

Science learning and teaching in a Creole-speaking environment

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Abstract The focus of this response to Charity Hudley and Christine Mallinson’s article, ‘“Its worth our time”: A model of culturally and linguistically responsive professional development for K-12 STEM educators’, is to underpin a pedagogy that encourages and provides opportunities for the use of non-standard language in the description and practice of science. I discuss this within the context of Jamaica and provide an alternative way of science teaching, one which promotes Jamaican Creole as a mode of instruction for classroom talk and printed material.

Keywords Jamaican Creole · Jamaican Standard English · Science teaching · Creole-speaking environment · Science literacy

Over the last two to three decades there has been a heightened awareness on the part of educators and policy makers of cultural and linguistic diversity in the US population. The US Census of 2012 reports that 36 % of the total US population is composed of people who are identified as racial minorities, and 21 % of the school-aged population speaks a language other than English as the primary language at home. According to Cory Buxton and Okhee Lee (2014) students with limited English proficiency comprise 11 % of public school students, an increase from only 5 % of the student population in 1993. As a result, there has been a burgeoning discourse which has examined diversity and equity, including

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second-language learning in science education, at all levels of the US education system. The model articulated by Charity Hudley and Christine Mallinson in their article “‘It’s worth our time’”: A model of culturally and linguistically responsive professional development for K-12 STEM educators’, reflects this discourse and builds on studies of communication and interaction patterns among students and teachers of various linguistic backgrounds in science, technology, engineering and mathematics (see Rosebery, Ogonowski, DiSchino and Warren 2010; Valla and Williams 2012).

Hudley and Mallinson focus on K-12 STEM educators from schools that serve primarily African-American students and propose a model of professional development designed to enhance teachers’ cultural and linguistic awareness in developing students’ understanding of STEM subjects while also acquiring proficiency in English language and literacy. This is a welcome model of professional development for STEM educators as too few teachers are given meaningful professional development opportunities focused on issues of linguistic diversity and how students’ ethnic, cultural and linguistic backgrounds may affect their educational experiences (Buxton and Lee 2014). There is a need for teacher education that specifically addresses teachers’ beliefs and practices with regard to students’ languages and cultures as related to STEM fields (Gere, Buehler, Dallavis & Haviland 2009). In this sense, Hudley and Mallinson address many issues of general importance for raising teachers’ awareness of the various linguistic dimensions of STEM-related fields and promote a formulation of classroom practices that are both academically rigorous and equitable for all students.

In this article, I argue that we need to ensure that science teachers encourage and provide opportunities for the use of non-standard language in the description and practice of science. Such a view is supported by research which suggests that non-standard languages offer a rich resource for learning science (Nyika 2015; Rollnick and Rutherford 1996). All too often, however, students’ mother tongues are undervalued because teachers do not easily recognise them as being valuable in providing language-rich and contextualised learning experiences.

The Jamaican context

In Jamaica there is a concern over the paucity of workers required for technological development and advancement in science-related fields (Dodani and LaPorte 2005). Invariably, students’ generally poor performance in the Caribbean Secondary Education Certificate (CSEC) science examination taken at the terminal point of their high school career appears to justify this concern (“CSEC results show true picture of science education-UWI lecturer” 2015). This situation, and the context from which it has emerged, has generated various theories that might explain the prevailing academic underachievement of Jamaican students in science when compared with their counterparts in the rest of the English-speaking Caribbean. Within this context, scholars in the field have criticised the uncreative and unimaginative didactic approach in science teaching (Berry 2012); others have expressed concerns about the pervasive existence of inadequately trained and under-qualified science teachers at all levels in Jamaican schools and the lack of scientific laboratory resources (Thomas and Wionczek 2013). Still others implicate students’ lack of interest in science, the lack of conceptual understanding of scientific ideas and the obfuscating language barriers that affect students’ ability to access examination items in mathematics and science (Beaumont-Walters and Soyibo 2001). A number of international

research studies have consistently pointed to students experiencing significant lexis-related difficulties in the interpretation and understanding of domain-specific vocabulary in science contexts (Osborne 2014; Rector, Nehm and Pearl 2013).

