Lyricism, Identity, and The Power of Lyricism as the third space

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Learning science is an opportunity that lives well beyond the doors of the classroom. Students engage in understanding phenomena that range from understanding their personal physiology, to appreciating why the stars seem to float in the atmosphere. The interactions that shape young people’s day to day experiences provide them with continued opportunities to query about the what and why of their daily routines. It is clear that in these experiences students come to develop a rich understanding of phenomena. However, we continue to question how well science educators understand what students’ know and more specifically, we question how we, as researchers, understand students’ existing knowledge and the language that represents it.

In considering the types of knowledge that students bring to the classroom, we are particularly intrigued by the language used to express those ideas. One could imagine that young people engaged in learning in everyday science contexts, would need to select language practices suited to the expression of their ideas. According to linguists, the linguistic culture that guides the norms of the environment would frame what language is used and how the use of that language is interpreted (Agar, 1994; Barba, 1993; Lee, 2001) For example, a young person in a subway station discussing how electricity generates power for subway cars must engage in a discourse selection that is both cognitive and cultural.[1] From a cognitive perspective, their description must include terms and descriptions that can accurately describe the phenomenon. Words like “insulator”, “drive train”, “Fuel cell,” “turbine locomotive”, “kinetic energy”, and “ultracapacitor” can do the job scientifically. However, from a cultural perspective, we have to consider how the use of these terms can alienate the speaker’s audience and/or position the speaker as a particular type of person (Brown, 2004; Gee, 2001). The tone,
pace, and word selection involved in an explanation can have both positive and negative impact on how a person is perceived (Brown, 2006; Nasir, McLaughlin, & Jones; Olitsky, 2007; Reveles, Cordova, & Kelly, 2004). How would a subway conversation about trains be received if the speaker used such complex academic terminology? Would the cultural meaning of those messages be received differently if the person speaking was of a different race (e.g. African-American vs. Asian-American)? Together these are cognitive and linguistic characteristics serve as a subtext to informal learning and formal learning alike.\[2\]

The vast research on learning progressions (Elmesky, 2013; Gotwals & Songer, 2013; Neumann, Viering, Boone, & Fischer, 2013; Songer, Kelcsey, & Gotwals, 2009) and years of work on conceptual change (diSessa & Sherin, 1998; Pintrich, Marx, & Boyle, 1993; Stenhouse, 1986; Vosniadou & Brewer, 1992; White, 1993), provide the research community with a wealth of information about how intuitive science knowledge is developed. By contrast, science education has not been as progressive as literacy and history education fields in their developmental understanding of how students’ everyday language practices and cognition can be used to enhance teaching (for exceptions see (Emdin, 2010; Emdin & Lee, 2012; K. Gutierrez, Rymes, & Larson, 1995; K. D. Gutierrez, 2008). If we know a lot about the basics of developmental cognition and alternative cognition, we should have equal evidence about the language that represents these thoughts. As a field, science education would benefit from acquiring greater knowledge about how to mediate the relationship between culturally based knowledge and the types of knowledge valued in school environments. In the educational field at large, scholars offered intriguing lenses about how to mediate
students’ cultural knowledge and language with those valued in academic spaces.[3]

Mastering mediators- learning in the 3rd space

Educational scholars have provided a number of valuable lenses that take an intriguing approach to exploring how to successfully assimilate students’ culturally based knowledge and language with that valued in school (K. Gutierrez et al., 1995; K. D. Gutierrez, 2008). Four of the more well known lenses for integrating everyday cultural knowledge with the knowledge valued in the classroom[4] include Gutierrez’ construct of the third space (Gutierrez, Baquedano-Lopez, & Tejada, 1999 Gutierrez, Baquedo-Lopez, & Turner 1997; Gutierrez, Rhymes, & Larson, 1995) Moll’s (Moll & Sablo, 1996) Funds of knowledge, Lee’s (2001) cultural modeling, and Hull & Shultz’s (2001) new literacy studies. Each of these perspectives offers insightful standpoints on how to integrate the intellectual resources that young people bring to the classroom. Although explored in educational research at large, science education would benefit from offering more explicit examples of how to create these mediating spaces for diverse student populations works in science instruction.

One preeminent example of this paradigm in found in the work of language arts scholarship (Gutierrez, Baquedano-Lopez, & Tejada, 1999 Gutierrez, Baquedo-Lopez, & Turner 1997; Gutierrez, Rhymes, & Larson, 1995). Gutierrez, Rhymes, & Larson (1995) introduced the notion of the “third space” as a stark contrast to the binary lenses that pit students’ native discourses against academic language. Gutierrez, Baquedano-Lopez, & Tejada, (1999) offered some insight about how to conceive of the relationship between discourses as they wrote:
We have conceptualized such a particular discursive spaces as the their space in which alternatives and competing discourse and positionings transform conflict and difference into rich zones of collaboration and learning [5] (Gutierrez, Baquedo-Lopez, & Turner 1997; Gutierrez, Rhymes, & Larson, 1995). Thus, the construct of the Third Space has been productive in helping us understand the complexity of learning environments and their transformative potential (p. 287).

Providing a comparative lens between native discourses and their academic counterparts offers a generative view on how educators can mediate relationships between types of knowledge. In an earlier article, they explained that taking a third space lens offers teachers a “radical middle;” a place where students can both learn a new discourse but also critique its value to the world. (Gutierrez, Baquedano-Lopez, & Turner, 1997, p. 372). The idea is powerful and quite timely. If students bring a dynamic set of discourses to the academic environment, then educators must learn to see those discourses as potential mediators of cultural similarity as opposed to conceiving of them binary opposites.

This perspective is supported by Moll & Sablo’s (1996) more knowledge based perspective on creating hybrid spaces. Moll offered the research community the idea of Funds of Knowledge as a conceptual lens to understand the mediating power of using students’ native knowledge. Moll, Armanti, Neff, & Gonzalez (2005) explained, “We use the funds of knowledge to refer to historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well being (p.73).” This idea that students’ households and communities can be viewed as cognitive resources because of the knowledge situated within them helps frame student’ cultural lives as powerful cognitive resources for teachers to explore.
Both perspectives highlight how building a nuanced understanding of student culture and discourse can serve as a powerful mediator of student learning. Yet, the question remains, how can science educators apply this mediation lens to the teaching and learning of science?

