip-Hop pedagogy is but one example. We propose that the practice can be applied to a variety of educational settings and learning targets to support individuals with and without exceptionalities. Whether the content area of interest is math, science, or social studies, the framework provided allows educators to generalize this activity to other topics as needed.

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