The debate about the importance of language for the learning of science has been the focus of much attention by theorists and constructivist thinkers for many decades (Lemke 1997; Osborne and Wellington 2001). As early as the 1970s, Neil Postman and Charles Weingartner (1971) highlighted the critical relationship between language and knowledge in their book, *Teaching as a Subversive Activity*. The nub of their argument is that “almost all of what we customarily call ‘knowledge’ is language, which means that the key to understanding a subject is to understand its language” (p. 103).

In the Jamaican context, educators and policy makers have begun to consider the critical role of language as a primary tool through which teachers mediate and through which students access the whole curriculum. This comes against the backdrop of a phenomenal increase in the number of students who graduate from various levels of the education system as functionally illiterate (UNESCO 2014). The educational system has produced and continues to produce linguistically challenged students who are unable to identify the different linguistic registers, sociolect and dialect, and the appropriate social contexts for which each variety is most suitable. The unsatisfactory communicative competence of students has become a major concern for educators at all levels of the educational system. This situation has fuelled a maelstrom of polemical discussions and debates on the nature and status of Jamaican Creole, its relationship to Jamaican Standard English, and its place in schooling and society, where a large proportion of students come to school as monolingual speakers of Jamaican Creole with little exposure to Jamaican Standard English. In most cases, the criticisms against the use of Jamaican Creole are based on the stigmatization of the language. For example, in the *Sunday Gleaner* column ‘Corruption of languages is no cultural heritage’ published on October 29, 1989, Morris Cargill contemptuously made the case for banning JC. Cargill argued that the Jamaican people’s rhetoric has been degraded to JC and wondered whether complacency in the decadent state at which English is in will lead to a regression in national development. Cargill overlooks the research of many Jamaican linguistic scholars who have given evidence on the intricate link that exists between language, education and identity in the education system (see Bryan 2010; Pollard 1998).

At the same time, a broad spectrum of academic intellectuals from the formerly colonized regions, encouraged by Caribbean governments, have contributed to our understanding of the complexity of the linguistic situation in these Anglophone territories. Dennis Craig’s *Education and Creole English in the West Indies* (1971), along with *Bidialectal Education: Creole and Standard English in the West Indies* (1976a, b) and the socialist text, *Language and Liberation: Creole Language Politics in the Caribbean* (1986) by the applied linguist Hubert Devonish, and *Language in Jamaica* (2003) by Pauline Christie, are regarded as trail-blazing texts in the study of language, the debate on language deficit and the new emphases on the use of language in the classroom. Collectively, the contributions of Craig, Devonish and Christie marked a critical shift from the earlier canonical binaristic logic of language debates: English versus Creole; the oral versus the written, to a richer multifaceted view of language that includes an intensification of research on the instrumentalisation of Jamaican Creole especially in the education system, language acquisition and the development of teaching method in Creole settings. The preceding works and others are testimony to a growing recognition of the critical role played by the Creole language in the education of Creole-speaking children in the

Caribbean. It does not mean, however, that all the questions relating to this aspect of education have finally been answered.

Despite the growing body of research and accompanying literature on the foregoing observations and their impact on education in the Caribbean region and elsewhere, there remains a relative dearth of work related to the impact of language proficiency as a barrier to the teaching and learning process of school science in the Anglophone Caribbean territories. In the Jamaican context, there has been a lack of sophisticated studies, which address the crucial question of how best to teach science to Creole speakers.

The teaching of science poses in the West Indies special problems not found in those countries in which English is the mother tongue nor yet exactly paralleled in those in those in which English must be taught as a foreign language while the students' mother tongue remains dominant. To rework the terms of the debate and develop a vision for creative science teaching, this paper will highlight key theoretical and practical considerations which need to be taken into account in formulating a strategy for science instruction in the Jamaican classroom. Although the discussion focuses on science teaching in Jamaica, it will have relevance in similar vernacular situations where English is an 'official' language, most notably in the other Anglophone countries where Creole is the everyday norm of speech for a significant majority of the population.