**Embedding culture and learning**

Borrowing from the work of literacy scholars, science educators should consider how the everyday communicative practices of students can potentially maintain a parallel relationship with those valued by science. Adopting this perspective would allow teachers and scholars of science education to identify the ways in which everyday discourse practices can provide the platform for identifying how the practices of scientists are common components of students’ everyday lives. Additionally, the work of sociolinguists suggests that drawing connections between everyday discourse and the lives of students would highlight the connections between their identities and the science identities that students need to develop in classrooms (Valeras, Pappas, & Rife, 2006).

This manuscript offers a qualitative exploration of how creating these “third spaces” can demonstrate potential as mediators of students’ learning (J. P. Gutierrez, Goyache, Fernandez, Alvarez, & Royo, 2007).

**Theoretical Framework**

A growing body of research on how everyday language mirrors scientific practice exists in science education (Emdin, 2008; Roseberry, Warren, & Conant, 1992a; 1992b, & Valeras, Pappas, & Rife, 2006). Research has offered insight into the numerous ways in which the communication practices of student everyday lives is
similar to those valued in science (Brown & Kloser, 2009; Ebenezer, Chacko, Kaya, Koya, & Ebenezer, 2010). These studies share two primary perspectives. First, they highlight how situating science explanations in the meaningful contexts of students’ lives, provides a rich repertoire of cultural resources that are similar to those valued by scientists. Lave & Wenger’s (1991) work on situated cognition argues that teaching content in the context of students’ experiences in cognitively generative. Students will arrive to the learning environment with a nuanced understanding of the context and will constantly revisit the content because it exists in their lives, providing a resource for cognitive transfer. Second, exploring the parallel practice in students’ lives can highlight the conceptual continuities that exist in the students’ world and that of the classroom. Ultimately, this situated cognition lens suggests that identifying practices in students lives can have a sustaining potential that is both cognitive and cultural in nature.

**Situated discourse**

Science, like any languaculture, maintains discursive practices that are vital components of the social interactions of the community of practice (Agar, 1994, 1997; Bazerman, 1988). Heath’s (1983) seminal piece introduced the education community to the idea that everyday science practices can be situated in meaningful activities of student culture. Wellington & Osborne (2001) highlighted how the thin veil between everyday discourse and science discourse often leads to misinterpretations of science terms. More recently, Rincke examined how heightening students’ awareness of relationship between science discourse and their own discourse could potentially enhance students learning. *Rincke (2011) explained:*
Often, in everyday talk ‘force’ carries the sense of ‘energy’ or ‘momentum’. Sometimes the attribute of ‘vitality’ is involved. Hence, in order to clarify the scientific concept of force, teachers are recommended to contrast the scientific use of the term ‘force’ with its everyday use. From the students’ point of view, learning the scientific concept of force requires them to distinguish everyday and scientific usage. So the situation in physics lessons may be experienced as similar to language lessons: In both cases, learners have to appreciate that words acquire their sense in a way that is dependent on, and in relation to, other words making up the whole sentence (p. 230).

This notion of the students’ need to “appreciate” the relational aspect of science discourse is what binds Rinke’s work to the work of other scholars of situated discourse like Heath (1983), Rosebery, Warren & Connant (1992); & Valeras, Pappas, & Rife, (2006) who highlight how students’ discourse maintains a critically valuable relationship with those modeled in science. These relationships, or what we call Conceptual Continuities (Brown & Kloser, 2009) between science discourse and everyday discourse have the potential to build bridges between students’ sense of identity and their pathways towards being members of the science community.

Scholars of the culture of science argue that failing to build bridges between students’ culture and the culture of the science classrooms can serve as a gatekeeper (Emdin, 2008). One could argue that allowing language learning to become a subtle aspect of science instruction is detrimental and must be addressed directly. Recently, Ebenezer et al., (2010) added to our growing knowledge of these issues in their study of the Using the Common Knowledge Construction model. They argued that their model could enhance students’ appropriation of science discourse. Although their model takes a conceptual change approach rather than a cultural lens, they focused on casting science language in relevant cultural contexts. The results of their study highlight how powerful identifying continuities across discourse can be in promoting learning.
In moving forward scholars much carefully consider how they build bridges to helping students apply the fundamental principles of constructing scientific explanation. As a line of inquiry, it is important to ask how we can identify conceptual continuities between the ways that students ask and refine questions in their everyday context and those valued in science. The term *Conceptual Continuity* (Brown & Kloser, 2009), describes the parallel and analogical relationships between science terms and descriptions expressed in everyday discourse and their canonical scientific alternatives. Ultimately, we contend that creating “third spaces” for students to reflect on and learn the science discourse can be done by incorporating students’ own discourse as tool for learning. Although the cultural benefits can be assumed, we must extend this argument by examining how learning is implicated in the building of these “third space” environments.

**The Self-Explanation effect**

Cognitive scientists are aware of the power of explanation (Fonseca & Chi, 2011). For years cognitive scientists and psychologists alike have engaged in research about the impact of explaining concepts of to one's self (Chi, 1994; De Bruin et al. 2007). Perhaps the leading voices in this area of research or Michelene Chi and Brenda Fonseca. They published a series of empirical research manuscripts documenting exactly how powerful a tool self-explanation can be in improving students’ understanding of a phenomenon.

In a comprehensive manuscript that attempted to assess learning theory and its relationship with self-explanation, they presented a theoretical hierarchy of learning dimensions (Fonseca, & Chi, 2011). According to their hierarchal lens, the pecking order of learning moved from passive to active to constructive (*self-explanation*), to
interactive. The passive learning condition involved what is most commonly found in our university systems, where someone explains or lectures to you as a passive listener. The active learning condition is similar, however in this condition you engage actively by responding actively to someone else’s explanation or lection. Note taking during a lecture or reading and producing notes from text would constitute active learning. In constructive learning, also known as the self-explanation effect, the learner generates his or her own explanation of phenomena. This would include explaining what you learned to yourself or writing a summary of ideas taken from a lecture or text in your own words. According to Fonseca & Chi (2011), the highest level of the hierarchy was interactive learning, which involved a group of individuals offering explanations or debating and contrasting concepts. Ultimately, their review of approximately twenty years of experimental research on the self-explanation effect found that self-explanation was the most consistent learning condition and that it outperformed social interactive learning, except where social interactive learning took place under ideal conditions.

