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Transformations in Kenyan Science Teachers' Locus of Control: The Influence of Contextualized Science and Emancipated Student Learning

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Abstract

This study investigated Kenyan science teachers' pedagogical transformations, which manifested as they enacted and experienced a reformed contextualized science curriculum in which students' learning experiences were critical catalysts of teacher change. Twelve high school teachers voluntarily participated in the study and were interviewed about their pedagogical transformations following their enactment of a reformed contextualized science curriculum. The outcomes demonstrated that students' emancipated behaviours, learning and performance, qualitatively influenced teacher change and pedagogical reform. Specifically, changes in students, as a result of the ways the science curriculum was implemented, resulted in epiphanies and dilemmas for teachers who subsequently resolved to surrender their tightly held pedagogical control (locus of control) for the betterment of the learning environment and their sense of professional satisfaction.

Keywords

Locus of control Pedagogical transformations Learning Teacher change Contextualized science curriculum

1.1 Introduction

Despite numerous attempts to reform education in East Africa, and in particular, Kenya, the question of relevance has always been discussed as part of the reform agenda, but to date careful analysis of the state of education, and especially science education, relevance is like a "mirage" (Knamiller, 1984; Yoloye, 1986). Since attaining independence from Britain in 1963 Kenya has had several major educational reforms, each of which has been preceded by a commission of inquiry including: Gachathi (1976), Kamunge (1988), Keriga & Bujra (1999), Koech (2000),

Mackay (1981) and Ominde (1964a; 1964b). All these commission reports have directly or indirectly affected the education system in Kenya, and at best, elicited the unending national debate on the question of relevance in terms of the role of science and technology in national development. Despite the major structural changes in Kenya's education system over the years, with the question of relevance characterizing the rhetoric for change, there has never been much effective shift from *traditional* British-modeled curriculum and pedagogy, especially in science education. Currently, the system is still overly exam-driven, teacher-centred with colonial as well as foreign-leaning science curriculum and pedagogy. This apparent static nature of curriculum and pedagogy is due in part to colonial hangover and influence whereby for a long time foreign experts who had limited knowledge of the local Kenyan context dominated high school curriculum development and implementation (Sifuna & Otiende, 2006). Also, those Kenyans positioned to influence change were often trained abroad, or trained locally by foreign experts, thus they lacked the skills needed to reform curriculum and pedagogy to reflect the local context (Sifuna & Otiende, 2006). In addition, they often borrowed from foreign instructional models not suited for the Kenyan learner, most of whom live and grow up in highly ruralized cultures, not privileged by conveniences such as electricity, running water, and motorized transportation. Over time, this has made teachers less receptive to pedagogies that claim to "innovate", but are often entrenched with multiple cultural assumptions about learning and the foreign contexts from which they originated. Instead, Kenyan teachers focus more on getting students to pass exams. The need to make science relevant to the students is regarded as superfluous to examination performance and, at best, perpetuates the traditional culture where science is presented as an encapsulated system that has no relevance to the students in terms of their local contexts and everyday lives (Tsuma, 1998). Any attempts to integrate into curriculum visits to local and authentic science learning environments, such as *Jua Kali*[1], are seen as unnecessary and time consuming distractions. But for most Kenyans, the question of relevance is very important as eloquently expressed by Tsuma (1998): "no Nation can develop in any sense of the term, with a population which has not received a thorough and relevant education" (p.i). And, despite the local setting's richness in scientific phenomena that can be readily mediated through curriculum,

[1] *"Jua Kali" is a small-scale manufacturing and technology-based service sector where artisans manufacture equipment and other household items such as charcoal stoves, kerosene lamps and chicken brooders, which are ubiquitous in everyday Kenyan culture while also providing related services to other small-scale producers (UNESCO, 1997).*

Kenyan science teachers rarely exploit the potential to mediate student learning. Hence, the pedagogical practices of Kenyan teachers remain in a state of inertia despite attempts at reform.

1.2 Background and Literature review

According to Anderson-Levitt (2002), teachers have cultural knowledge (or teaching culture) from which they draw when organizing teaching. Cultural knowledge is in this case the knowledge teachers "use to interpret experience and generate social behaviour" (Spradley, 1979, p. 5). Moreover, Anderson-Levitt (2003) sees this behaviour to include beliefs, feelings and values and points out that knowledge is cultural when it has been constructed (learned) including procedural knowledge, which is about knowing how to do things such as organizing student learning experiences, and which gets shared during teacher interaction (socialization). In this study the focus is on how emancipated student learning affected teachers' locus of control, that is their belief about whether the outcomes of their actions as teachers are contingent on what they do (internal control orientation) or on events outside their personal control (external control orientation) (Zimbardo, 1985).