The literature of the last two decades is replete with suggestions for classroom practice to help English language learners reach high standards in science when it is taught in their second language (Swanson, Bianchini and Lee 2014). Many of these suggestions contained in the literature are relevant to science teaching in countries where English is the dominant language. However, in the Jamaican context, English cannot be regarded as the native language of many of the students as the majority of the population are first language speakers of Jamaican Creole (JC). Furthermore, each Jamaican speaker commands a span of linguistic continuum stretching from a conservative base or basilect (usually spoken in the rural areas) through the mesolect (associated with urban areas), to the standard or official language. Most speakers can shift their speech from one point to another on this continuum, without necessarily being able to take in the whole range. Therefore, these suggestions are unlikely to address the problem of teaching science to students in countries like Jamaica and the rest of the English speaking Caribbean. Against this background of a Creole-speaking environment, I argue that science has to be understood in the local tongue if effective learning is to take place. With this in mind, I provide an alternative way of science teaching, one which recognises and promotes Jamaican Creole as a mode of instruction for classroom talk and printed materials. In taking this position, I am struck by the wide range of materials which I was able to draw from that support the notion of Creole as a mode of instruction in other disciplines, namely reading and literacy (see, for example, Simmons-McDonald 1996).

The Jamaican language situation

Jamaica is one of the many countries in the world that has two languages, and a 'language problem'. The official language is Jamaican Standard English (JSE), the tongue spoken formerly by her colonial masters; all of Jamaica's official institutions use this language. Creole is Jamaica's unofficial language, which has been inherited by modern Jamaicans from their slave ancestors. The languages, however, do not enjoy equal status within the society and remain broadly incompatible and non-synchronous. The socio-linguistic reality is that Jamaican Creole (JC) is historically associated with the African-Jamaican majority

and considered the voice of the poor and marginalised communities while JSE, the official language of the state, is associated with the educated, of high status and concomitant with the minority of inter-racial and European-Jamaican members of the society. According to Vilma Pollard (1998), JSE is the linguistic badge which one wears when one wants to identify with a certain level of sophistication, of linguistic competence and having 'arrived' in a highly stratified society.

Reports that come down to us from as recently as 25 years ago and my own experiences of having been born and brought up in Jamaica, indicate that language attitudes are very unambiguous and simple (Cooper 1995). Creole speech was generally stigmatized: it was referred to as 'bad English' or 'broken English' (Craig 1976a, b). However, Creole stands roughly in relation to English as English once stood in relation to Latin, although it is no more correct today to call it a corrupt English than it would be to call English a corrupt Latin. More generally, JC was regarded as the sign of a lack of education or of poor education, and consequently of low social class. The behaviour of JC speakers showed that they themselves regarded their language and themselves in these ways. In the presence of strangers, or in prestigious social situations, they tried as much as they can to speak like JSE speakers and became embarrassed at failure in this respect. When asked, they never admitted to being speakers of JC, but insisted that JSE was the language they spoke. These behavioural patterns of Creole speakers at that time can be understood in terms of the hegemony of the English language and the aspirations towards a social mobility that could be achieved through English, as a result of the judgements of status that were usually based on English speech.

Another perspective on JC that does not always gets emphasised, is one that is seen by its speakers as rich, and a treasury of folk literature, songs and expressions. Indeed, from my own experience of living and working in Jamaica, it would seem reasonable to say that most Jamaicans are attracted to films, or radio programs delivered in JC. They love their proverbs and folklores in JC; it is also not uncommon to hear Jamaicans express the view that JC jokes are just not as humorous when put into JSE. Moreover, the richness of JC as a medium of artistic expression is also demonstrated in the works of international poets and reggae singers such as Louise Bennett, Bob Marley and Mutabaruka. For example, in the poem "Dry Foot Bowy"¹ Louise Bennett employs an earthy metaphorical proverb to satirize a Jamaican of peasant stock who has travelled to England and returned with an English accent and a bad case of linguistic amnesia. He can no longer converse with his former acquaintances, much to their annoyance, for he disclaims knowledge of JC:

Me gi a joke, de gal dem laugh
 But hear de bwoy, "Haw-haw!
 I'm sure you got that ballydash
 Out of the cinema!"
 Same time me las me tempa, an
 me halla, "Bwoy kir out!
 No chat to me wid no hot pittata
 Eena yuh mout!"
 Him tan up like him stunted, den
 Hear him noh, "How silley!
 I don't think that I really
 Understand you actually."

(Bennett 1980, p. 206)

¹ Skinny legs (term of mild abuse).