What Fonseca and Chi discovered was that the most efficient way for individuals to learn was to allow them opportunities to explain phenomena to themselves. The idea is simple; if I can explain a concept to myself I will have a much clearer idea of the concept. The power of the self-explanation effect is founded on two primary principles. First, engaging in self-explanation provides individuals with an opportunity to diagnose their strengths and weaknesses. If an individual is involved in a learning activity where they are required to produce an explanation, the cognitive task of generating an explanation provides them a clear indication of their strengths and weaknesses in understanding the concept. Second, if students are forced to provide
explanations, the cognitive task of writing their own interpretations produces opportunities to develop accurate schema. It is unfortunate that in many classrooms students are only asked to provide explanations of phenomena on their summative assessments, thus robbing them of the benefit of engaging in iterative explanations of phenomena. Assessments that provide students with opportunities to explain have the potential to have a powerful impact on the ways in which people come to understand ideas.

As an instructional resource, this concept of the self-explanation effect is an important tool for us to consider. Given this notion of identifying third spaces wherein students can become reflective on the value of their discourse and the value of alternative discourses, we must consider how using the culture of hip-hop, and specifically the cultural practice of lyricism, can become generative. If we take the research on the self-explanation effect on its merit we can reconsider the value of using the culture practice of lyricism as a cognitive resource. Said differently, if young people are placed in a context where they need to generate a scientific explanation and that explanation is rich in cultural meaning we can assume these descriptions can become quite generative. Our goal is to identify exactly how the act of lyricism can be used for the purposes of creating opportunities for student learning.

Given the wealth of research on situated cognition (Lave & Wenger, 1991) and the emerging body of research on the value of using students everyday culture, in particular the hip hop culture for learning (Emdin, 2008), we can assume that one of the potential benefits of using lyricism for research is that students will draw stronger connections between their own culture and the culture of science. More importantly, we
can assume that because of the nature of self-explanation of science phenomena that the very task of writing lyrics will provide opportunities for students to gain cognitive understanding of the phenomena being discussed.

**Lyricism**

One potential framework for building conceptual continuity relationships in schools involves an analysis of the role of lyricism in classroom teaching. Lyricism, which is commonly associated with hip-hop based teaching, involves more than hip-hop music. It involves the construction of text, either spoken or written, that is intended for rhythmic, ironic, and artistic purposes. Lyricism is an essential component to the artistic value of many genres of music and offers a potentially medium for students to learn to generate scientific explanations.

<table>
<thead>
<tr>
<th><strong>WRITING COMPONENT</strong></th>
<th><strong>DEFINITION</strong></th>
<th><strong>COGNITIVE RESOURCE</strong></th>
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<tbody>
<tr>
<td><strong>Irony</strong></td>
<td>The use of words to express something other than and especially the opposite of the literal meaning</td>
<td>Students must understand the primary concept to design/select an ironic premise</td>
</tr>
<tr>
<td><strong>Metaphor</strong></td>
<td>A figure of speech in which a word or phrase literally denoting one kind of object or idea is used in place of another to suggest a likeness or analogy between them (as in drowning in money); broadly: figurative language — compare simile</td>
<td>Developing a clear understanding and applying it to a secondary context, which is transfer</td>
</tr>
<tr>
<td><strong>Analogy</strong></td>
<td>Inference that if two or more things agree with one another in some respects they will probably agree in others 2</td>
<td>Students must develop an initial schema in order to compare it to another context. It is a transfer task</td>
</tr>
<tr>
<td><strong>Simile</strong></td>
<td>A figure of speech comparing two unlike things that is often introduced by like or as (as in cheeks like roses) — compare</td>
<td>Students must compare multiple contexts. To make similes between specific characteristics, students must identify similar characteristics.</td>
</tr>
<tr>
<td><strong>Personification</strong></td>
<td>Attribution of personal qualities; especially: representation of a thing or abstraction as a person or by the human form</td>
<td>Students must identify initial understandings about themselves and their experiences that would be useful for personification narratives.</td>
</tr>
<tr>
<td><strong>Narrative</strong></td>
<td>The representation in art of an event or story; also: an example of such a representation</td>
<td>Students must tell the story of the phenomenon, which produces the necessity for understanding context, role.</td>
</tr>
<tr>
<td><strong>Double Entendre</strong></td>
<td>Ambiguity of meaning arising from language that lends itself to more than one interpretation</td>
<td>Students must develop an clear conception of the meaning of the primary word to produce an ironic secondary meaning</td>
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</table>
In our approach to lyricism, we focus on eight basic principles of lyricism and their potential impact on students’ learning. Table 1 provides an overview of these components of lyricism and an analysis of their potential use as a cognition generating teaching tool. One of the primary features of lyricism is irony. Irony is the process through which a word or phrase sustains an additional meaning that extends beyond its literal meaning. When the listener understands the history of the contexts of words or phrases, it can produce irony. As a teaching mechanism, we are intrigued by the potential of Irony, because if students are to generate ironic phrases or words, they must first learn the concept and the context that makes it ironic.

A second category of lyricism is Metaphor. A metaphor is a figure of speech or text where the parallel meaning or likeness is expressed between two or more items. As a teaching tool, writing metaphors offers a potential to improve students’ cognition. If students are to generate scientific metaphors, they must first understand the concept in the academic context and then generate a paralleled alternative; or metaphor. Third, lyricism also includes the nuanced practice of writing similes. Similes are slightly more narrow than metaphors because they focus on the production of simple comparisons of likeness. Similes are connected by the use of connecting terms like “as” or “like” which enable the lyricist to focus on the feature of comparison.