According to French and Raven (1973) and echoed by McCroskey and Richmond (1983), Richmond and McCroskey (1984) and Kearney, Plax, Richmond and McCroskey (1985), teachers are, in a way, managers of classroom events, and they require power in which authority to influence and control student behaviour and the learning environment reside. French and Raven articulate five forms of teacher authority characterized as internal control including attractive/referent, expert, reward, coercive and position/legitimate orientations. Attractive/referent authority orientation arises out of a teacher's belief that being nice to students by knowing and emotionally investing in them will influence their behaviour (Covey, 1992). However, as Murray and Staebler (1974) assert that, although the students will work hard and for teachers they like and perceive as being caring, pandering for approval and allowing the need to be liked to drive teaching choices can lead to problems such as giving away power and being taken advantage of. Expert authority orientation resides in the perception that one is knowledgeable in the subject, well prepared or intelligent. However, Valli (1992) has observed this to lead to teachers' downfall when assumed to be sufficient in itself as a form of authority. It is often the case to see many teachers entering the profession with a passion for their subjects,

but leave shortly after with a very disappointingly high degree of disinterest and disrespect for the profession (Valli, 1992). Reward authority orientation resides in a teacher's ability to reward student forms that include grades, recognition, prizes, praise, privileges and anything else the students might desire. However, French and Raven warn that although this has the effect of modifying behaviour, often it essentially creates "addicts" of reward – doing the work to obtain the reward rather than learning or growth. Coercive authority orientation is manifest in a teachers' power to use disincentives including withholding privileges, and spelling out consequences or punishments to students (French & Raven, 1973). They argue, these can be used constructively to draw boundaries. However, when used unconstructively, such as shaming, humiliation and withdrawal of affection, they can be highly ineffective. Finally, position/legitimate authority orientation is derived from the fact that one is the teacher and wields the responsibility of school or class management. This authority according to French and Raven (1973) is not earned but it exists culturally and by norms. Here the teacher is the sanctioned authority in the class as the educator. Rose and Medway (1981) point out how teacher locus of control can differ depending on the nature of task performance outcome.

In the Kenyan context, teachers maintain high levels of classroom and learning environment control with a view to affecting student performance on national exams, and also because of fear of losing command of authority in all forms articulated by French and Raven. A study by Khany and Ghoreishi (2013) revealed that transformation leadership style was a predictor of teachers' sense of responsibility and that this in turn affects students' learning and achievement of educational purposes. Lauermann and Karabenick (2011) have reported that changes in teachers' institutionally mandated roles and responsibilities are often inconsistent with their beliefs about good teaching. Moreover, those mandated roles tend to focus on basic skills at the expense of cognitively complex and meaningful instruction. And, accordingly, they shift attention from students' problems and needs to their test scores, and policy demands (Pedulla et al., 2003; Valli & Buese, 2007). In the Kenyan context, the teachers would tighten control over what should be learned and how it should be learned with the aim of achieving high student exam performance and maintaining centralized authority at the expense of learning for understanding. Maes and Anderson (1985) determined four factors: recognition, teaching/learning process, relations with teachers, and attitudes of parents and society, from the validation process of developing an instrument to measure teachers' locus of control. They

concluded that control expectancies of teachers depend on the aspects of their roles they consider valuable to the control of the learning environment.

According to Lasky (2005) the interplay between teacher identity, agency and context affect how they report what and how they experience teaching students. Furthermore, social context plays a role in shaping a teacher's sense of identity and purpose as a teacher (Lasky, 2005), and that individual cognition is the result of social interactions (Lerman, 1996; Harré & Gillet, 1994). Teachers as agency in this study, refers to the belief that teachers have the ability to influence their lives and environment (Lasky, 2005). Further, it is recognized that teachers enact their practice and hold agency within the contextual bounds of school and school culture in which they are situated. According to Hinde (2004), school culture surrounds and influences teachers' decisions and actions since they work in a cultural context where all aspects of school life are affected (Peterson & Deal, 1998). It even shapes what they talk about (Kottler, 1997) and how they choose what to emphasize from curriculum (Hargreaves, 1997). In fact, whenever culture changes, everything else changes (Donahoe, 1993; Fullan, 1991). In short, culture is the norms, beliefs, values, traditions, and rituals that pervade a school (Goodlad, 1984). Thus, culture changes constantly as it is constructed and shaped through school community member interactions (Finnan, 2000). Inevitably school culture will affect a teacher's teaching behaviour including subject matter (content), pedagogical and context knowledge.