Nevertheless, aggressively snobbish towards JC in public, most educated Jamaicans feel impelled to denounce the language, declare that it is vulgar, ugly, crude, that it hurts their ears, and even, in some cases, maintain that they hate it or 'never speak it'. The collective disdain for JC undoubtedly reaches its absolute pitch when the educated Jamaican travels abroad, even for a few months, and—as so often happens—returns to Jamaica, insisting to all who will listen that s/he has forgotten how to speak Creole. So great is the official respect for JSE, and the contempt for JC, that in educated homes of the middle class and bourgeoisie elites, children after 3 or 4 years are scolded, and even beaten, for speaking JC, despite the fact that their elders use it constantly, and are disciplined into talking JSE.

In popular and academic debates in Jamaica, and in the minds of some Creole as well as JSE speakers, the conditions just outlined still persist today. Nevertheless, it seems true to say that that in the most recent times, attitudes and practices in the formal, public spaces of the media, churches and public-functions towards the use of JC have been changing. The change, not surprisingly, intensified with the acceptance of JC as a language with its own grammatical integrity by international linguists and educators from the 1960s. This legitimisation of Creoles in general, and JC in particular, confronted centuries of prejudice and challenged the hegemony of English from within. Another phenomenon that has contributed to the changing attitudes of most Jamaicans towards Creole is its accepted use by educated figures in official public-formal function. Consequently, it is not uncommon to hear popular talk show hosts using and encouraging the use of JC to increase the perception of their affinity with their audience.

In the context of this discussion, there has been a recurring call from different interest groups for JC to be formalised in the education system and to serve as the medium of instruction in the classroom (Devonish 1986), to bring more of its speakers into governance, and to develop the language with a vocabulary wide enough to fill its new range of functions. Such advocacy is particularly relevant in the light of findings from several studies (UNESCO 2008) confirming that children learn best in their native language and is an integral tool for improving educational achievement. However, there has been a strong reaction to these calls by the educated elite and the media expressing the following concerns: that such proposals will lead to regression in national development and will eventually result in cultural and economic isolation; that Creole is not qualified to have a place in education because it is not a 'real language'; and that such an approach will keep Jamaicans backward (Christie 2003). Scholars such as Craig (1971) have suggested that school children would fail to recognise the closeness of the two languages, where they might be seen as bidialectal rather than bilingual. These points have been made elsewhere (Christie 2003), but the core arguments are made from political and economic grounds, focusing on society's equivocal attitude to the use of JC, rather than discussing the cultural harm of educating Jamaican students in Standard English, a language they do not speak and almost never hear at home. These perspectives have come to dominate the language discourse debate for more than a decade.

The hegemony of English language in science

The notion of hegemony is once again moving to the centre of debates in contemporary educational thoughts (Mayo 2015). This concept, derived from the ancient Greek word for leadership was first used by Lenin in an analytic sense to refer to the leadership which the proletariat in Russia was required to establish over the peasantry in the struggles to form a socialist state (Hall 1996). Hegemony is most associated with the Italian Marxist Antonio

Gramsci (1971, p. 57) who described it as the process of establishing dominance within a culture, not by brute force but by voluntary consent, by leadership rather than by rule. Gramsci argued that civil or lay society is directed both by ‘domination’ and ‘intellectual and moral leadership’. In the course of his later writings, he went on to expand the concept of hegemony even further by suggesting that the maintenance of that consent is dependent upon an incessant repositioning of the relationship between rulers and ruled (Jones 2007). This means that the dominant class must be sufficiently flexible to respond to new circumstances and to the changing wishes of those it rules: precisely because it is a process, it cannot be secured once and for all, operative even at those moments when a ruling class can no longer generate consent (Procter 2004).

One group that was a focus for his assessment was the intellectuals and their relationship to the state and social change. Gramsci posited that the relationship between intellectuals and the world of production is mediated by civil and political society. However, both display hegemony in different ways. The civil society is dominated by a single social group exercising their cultural hegemony through society, while the political society displays hegemony through direct command by a government. Gramsci criticised the intellectuals as potential ‘deputies’ or functionaries of the hegemon, “exercising the subaltern functions of social hegemony and political government” (1971, p. 264). It is possible for the intellectuals to be tricked into alliance with hegemonic rule by their showing support for policies which enjoy a fairly high regard among the wider community and in which the intellectuals themselves also share abiding interest, due to what Gramsci called their ‘organic’ and/or ‘traditional’ associations with the classes in the society. These policies are used by the hegemon to put into effect an ideology which maintains and stabilizes the leadership of that hegemon and allows for the production of other controls. Gramsci’s expressed ideas did not specifically address the problems of minority language in the society, however, his concepts are useful in providing a theoretical understanding in thinking about the hegemonic influence of English in science teaching.