Theoretically, we recognize the potential intersection between the notion of the self-explanation effect and the culturally enriching creation of the third space. If we are able to create opportunities to explain phenomenon by requiring students to engage in
the cognitively complex tasks of lyricism (irony, metaphor, analogy, simile), we may be able to produce the type of learning tasks that allow students to develop an improved understanding of concepts, while simultaneously developing an appreciation of the relationship between their discourse (lyricism) and the discourse of science. We adopted this a lens in our exploration of how lyricism was used as a teaching tool for urban science learning.

Methods

This study used a hybrid method that combines a content analysis approach with a basic interviewing methodology to examine students as they used the principles of lyricism to construct scientific explanations. To examine the cognitive potential of learning science through the medium of lyricism, we conducted daily video analyses of the process through which students moved from preparation of the instructional materials to the performance of the lyrics. Additionally, we interviewed all of the participants during postproduction to gain an understanding of their experiences with science. This project appropriated a qualitative approach using interview and content analyses to examining language and cognition through the use of basic content analysis principles.

Design

To examine students’ use of lyricism and its potential as a mediator for learning, we worked with students from an after school program that focuses on the arts. The third author, Keith Cross, worked with this program for three years, teaching its students the principles of lyricism. For this study, he developed a situated learning task where students were required to create 2 songs that would be used to teach 5th grade students
science concepts. The students were given 2 weeks to create two songs. One song explored the Urinary System, and the other explored the Digestive System.

Figure 1. Study design

Figure 1 provides an overview of the design of the study. To explore our two primary research questions (RQ1 & RQ2), we videotaped and transcribed students’ lyrics. We then performed a content analysis on their writing. Second, we conducted individual interviews with the participants to explore their reflections on their learning experience (see figure 1). Collectively, our exploration of the role of lyricism was comprised of two synergistic analyses; one involving the construction of lyrics and the second involved students’ reflections of their learning.

Participants
The participants of this project come from our collaborative work with the Music and Mural Arts Project. This organization is a non-profit organization that focuses on educating, empowering, and inspiring youth through the arts. Participating students can learn the value of mural arts, musical arts, and dance as a means of community empowerment and services. Since its founding, MMAP has served over 3,000 youth in arts-based, youth development programs who have created 124 murals, produced 68 original songs, and choreographed 16 dances.
Consistent with MMAP’s mission, its lyricists are typically involved in the learning and artistic transmission of content intended to inspire or educate community members. Themes such as leadership and civic engagement are studied by the lyricists, who then present that content in memorable poetic and musical form. The leadership of MMAP and the first author decided to build on this production model to create Hip-Hop science videos as an additional type of artistic medium.

The students who participated in the study—Betai, Imani, Amir, Dakarai, and Kenyatta—were all multi-talented members of MMAP for years prior to the project. All five of the participants were young African-American men, age 17-21, and speakers of African American Vernacular English, and Standard American English. Kenyatta, the youngest participant, was completing his senior year of high school and preparing to attend college in southern California. Imani, who had apprenticed with Keith for two years, had taken over the role of teaching songwriting to MMAP’s younger lyricists. Similarly, after a 2-year apprenticeship with MMAP’s previous dance instructor, Amir had assumed leadership of MMAP’s dance cohort. Dakarai, also a talented dancer, was assisting Akil, as well as working full-time at a local restaurant. Betai was enrolled at the local community college, taking music and acting classes in addition his general education requirements.

Content Analysis
Our first analysis was a content analysis of the lyrics constructed by our participants. At the completion of the project, the students produced and released two music videos, one about the Urinary System¹, and the other about the Digestive System²

¹ [http://www.youtube.com/watch?v=XyS5QT_8v-w](http://www.youtube.com/watch?v=XyS5QT_8v-w)
² [http://www.youtube.com/watch?v=5jRbKtwNKeQ](http://www.youtube.com/watch?v=5jRbKtwNKeQ)
(links to videos available below). We transcribed the lyrics from each of the songs and coded the lyrics according to the basic principles of domain analysis (Spradley, 1980; Silverman, 2006).

Our approach to data analysis evolved from the domain analysis approach first proposed by Spradley (1980) and documented in Silverman (2006) under the heading of content analysis. Both approaches share a common assumption that the goal of this type of qualitative analysis is to create a taxonomical map of the structure of the content. In adopting a taxonomical approach, the goal is to identify the different types of text used and their relations to each other.

To do this, we created a code list based on the principles of lyricism described in the theoretical framework above (see table 1). Using the lyrical “bar” as our primary unit of analysis, we were able to organize their talk into consistent units. For musicians, a bar is a structured count of 4 beats. For lyricists, there is a consistent pattern of talk that corresponds to each bar, or 4 count. We created a codebook based on each of the principles of lyricism and then coded each bar according to the categories. We then used HyperResearch software to code every line of the lyrics according to the coding system. To insure the accuracy of our coding process, we followed 3 steps. First, the transcripts were completely coded. Second, we had a second reviewer review every code to determine accuracy. If there were conflicts in coding interpretation the two coders met, reviewed the coding and recoded as necessary. Third, to assess our reliability we created a random number set of 25% of the codes used. We then had a third hired a research team of research assistants to party review each of those codes to assess whether the coding set was accurately reviewed. The reported reliability of this reliability review
was \textit{91X} %. The results of that analysis are reported as analysis 1 in the findings section below.

**Interview domain analysis**

Our second analysis involved an interview analysis of students’ reflection on learning. To explore their experiences with learning, we used Kvale’s (1996) semi-structured interview approach. The interview protocol was designed to explore \textit{5 critical categories}. First, we had questions about students’ experiences with science. Second, we asked questions about their experience learning in school and their experience learning using lyricism. Third, we asked questions about their thoughts and perceptions of science. Finally, we asked the students to analyze their lyrics to gain a sense of what they wanted to accomplish with their lyrics. A copy of the interview protocol is in the appendix.

Each participating student was interviewed. The interviews were videotaped and transcribed. After transcription, we uploaded the transcripts into HyperResearch software and used the software to code the data. As mentioned above, we used a domain analysis approach to coding, where we coded the students’ comments into categories of meaning that provided a taxonomical overview of all the ways they answered questions.