Characteristically, **Kenyan** teachers would for instance not talk to fellow teachers about content to appear not to have the expertise required. During the teaching learning process, they orientate students to understand and achieve at any cost concepts being taught. In addition, teachers do not expect their authority of knowledge to be questioned. In other words, challenging questions posed by students are not considered part of a normal learning environment. In this way, teachers maintain a very high position legitimate authority orientation (French & Raven, 1974) to ensure that expert authority is kept central to their identity and therefore cannot be challenged. In addition, rewards resulting from assessment are narrowly defined within the boundaries of the mandated textbook curriculum. As a result, teachers would not consider knowledge obtained outside the class curriculum worthy. Hence, students do not seek to expend themselves beyond this boundary, as they do not expect any rewards. Thus teachers control the learning internally to the detriment of the students' learning. Any change in a teacher's subject matter, pedagogy and context will affect his/her overall teaching behaviour, which includes

carving out his/her locus of control. We argue that student learning or performance has the capacity to influence teacher change and pedagogical reform including transformation in teachers' locus of control.

1.2.1 Theoretical framework

In this paper the teacher change theory, which ascribes agency to student learning (Elmore, 2002; Nashon, 2013; Nashon & Anderson, 2013), formed the foundation of the theoretical framework. The model suggests that significant change in teachers' attitudes and beliefs occurs primarily after they gain evidence of improvements in student learning. It is ironical that typically, these improvements are a result of changes teachers make in their pedagogical practices, such as new instructional approaches, use of new materials or curricular, or simply a modification in teaching procedures (Guskey, 2002). There are many models on how teacher change can be influenced. However, contemporary methods of promoting teacher change come in the form of teacher professional development (PD). According to Elmore (2002), there are two formats of PD: traditional and job-embedded. Traditional PD format is a top-down model arising from policy mandates where experts hold workshops, seminars, lectures, etc. (Elmore, 2002) on what they consider to be effective pedagogy or curriculum reform.

On the other hand, Job-embedded PD locates training within the school or local context by utilizing for example, inquiry groups (collaborative in nature) where teachers participate more closely to their own context in shaping curriculum and pedagogy to the service of student learning (Elmore, 2002). Literature on traditional PD format indicates that it is effective in changing teachers' practices when it is longer in duration (Porter et al., 2000) since teachers need more time (Stein, Smith & Silver, 1999) and variety of activities (Mazzerella, 1995) to learn more about their practice. On the other hand, studies that advocate job-embedded format advise locating PD within the school for purposes of creating ongoing communities (Hord, 1997) and allowing teachers to do the talking, thinking and learning about their practice and student work (Feinman-Nemser, 2001). However, the PD activities described in both formats seem to focus on teachers as change agency and disregard student learning as a change agency. Yet student learning or performance has the capacity to influence teacher change and pedagogical reform. Thus, this is the type of change the study sought to investigate among Kenyan science teachers as they enacted and experienced student learning in a reformed contextualized science

curriculum. For this, paper, we will report on one aspect of teacher change, teacher locus of control, that was influenced by students' emancipated learning in a contextualized science curriculum unit. Hence the question: *What transformations in locus of control are evident from Kenyan science teachers' narratives after enacting and experiencing student emancipated learning in a reformed contextualized science curriculum?*

1.3 Methodology

1.3.1 Design and sample

This study employed an interpretive (Schwandt, 2003; Gallagher & Tobin, 1991) case-study (Merriam, 1998; Stake, 1995) approach to investigate the above question. The case here refers to a group of Kenyan Form 3 (Grade 11) science teachers whose perspectives regarding their pedagogical transformations during and after enacting and experiencing student learning in a reformed contextualized science curriculum were analyzed. Fundamental to the interpretivist assumption is the belief that knowledge comes from human experiences and that reality exists only through interaction (Firestone, 1987; Howe, 1985; Palys, 2003; Smith, 1984). Hathaway (1995) asserts that those participating in it construct reality, since understanding the reality experienced by participants guides the interpretive researcher. Thus, this study reports the results of the analysis of perspectives of 12 Kenyan teachers about their pedagogical transformations after enacting and experiencing student learning in a reformed contextualized science curriculum.