Thinking about language hegemony from a Gramscian perspective is:

Wherever more than one language or language variety exists together, their status in relation to one another is often asymmetric. In those cases, one will be perceived as superior, desirable, and necessary, whereas the other will be seen as inferior, undesirable and extraneous (Shannon 1995, p. 176).

Linguistic hegemony extends from how languages are perceived to how their speakers are seen (Shannon 1995). Indeed, John Honey (1997) argues that those who are not taught to speak and write in Standard English are not as intelligent as those who speak and write it. Honey further argues that Standard English is superior to all other forms of language and to achieve equality all children should be taught Standard English and use it in everyday communication. He suggested that “speakers of non-standard social and regional dialect forms suffer comparable forms of disadvantage” (1997, pp. 21–22). As problematic as such an assumption is, Honey’s arguments resonate with many people in Jamaica who accept the view that those who predominantly speak JSE are more intelligent and are more likely to be successful than people who are primarily JC speakers. From such a perspective, linguistic hegemony ideology is reinforced with JC continuing to be marginalised in terms of acquisition and learning.

During the twentieth century, international communication has shifted from a plural use of several languages to a clear pre-eminence of English, including in the field of science and technology. Indeed, many research studies focusing on international periodical publications have reported that well over 90 % of articles in the natural sciences are now written in English (see, for example, Enrique Hamel 2007; Tardy 2004). Alastair

Pennycooke (2014) argues that it is the discourse of English as an international language that has primarily justified the present dominance of English. A similar perspective is expressed by Robert Phillipson and Tove Skutnabb-Kangas (2013) who suggest that there is a structure of inequality between English and other languages which is justified and reinforced by international power politics, exploiting development aid and worldwide English language teaching.

This shift towards English has created a hegemonic influence not only in scientific publications and academic exchanges, but on science education as a whole, including classroom discourse. In this formulation, English hegemony can be seen as a source of inequality, injustice and discrimination in intercultural and international communication (Phillipson and Skutnabb-Kangas 2013). Scholars of the non-English speaking countries encounter difficulties in getting their research accepted, not necessarily because of the quality of their work, but because of their poor English Language proficiency (Huang 2010). In such a system, it is reasonable to argue that publication of international journals and scientific discourse benefit the scholars who are native speakers of English.

In the Jamaican context, the dominance of JSE is played out in the everyday interactions of science classrooms where teachers, many of whom, consciously or unconsciously, fail to recognise the importance of the mother tongue of children and encourage children to express scientific understanding, both oral and written, in Standard English. In such cases, a student's accurate, insightful contribution to classroom discourse may be devalued when she or he uses JC in the development of scientific ideas. Hazel Simmons-McDonald (1996) reviewed a range of studies showing that even at a young age Creole-speaking children bring a rich bilingual experience of scientific knowledge to class and, when given the opportunity, are able to make creative use of these experiences in moving towards scientific understanding. For example, in a discussion on the changes of the states of water, the children clearly had ideas about the scientific processes involved and could express their conceptual understanding in Creole. Yet these experiences often are not acknowledged in the classroom and science teachers continue to perpetuate a monolingual order of discourse.

The role of language in science education

Over the last two decades there has been a strong interest by science researchers in the role of language in the complex interactions related to science teaching and learning. Researchers such as Jay Lemke (2012), Joan Solomon (1994) and Clive Sutton (1996) have drawn specific attention to the intrinsic relationship between language and school science and the important role that language plays in mediating scientific thoughts between learners and teachers. The language of science lessons is the medium, which enables learners to explore scientific ideas, clarify the meaning of technical terms or new concepts, develop new understanding and vocabulary, and communicate methods of scientific reasoning and inquiry.