Similar to the process described above, we conducted an identity 3-phase reliability assessment that proceeded from initial coding, to coding review, to a reliability assessment of 25% of the entire codebook. The results of that reliability analysis was a X\% reliability result.
Collectively, the steps described above allow us to identify emerging patterns of the lyric writing and patterns of explanation that occurred in both the content analysis data and the interview data.

**Research Questions**

Given the process described above, this manuscript hopes to answer two primary research questions:

1. How does the use of lyricism to teach science create opportunities to learn for urban students?
2. How do the component of lyricism impact students’ cognition and experience with science learning?

The section that follows provides the results of our analysis.

**Findings**

Overall, the results of this study highlight the critical value of using students’ culture as an instructional medium. As students constructed lyrics they found themselves in a position where they were required to gain understanding due to the necessity of the task. Consistent with research on situated cognition (Lave & Wenger, 1991), these lyric building activities showed great potential as the necessity of producing irony, metaphor, and double entendre required students to develop their own cognitive schema. Finally, the interviews suggested that students’ developed stronger connections between themselves and science as a response to these culturally rich experiences.

**Analysis 1: Content analysis of lyrics**

Consistent with our theoretical assumptions of the principles of lyricism, we developed our initial coding of lyrics using codes based on the theoretical assumptions described previously. Table 2 provides an overview of how each of these components of
lyricism was used by the participants as they produced the two songs. The students used the narrative approach more commonly than any other feature (n=57). Given the task of explaining how the Urinary system and the Digestive system work, the application of this approach was expected. As students explained how both urinary and digestive systems worked, they choose to do so through telling stories. These narrative practices served as a central component of their writing. As indicated in Table 2, students also used analogies (n=3), direct explanations (n=38), double entendre (n= 4), irony (n=10), Metaphors (n=32), personification (n=44), and similes (n=9) to varying degrees. Each of these lyrical devices required students to produce something different cognitively and thus produced unique opportunities for learning.

<table>
<thead>
<tr>
<th>Fr.</th>
<th>CODE</th>
<th>DESCRIPTION</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Analogy</td>
<td>These are instances of talk where the writers use inferences that suggest if two or more things agree with one another in some respects they will probably agree in others.</td>
<td>Or a left and right shoe without shoe strings</td>
</tr>
<tr>
<td>38</td>
<td>Direct Explanation</td>
<td>These are instances of talk where the writer uses simple non-stylistic narrative to offer an explanation.</td>
<td>Plus you got cells called nephrons to help me</td>
</tr>
<tr>
<td>4</td>
<td>Double Entendre</td>
<td>These are instances of talk where the writer uses ambiguity of meaning arising from language that lends itself to more than one interpretation.</td>
<td>Middle man to the kidney and bladder</td>
</tr>
<tr>
<td>10</td>
<td>Irony</td>
<td>These are instances where students the use of words to express something other than and especially the opposite of the literal meaning.</td>
<td>Respect me like Aretha, call me urethra</td>
</tr>
<tr>
<td>32</td>
<td>Metaphor</td>
<td>These are instances where the speakers use a figure of speech in which a word or phrase literally denoting one kind of object or idea is used in place of another to cellular waste, goes down the flush</td>
<td></td>
</tr>
</tbody>
</table>
suggest a likeness or analogy between them (as in drowning in money); broadly: figurative language. Compare simile.

<table>
<thead>
<tr>
<th>Fr.</th>
<th>Device</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>Narrative</td>
<td>These are instances where explanations are offered in a series of contextually connected events.</td>
<td>Filter the good blood from cellular waste,</td>
</tr>
<tr>
<td>44</td>
<td>Personification</td>
<td>These are instances of text, where students create explanations of science phenomenon where they describe themselves as the phenomena and describe their associated actions and activities.</td>
<td>So I get rid of it every time that you pee</td>
</tr>
<tr>
<td>9</td>
<td>Simile</td>
<td>This is a type of explanation where the writer uses a figure of speech comparing two unlike things that is often introduced by like or as (as in cheeks like roses) Compare metaphor.</td>
<td>I look like two potatoes or even two beans</td>
</tr>
<tr>
<td>1</td>
<td>Miscellaneous</td>
<td>These are instances of talk where the explanation does not fit other categories for analysis.</td>
<td>Level numero uno and it’s simple to do</td>
</tr>
</tbody>
</table>

*Fr.=Frequency

**Analogy**

One of the lyrical devices used in the explanation of science was analogy. An analogy is when a writer offers a description of principle similarities that exists across two different contexts. Accomplishing this task required our students to recognize the fundamental similarities of science phenomena with a contrastive alternative. For example, in a description of food traveling through the body, Kenyatta explained that if he were a molecule of food he would surf the waves of the digestive system as he wrote “I’m swag surfing these waves, hanging ten on the pipeline.” In this case the pipeline refers to the digestive system and the “swag surfing” reflects the idea he is traveling with confidence through the digestive system. In a more direct use of analogy Betai wrote the following as a physiological description of the urinary system:
“See I’m the kidneys, no I ain’t kidding. I look like two potatoes or even two beans.” – Betai

This excerpt highlights how Betai offers two contrastive cases to give students an image of what the kidneys look like. The explanation that he provides describing how kidneys look like either “two potatoes” or “two beans” provides an example of the generative potential of this explanatory medium. In an effort to offer a vision of the basic physiological structure of the urinary system, he had to learn what the kidneys looked like and provide alternative models that would resonate with the students. In order for him to produce such a contrast he needed to develop an understanding of the models for himself.

[11]
Direct Explanation

Although the practice of lyricism is fundamentally artistic, there are times where there is a necessity to offer an explanation in simple accessible terms. We coded instances of this type of talk as “direct explanation.” There were 38 instances of this type of explanation. For example, in the urinary track video Akil explained, “Peristalsis, that there is the process bruh.” Although these lyrics come in the context of the song, he offers a direct description of Peristalsis as a process. Other more physiological descriptions were found when Kenyatta wrote, “Then the esophagus is where it goes down.” Another example was found when Dakarai offers a description of the problem associated with not removing waste. He simply states, “Cause the waste is poisonous to your body.” In continuing with this approach to lyricism he simply explains, “So I get rid of [urine] every time that you pee.” Collectively these examples show how although
the use of lyricism as an explanatory device is artistic, it also includes opportunities for direct explanations.