The importance of language in discovering new ideas and making sense of scientific concepts is highlighted by Lay Hoon Seah (2010) who argues that learning the language of science is constitutive of learning science. In this formulation, language is seen as one of the most important ways in creating relationships among ideas and as a means of developing scientific understanding. Lemke (2012) emphasised that language is the most pervasive system of semiotic resources used in deductive and inductive reasoning,

in formulating hypotheses and making scientific generalisations. Lemke (1990) also drew from what he called the “social semiotic” to suggest that learning science involves learning to talk science: it means doing science through the medium of language to communicate “and act as a member of the community of people who do so” (p. 1). In his later writings Lemke (2004) extended his ideas in *Talking Science* to outline the multi-modal nature of science discourse. In this sense, the spoken language is used “in coordination with many other modes of semiotic representation: visual images, diagrams, graphs, mathematical formulas, and the semiotics of artifacts, and the meaningful activities of using them” (Lemke 2004, p. 1).

Drawing explicitly on the ideas of Lev Vygotsky’s sociocultural views of learning, Sutton (1996) proposed that science learning involves children *learning to talk in new ways* in understanding the nature of science and the ways in which it is changing, making sense of scientific ideas and communicating these ideas to other people. In Sutton’s view, such perspectives and approaches encourage exploratory activities and elaborate talk using language in new and powerful ways. In this environment, the role of the science teacher is to convince pupils of the value of those new ways by providing activities and conversations that challenge perspectives and promote a richer way of looking at the world.

Elsewhere, a further perspective that highlights the importance of language in classroom discourse is illustrated in Solomon’s (1994) account of how children learn science. In Solomon’s view, the process of learning science is akin to a child’s “arrival on a foreign shore or struggling with a conversation in an unknown language” (p. 16). She writes further:

Imagine an alternative picture of pupil learning:- a young student sits outside a circle of disputing scholars picking up fragments of conversation and trying to piece them together. Once we were all that child, the family was the circle, and we turned over the phrases that we heard until they built up into an idea. We tried out the sense of it, and occasionally we were amusingly wrong. If we were lucky no one laughed. Then it was explained once more in helpful ways and with good games to go with the learning of it. When we tried it again and the half- formed idea seemed to be accepted by others, it became stronger. Kindly adults encouraged us to use it in new ways: our understanding and pride in using it grew. The idea gradually became ours and, by the same token, we became a part of the privileged and knowing circle who use it (1994, pp. 17–18).

Solomon’s description highlights the crucial role that language plays in discovering, developing and consolidating new ideas and making sense of scientific concepts. In this sense, learning is seen as a process of enculturation in socially organised practices, through which students learn to think scientifically by participating in a community of science practice, within which they acquire not only knowledge and skills, but also the epistemological value of the discipline. Students’ participation in these social processes will enable them to generate and validate these ideas as they engage in conversation about science.

The extensive body of literature provided by Solomon, Sutton and Lemke on the critical role of language in science learning have important implications for science instruction in a Creole-speaking environment. This research supports the notion that the Creole speaking child needs first to encounter and experience science in their own language before having learning imposed upon them via codified discourse that is the established language of science and scientists. Mervyn Alleyne (1983) points out that JC shows a preference for definitional labelling over the purely arbitrary labelling that is supposed to be the cornerstone of the symbolic system that language is. In other words, JC provides a more direct link between the linguistic sign and the concept. So, to the Creole-speaking child *nostril* is a purely arbitrary sign to refer to either of two external openings of the nasal cavity in vertebrates that admit air to the lungs and smells to the olfactory nerves. *Nose*

hole is much less arbitrary. Likewise, *saliva* which in the English lexicon refers to the thing produced by certain glands to aid mastication and digestion is a more arbitrary sign than the Creole equivalent *mouth water*.

From this perspective, teachers could encourage pupils to use the less arbitrary Creole words to express their scientific ideas. For example, when discussing the human anatomy pupils should be encouraged to use terms such as *seed bag* (scrotum); *knee cup* (patella); *seed* (testicle); *maw* (stomach); *nose hole* (nostril); *tripe* (small intestine); and *navel* (umbilicus). Similarly, a lesson on the plants and animals found in Jamaica could incorporate words from the Creole lexicon that the pupils are most familiar with. Thus, the *shoe-black* flower (common hibiscus, used to polish shoes), the *bunga-bee* (bumble-bee), the *single-bible* or *sinle-bible* (Aloe Vera plant), or the *alligator pear* (avocado) to describe local fauna and flora provides a rich resource of scientific terms before negotiating the more arbitrarily vocabulary and grammatical challenges in learning science. Such a common-sense approach will not run the risk of “stranding students in their own words” (Halliday and Martin 2003, p. 170) but will provide a platform for moving students from their everyday ways of talking, thinking and doing to becoming competent in the ways of scientific thinking and scientific discourse.

Language difficulties in science education

There has been a significant body of research that has consistently highlighted the language of science as one of the major difficulties students have in learning science (Fang 2006; Osborne and Wellington 2001). These studies indicate that even students whose first language is English and are learning science in English, experience difficulties in dealing with specialist vocabulary and in coping with the language demands and assumptions made by science teachers and writers of curriculum materials (Henderson and Wellington 1998).

Considerable research energies have been devoted to explain the linguistic challenges in science education. For example, in the United States, Lauren Swanson, Julie Bianchini and Jin Sook Lee (2014) examined how an urban high school science teacher engaged her English language learners in the discourse-intensive science and engineering practices of (1) arguing from evidence and (2) obtaining, evaluating, and communicating information. They concluded that the students encountered significant difficulties in participating in classes, crafting arguments from evidence and reading the technical vocabulary of the texts. The researchers contended that the outcomes emphasise the need for more attention to be placed on the teaching and learning of discourse in science. A similar picture emerged from a study conducted by Jennifer Miller (2009) on a group of year 8 science refugee students in a high school in Australia. The research highlighted the difficulties the students encountered in grasping scientific concepts as a result of their poor linguistic understanding. Furthermore, technical vocabulary, dense noun phrases and the over use of conjunctions were also emphasised as major barriers to learning.

The case for Jamaican Creole as a medium of science instruction

On the basis of the foregoing discussion, if one accepts the notion of the importance to learning of the relationship between science and language, then the case of a bilingual and bidialectal society, such as Jamaica, causes special problems in the field of science. As I

have previously indicated, many Jamaican students are not proficient in Standard English but are fluent in Creole. This poses significant difficulties of cognition and understanding as the learner has to transpose concepts from one language to another. Moreover, such a situation may present additional difficulties if one considers the model of science teaching and learning in Jamaica. Textbooks are heavily relied on because of the scarcity of suitably qualified science teachers and the lack of scientific laboratory resources. Research indicates that Jamaican students have difficulties in gathering information, interpreting data and dealing with inferential levels of reasoning (Soyibo 1998). Such findings are not surprising in light of the overwhelming anecdotal evidence and day to day experience highlighting the less than adequate command of English for science purposes by both learner and teacher.

Drawing from my own experiences as a science teacher in Jamaica, many of my science lessons often began with presenting students with science vocabulary words and asking them to write the words, which would be followed by a discussion of the meaning of those words. In this model of instruction, I came to realise that the language I was using and the language of the textbooks were significantly different from the language the students were using to respond to my questions. The problems the students were having were not only of non-comprehension of English idiom and of expression unacceptable within the syntactic framework of English, but of the inability to handle certain language forms that occurred over and over in the description of experiments- the passive form. For example, it is more common for the Creole-speaking child to say *we do di experiments* (active voice) rather than *the experiment was done by the teacher* (passive voice). The passive form is very infrequently used in Creole contexts and its manipulation is therefore difficult for Creole speakers.

A problem, which all Jamaican science teachers know only too well, is JC's lack of words, expressions, modes of meaning for communicating science. This presents a constant and ever-increasing problem to Creole-speaking children when learning science through the Jamaican Standard English medium when they encounter a word that is not exactly equivalent or expresses no idea or notion formulated in Jamaican Creole. For example, words such as, *classification*, *photosynthesis* and *hypothesis* have yet to be developed in the Creole language and therefore the learner "cannot appeal to translation into his mother tongue for resolution of doubt or dissipation of ignorance" (Stevens 1976, p. 58). Such situations are exacerbated through concepts, relationships, operations or processes which cannot be illustrated or displayed, e.g. *infinity*, *gravity*. Faced with such a situation, the Creole-speaking child will follow the teacher only so far as their language practices remain in common; they will seek to interpret what is alien to their thinking in terms of their own language, and will either disregard in entirety what does not fit their own usage, or misinterpret what appears to resemble their own practices.