**Polysemy/ Double entendre**

In another example of appropriating the principles of lyricism for generating explanations, students were taught to use Polysemy. Polysemy is the idea that words and phrases maintain multiple meanings across contexts. In pursuit of offering accurate examples and sustaining lyrical quality, students offer some interesting applications of this principle. In the chorus to his song, Imani explains, “The urinary system is down to flush” In this example the double meaning is that being “down” to do something means you are willing to do it. By suggesting that the urinary system is “down to flush,” Imani is highlighting how the urinary system (as personified) is willing to flush waste while simultaneously referring to the direction urine travels when it is literally flushed “down” the toilet. Imani offered another example of this practice as he simply described the urinary system with the phrase “I’m number 1!” Appropriating an existing song that uses the same words to make a statement of rank among competition, Imani uses polysemic principles to intentionally conflate the phrase’s braggadocio meaning with that of the colloquial name for urinating, ‘doing a number 1.’

Another example is found in Dakarai’s explaining:

“But instead of the water this is where the urine falls. Pause, without me nothing matters: Middle man to the kidney and the bladder.”

In this line Dakarai uses the pause sign to mark a cultural statement where people will say “pause” to make sure the listener did not misinterpret their statement. He is also suggesting that the physiological structure of the ureters look like the symbol for
pausing; two vertical lines. This clear double meaning offers a primary example of using polysemy for explanatory purposes.

Ultimately, these examples highlight the role of lyricism practices in producing opportunities for students to develop, critique, and refine explanations. [12]

I irony

Another component of lyricism used in this study involved the use of irony. One of the primary features of writing interesting lyrics is capturing ironic premises to help tell a story. For example, Bryson offered, “See I’m the kidneys, no I ain’t kidding” using the word kidney multiple ways to highlight the irony of the relationship between the words. He also wrote, “Respect me like Aretha, call me urethra” to highlight how we needed to respect what the urethra does. The irony was based on the fact that rhyming Urethra with Aretha referenced Aretha Franklin’s famous song entitled Respect. Ultimately, the creative genre of lyricism promoted word play that resulted in students’ use of irony.

Metaphor

Another more prominent mode of lyricism was found in the use of Metaphor (N=32). In order to produce metaphors about science concepts, students needed to develop a fundamental understanding of the ideas. For example:

I chew beats how the mouth chew food
Look out for the big boss tongue, he run this town

--Kenyatta

Passing through these levels,
ain’t nobody out here stopping this
In this excerpt, the metaphor is found in the notion of “chewing beats.” A skilled lyricist may be considered so skilled that one might argue that he or she devoured the beat. Kenyatta continues with this metaphor as he describes how the “big boss tongue” runs this town. The remainder of this song is an extended metaphor about how the lyricists, as food items/video game characters, navigate the organs of the digestive system as if traversing “levels” of a video game. In another example, that demonstrates both metaphor and polysemy song about the urinary system was entirely based on the idea that urine goes “down to flush.” The metaphor is found in how the explanation of the urinary system as being “down”, or willing to flush waste. The hook of the song is as follows:

The urinary system is down to flush  
Cellular waste goes down the flush  
Kidneys clean blood, cause they down to flush  
Convert waste to urine, cause its down the flush  
Ureters move urine cause they’re down to flush

This entire song is based on the double meaning metaphor that he urinary system is wiling to flush the poisons out of our body.[14]

Simile

In a similar fashion, students also used Similes as a mechanism for lyrical explanation. Unlike analogy, which focuses on similarities in relationships, a simile is more focused on specific features. As a result, similes use pairing words such as “like,” “as,” “if” or “then” to bridge particular features or aspects of two things together. As a
mechanism for conceptualization and as a tool for helping students generate scientific explanations similes are potentially valuable instructional resources. For example Dakarai explained, “I’m your Ureter, similar to a water hose. Me plus your kidneys looks like something like headphones.” His description of the Ureter as a water hose starts his explanation, but the simile comes into play when he explains that the Ureters in their attachment to the kidneys look “like headphones.” This description has the potential to be particularly generative for him and his audience as our contemporary culture is one where students regularly wear headphones as a fashion statement. Dakarai’s selection of this simile is productive for his own developing understanding, but it also offers the his audience a cognitive resource to build an understanding based on something that is a central component of their cultural climate (headphones).

**Personification**

The final lyrical tool used involved the use of personification as a lyrical device. In this context students place themselves in the position of the phenomenon and offer example of the anatomical and physiological nature of the urinary and digestive systems. Dakarai offered an example of personification as he described himself as the urinary system. “I’m your urinary system just in case you didn’t know. I filter good and bad blood to start your urine flow.” In a different verse, Betai, speaking as the bladder, says, “I’m the bladder. Feel me getting fatter? I stretch like a balloon but make you move like a dancer.” Betai’s and Dakarai’s excerpts are another example of how these students were able use lyricism to generate self-explanations about scientific phenomena.
### Analysis 2: Reflecting on Lyrical Explanation