A similar challenge for the Creole-speaking child is the notion of two meanings to one word: The Jamaican Standard English meaning and the Jamaican Creole meaning. For example, terms that have specific meanings in science discursive practice and are clearly part of the lexicon, such as *clot* and *salt* have different meanings in Jamaican Standard English and Jamaican Creole. In the Jamaican Creole *clot* means to 'hit or strike', but in Standard English it refers to a thick mass of coagulated liquid stuck together. Similarly, the word *salt* in everyday Jamaican context denotes 'empty-handed' or 'low funds' while used in the lexicon and discourse of science it refers to an ionic compound that results from the neutralisation reaction of an acid and base. A further example is *belly* which in JC can refer to pregnancy. In such a situation, the Creole speaker has to internalise two or three meanings of a given concept or word, none of which is the same as any Jamaican Creole

meaning. In the kind of argument I have been developing, it is tempting for teachers to dismiss the learner's preconceived notions and ingrained non-scientific beliefs.

A further entrenched impediment in understanding and communicating science meanings in a Creole-speaking environment in Standard English relates to sentences and phrase structures—syntax, the rules for constructing and comprehending sentences. According to Craig (1971) the syntax of Jamaican Creole is not that of Standard English and the grammatical categories and practices of one cannot be transferred directly to the other. For Craig, both are complete systems of expression, according to their respective cultural and environmental needs. For the science teacher, problems arise because the discourse of the Creole-speaking child does not contain the same type of logic-structure which Standard English contains. Standard English favours complex sentences patterns and the use of abstract nouns, while Jamaican Creole uses fewer verb conjugations and favours a sequence of simple sentences with the most limited and fragile of linking words. The result is that the Creole-speaking child has difficulties in developing patterns of relationships among the meaning of key science terms and hence struggles to write about science ideas or experiments in Standard English.

As an illustration let us consider the following two examples:

Example 1

JC

Di wata dutty so all de fish dem dead.

SJE

The water is dirty so all the fish died.

Example 2

JC

To much suga no good fi you

SJE

Consuming too much sugar is not good for you.

In both examples I have highlighted, it is clear that the Creole-speaking child is talking and thinking in ways that demonstrate scientific understanding. However, such expressions are frowned on in the science classroom and students who use it will have their paper heavily corrected. Such practices ignore the importance of JC as a valuable resource to science learning. Students more nuanced understanding of their home language allows them to express more precise meanings when doing science. Thus, teachers can build on that knowledge by connecting it to the practice of science and provide opportunities for students to learn to use language, to think and to act as members of a science learning community.

Concluding remarks

In the preceding discussion, I advance the argument, as part of the debate on the centrality of JC as a medium of instruction in Jamaican schools, that there should be less emphasis on the writing of SJE by science students since it restricts their ability to adequately express scientific ideas and creativity. Adopting such an approach will no doubt pose unique challenges for science educators and policy makers. For example, in my earlier discussion I have highlighted concerns that JC is “reduced” lacking in abstract terms, hence, inadequate for science discourse. However, all too often, such arguments are tainted by neo-

colonial biases inherent in the work of many scientific hegemonic SJE narratives. This narrative, in some of its central aspects is both social and political, focusing on the attitudes of many to Creole as a medium of instruction in the classroom.

Perhaps, a more valid argument against Creole as the language of instruction in the science classroom is one which concerns the fundamental scientific terms which do not have any Creole meaning. In such cases, a term might need either to be borrowed from JSE or invented- which I would argue is precisely how language evolves. Indeed, English speakers have often created scientific terms by inventing neologisms out of Latin and Greek roots. Advocates of borrowing further argue that even both Latin and Greek had also borrowed from other languages in support of current load words in science (Lancor 2014). Therefore, JC, like any other language, has the means to expand its science vocabulary as needed.

In other cases, it might be that while there isn't a single word in JC for a certain term (e.g. gravity), the scientific concept can adequately be described in JC using a circumlocution. For example, in many languages 'gravity' is represented by 'the force that causes objects to fall to Earth'. By 'can adequately be described' I do not mean that the scientific term 'gravity' is identical to the phrase 'the force that causes objects to fall to Earth' but for school teaching purposes the phrase is enough to get going and a clarification of what is meant could continue (e.g. we aren't just talking about a force to Earth) in JC without resorting to JSE.

The ideas that I have put forward are not without their problems and internal tensions. However, a pedagogical approach which underlines the importance of language in science teaching, while promoting mother tongue-based education is a valuable model to improve students' engagement in science classroom discourse.

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