<table>
<thead>
<tr>
<th>CODE NAME</th>
<th>CODE DESCRIPTION</th>
<th>FR</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Association With Science</td>
<td>These are instances of talk where the interviewee offers and explanation of how they see themselves as connected or disconnected to science.</td>
<td>12</td>
<td>I'm no scientist, but I know my science, which is saying like you should still be knowledgeable of what goes on around you.</td>
</tr>
<tr>
<td>2. Background Information</td>
<td>These are instances of talk where the interviewee offers detailed information about their personal background.</td>
<td>10</td>
<td>In making these videos, I used the name Fluent, which stands for “fluid movement.”</td>
</tr>
<tr>
<td>3. Direct Explanation</td>
<td>These are instances of talk where the interviewee offers explanations of what their literal explanations meant.</td>
<td>15</td>
<td>And then the “bladder collects urine” is literally what the bladder does. The bladder is there to collect urine and it’s part of the system that is down to flush. Therefore, the bladder collects urine, so it’s down to flush. You know what I mean?</td>
</tr>
<tr>
<td>4. Double Meaning</td>
<td>These are instances of talk where the interviewee offers an explanation of the dual meaning of lyrics.</td>
<td>8</td>
<td>So number ones like, “Do you gotta do the number one or the number two?” And “number one” is peeing, and so we were playing on the fact that “number one” also means you’re number one. Like, you’re the winner – numero uno.</td>
</tr>
<tr>
<td>5. Hip-Hop Lyric Culture</td>
<td>These are instances of talk where the interviewee offers explanations of the culture of lyricism in hip-hop.</td>
<td>2</td>
<td>Yes, my interpretation of “Bladder collects urine, so it's down to flush,” so “down to flush” was like – if you pay attention to like hip-hop culture and things like that, sometimes they come up with slogans and things like these. One major one over the last two years has been “Yo, that's swag. He got swag,” things like that.</td>
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<tr>
<td>6. Ironic Premise</td>
<td>These are instances of talk where the interviewee offers an explanation of the ironic premise that serves as the subtext of their lyrics.</td>
<td>22</td>
<td>Oh, that one, I tried to use a lot a word play with that, so since we were making songs for fifth graders, I had to make the kidneys sound cool, and I had to make it rhyme with something, so the first word that came to my mind, even though it might not seem like “kidding” would rhyme with “kidneys.”</td>
</tr>
<tr>
<td>7. Memories of Science</td>
<td>These are instances of talk where the interviewee offers explanations about their experiences prior to working on the project or activities in class.</td>
<td>2</td>
<td>So my experience with science and school is some of my first inspiration that’s just exploring my intellect and what my brain was capable of. I think my most prominent memory of science in school was when I was in, I think, middle school, and my dad took me to a special Saturday workshop about electricity.</td>
</tr>
<tr>
<td>8. Personification</td>
<td>These are instances where the interviewee explained how they used personification to clarify their idea.</td>
<td>2</td>
<td>So picturing myself as a bladder. So I had to get into that character, what would a bladder say to urine, or somebody urinating, what it would say to them when they’re trying to go to the bathroom.</td>
</tr>
<tr>
<td>9. Reflections on Community</td>
<td>These are instances of talk where the interviewee offers explanation of their association with the local community.</td>
<td>1</td>
<td>So it’s not like the statistic is horribly wrong, but my hypothesis is that when you take this black man and you put him in this setting in which I grew up in, then he's probably not gonna make it to 18 because of all of the variables.</td>
</tr>
<tr>
<td>10. Reflections on Learning (Non Project)</td>
<td>These are instances of talk where the interviewee offers explanations of how they learned phenomenon through lyrics.</td>
<td>19</td>
<td>I think I learned best through the reflection part of the lab that was prepared for class, so you do the lab, you do all the calculations, and before you do all of that, you come up with your question that you’re asking, and your hypothesis, I think.</td>
</tr>
<tr>
<td>11. Reflections on Learning (project associated)</td>
<td>These are instances of talk where the interviewee offers explanations of how they learned phenomenon through lyrics.</td>
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<td>Had to learn it. It was completely new to me. And then writing about it, it made me have to pay attention to it even more ‘cause I had to know. I had to sound like I knew what I was talking about.</td>
</tr>
<tr>
<td>Science Interest</td>
<td>These are instances of talk where the interviewee offers explanations about their personal background and associated.</td>
<td>6</td>
<td>I didn’t know if it’s like technically just science, but robotics, I’m interested in that.</td>
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In addition to exploring students’ production of lyric based explanations, we also engaged in brief interviews. The interview protocol asked them to explore their past learning experiences, explain their learning through lyricism, and to describe the meaning of their lyrics (see appendix). Students were asked to reflect on their perceptions of their learning and describe the experience of using lyricism as a means to learn science phenomena. The results of our analysis highlight some insights about students’ perception of their learning and their thoughts about the process.

Table 3 provides and overview of the results of our analysis. Students indicated that there were intriguing differences between their learning in school (cell B-10) and their learning through the use of lyricism (cell B-11). The majority of the responses analyzed highlight descriptions of how the students integrated the principles of lyricism with their attempts to be scientifically accurate.

Given our research question, we paid particular attention to the ways students described their learning experiences using lyricism. One student, Imani, explained, “Obviously, me transferring that information into a more interactive and a more engaging way to where it was like, Okay, yeah, I know I'm just basically regurgitating this information, but I'm [making it interesting] so that they can learn better.”

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</tr>
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<td>These are instances of talk where the interviewee offers an explanation that does not meet or match other categories of talk.</td>
<td>I'm no scientist, but I know my science, which is saying I should still be knowledgeable of what goes on around you.</td>
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Table 3. Overview of interview analysis
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<td>How I interpreted “Bladder collects urine, as it’s down to flush” is like, oh, you pay attention to the hip-hop culture and things like that sometimes they have sentimental language and things like these. One memory over the last two years has been “swag.” Like, “Oh, that’s swag.”</td>
</tr>
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<td>There are instances of talk where the interviewee offers an explanation of the ironic premise that serves as the subject of their lyric.</td>
</tr>
<tr>
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<td></td>
<td>Oh the first two words I used were something with the word Swag. I was making a song for fifth graders and I had to write the lyrics and sound cool and I had to make a rhyme with something on the first word that came to my mind, even though it might not seem like “kidding” would come with that word.</td>
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<tr>
<td>49</td>
<td></td>
<td>Ethnically, learning but through the ethnographic part of the lab that was prepared for class, so you talk in the lab you read all the instructions and before you do all of that you come up with some question that you’re asking and your hypothesis, I think.</td>
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<td>Reflection on Learning (project associated)</td>
<td>There are instances of talk where the interviewee offers an explanation of how they learned through their project or activities in other contexts.</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>Hard to learn it. It was completely new to me. And then writing about it, it made it so much more interesting.</td>
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<td>12</td>
<td>Science Interest</td>
<td>There are instances of talk where the interviewee offers an explanation of what topics of science and what topics in science they find interesting.</td>
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<td>4</td>
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<td>I don’t know if it’s because I just science but robotics. I’m interested in that.</td>
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<td></td>
<td>Okay, cool.</td>
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</table>

His challenge of transferring knowledge generated opportunities for him to learn the context as he explained the process of learning. Imani suggested:
“So yeah, I think that's what drove me to [learning science]. And I don't think I really, really retained the information until after I finished the song, which was the most interactive part of the learning.”

His reflections on his learning indicated that his clarity only emerged after the process of completing the song was completed. This would suggest that the process of generating meaningful analogies, personification scenarios, similes and polysemic expressions were critical in this learning process. Imani also explained how the group task of writing lyrics produced a learning opportunity as he explained, "Okay, so I'm gonna say this word, but I don't necessarily know what it means. Then you can ask your classmate, and your classmate knows what it means. And then you're like, ‘Okay, it's good. Okay, so then I can put it here, and then that works, and you know.’” In continuing with this type of reflection, Dakarai explained how he learned by saying “Through rhymes. That’s how I memorized the periodic table.” He also described how the interactive aspect of learning was valuable as he said, “It was fun there because it wasn’t just like somebody just sitting there talking and me just having to be at a desk. We were actually able to do it [my] own way, which makes it a lot funner.”

In continuing this type of reflection Dakarai explained his lyrics and learning. In describing his attempt to make sense of the role of the ureters he explained how his learning was enhanced through the process. As he explained the line, “Middle man to the kidney and bladder.” In his reflection on why he wrote that line, he explained:

I had to think. I did it because I didn’t even know that they were connected. It took me a while. I didn’t understand all the bodily functions of the urinary system. So what I meant by that is basically like the way I said it was it always takes something to make something else, in my perspective.
His suggestions that he didn’t understand prior to writing, was further evidence of the value of the process. Along these same lines, Betai offered a more specific explanation of how he learned through the process. Betai explained,

> Well, we had some paperwork that talked about different types of functions that was going on in the urinary system, like the sphincter and the bladder, so we learned things about that, and also did further research on our own by figuring out the functions and what it relates to and what it looks like. Like a bladder can look like a hot air balloon, and the ureters can look like noodles.

Betai’s explanation of how he sought additional learning resources by doing subsequent “research” also highlighted the value of situating students’ science learning in the process of lyricism. We do not contend that writing lyrics is analogous to scientific writing. However, we suggest that providing students with access to the practice of generating and creating scientific explanations in their own voice has the potential to build cognitive bridges for students to see the similarities between their cultural language and those used by scientists. More specifically, using the cultural resources that diverse students bring to the classroom has the potential to create opportunities for teachers to situated meaningful learning in the context of offering scientific explanations in culturally authentic ways. If students are able to see these continuity relationships build their own explanations, then perhaps our vision for science for all can show students scientific communication practices by creating culturally rich parallels.

**Conclusion**

Our findings shed light on our two research questions (a) how does the use of lyricism to teach science create opportunities to learn for urban students? And (b) how do the components of lyricism impact students’ cognition and experience with science learning? We can derive that the use of complex lyrical devices like irony, metaphor,
and simile produce a complex cognitive task. If students are to offer descriptive explanations of phenomena using these approaches, they must first develop a clear conception of the tasks that will allow them to engage in the act of lyricism. Said differently, students cannot create interesting lyrics if they do not understand the idea. This principle was confirmed in students’ interview reflections and is consistent with cognitive science research on the role of explanation (Fonseca & Chi, 2011). Ultimately, this project highlighted the potential of lyricism in two ways. First, lyricism has the potential to create opportunities to learn. Second, lyricism can help students draw greater connections between themselves and the community of science.

**Cognitive connection**

One of the more intriguing results of this study involved the cognitive connections that lyricism created for students. Fonseca & Chi’s (2011) recent manuscript about the power of the self-explanation effect reported how years of research on self explanation revealed how students who explained concepts to themselves demonstrated improved learning. Given that research, the action of writing similes, metaphors, and analogies would all constitute self-explanation opportunities. Each particular task would require a different cognitive skill. A simile for example would require their using comparative terms like “as” or “like.” These would create heuristic guidelines where students would have to compare particular features of phenomenon. Personification, for example, would allow students to envision themselves as the phenomenon, demanding that they be cognizant of the properties or processes involved in the phenomenon such that they could convincingly represent them as their own characteristics. In order to do so, they would need to develop an understanding of the
concept. This process is very much like the self-explanation effect described by Fonseca & Chi (2011).

Where the process of describing phenomenon through lyricism differs is in the cultural cache it maintains. Language is not a neutral medium. Given this assumption, the impact of using language that is closely connected to students’ cultural identity[18]. If we are to help students draw connections to the content and culture of science, lyricism can be seen as a resource for connecting students and helping them develop nuanced cognitive understandings.

**Identity connections**

The results of this research contribute to an ongoing discussion about the value of hip-hop culture for school learning. As indicated in the interviews, students suggested that they noted a critical difference between engaging in science then normally experience in school and the science the experience as a part of engaging in lyricism activities.[19] This identity connection is well documented in the research of Chris Emdin (2010). In a (2010) manuscript exploring the role hip-hop in curriculum he offered the following:

As a result of these observations, I suggest that there are deep connections/disconnections between hip-hop culture, urban youth identity, and urban science education that need to be revealed. Furthermore, I maintain that science education as traditionally practiced may not sufficiently meet the needs of students who are a part of hip-hop culture if it is blind to the fact that this culture and its complex relationship to teaching and learning even exist (Emdin, 2010, p. 6).

We agree with this perspective and recognize the value of lyricism as a sub component of Hip-Hop culture. As a feature of Hip-Hop culture, lyricism is fundamentally unappreciated a resource for teaching and learning. As students engage in lyricism
practices, their find themselves in situation that require them to learn about science phenomenon. Ultimately, this has a great deal of potential, as an instructional medium because it allows science educators to tap into urban student culture is ways that both promote conceptual understanding and build connections to student identity. It is our hope that the tools of lyricism are further explored as formative assessment devices, summative assessment activities and as a general component of science instruction.
Literature Cited