The 12 teachers who participated in the study had between 8 and 20 years of teaching experience. Irrespective of the category of the schools from which the teachers came, the five select schools from where teachers in this study were drawn were known to perform well on national exams. Each of these teachers had produced outstanding results in terms of student performance on national examinations. Upon accepting to participate in the study, the teachers and research team developed and implemented a 9-week contextualized (*Jua Kali* – Classroom) science unit. McCormick (1998) eloquently describes *Jua Kali* as a place alive with activity and sound of hammers on metal; a place where hundreds of artisans and their trainees fabricate metal products including kerosene lamps, chicken brooders, wheelbarrows, charcoal stoves, cooking pots and utensils, and many more, which are sold to local people, and represent items that are

ubiquitous in the households of almost every Kenyan student. This local manufacturing context embodies a wide diversity of applied sciences including thermodynamics, chemical transformations, and reactions, which students could investigate. Through interviews, teachers' perspectives on their pedagogical transformations were elicited one-year after enacting a contextualized science curriculum.

1.3.2 Procedure

Initially the study was introduced to science (biology, chemistry and physics) teachers in five select high schools. The study commenced by having the research team and the science teachers from the five schools visit a Jua Kali site, where they identified a variety of production activities and products that could be integrated with school science experiences (Nashon & Anderson, 2013). As well, the activities, production processes and products identified were those that could be linked to school science curriculum or understood in terms of school science as well as attract students' curiosity and attention to understand the embedded science. In collaboration with Jua Kali artisans the teachers and researchers divided the site into 10 production stations, clearly labeled them according to the various activities of specialization to ensure that during the impending class visits, the students engaged in science learning. This was followed by a one-day sensitization workshop that involved cueing the teachers further on the purpose of the study as well as discussing the preparation for the Jua Kali visits. The workshop also involved formation of groups, identifying from the school syllabus science topics related to activities at Jua Kali, and developing a questionnaire that was aimed at guiding students' engagement with Jua Kali artisans and their peers at the site and back in the classroom. The purpose was to facilitate student understanding of science through or embedded in Jua Kali products and production activities. During the workshop the teachers were allowed the flexibility of developing science lessons that capitalized on the richness of Jua Kali as a context for making science learning more engaging and relevant. Thus, the teachers agreed to develop and implement science lessons that constituted a 9-week—contextualized science unit. Noteworthy, is that the learning activities that integrated classroom and Jua Kali experiences, which demanded on the students to use, engage or understand science knowledge holistically as opposed to compartmentalizing it into physics, biology or chemistry. Further, the 12 teachers

agreed to co-teach the science unit to the Form 3 classes to ensure a coherent integration of subject content that met curricular requirements for each science area (physics, chemistry and biology). In other words, since they each were specialized in different science subjects, there was a realization among the teachers that co-teaching was the best way to ensure that their three curricular areas were sufficiently addressed, even though co-teaching was not a part of their teaching practice. Also, the contextualized science unit had to be in accord with the guiding question and in harmony with the Kenyan national curriculum. The unit was implemented in a series of lessons that involved a visit to a local Jua Kali site.

After the workshop, the teachers, equipped with the general framework for implementing the integrated science unit, organized introduction sessions with their Form 3 classes that was aimed at sensitizing or cueing the students about the potential role local contexts could play in enhancing science understanding, our role as researchers and the aim of the study. One year later, teachers were interviewed. The narrative interviews with the science teachers were about how their pedagogy, roles and views about their experience with previously modeled science pedagogy were impacted by their students' engagement with learning during the Jua Kali visit and the entire contextualized 9-week science unit experience including any new subsequent units they might have modeled on the 9-week unit. The Form 3 science teachers' narratives embodying perceptions of how one year later their students' learning affected their pedagogy, roles and views about their experience with previously modeled science pedagogy as they enacted a contextualized science curriculum unit in five select Kenyan high schools were analyzed. Select key interview excerpts illustrate emergent themes.

1.3.3 Data analysis

Data analysis is an attempt to summarize the data that have been collected in a dependable, accurate, reliable and correct manner (Mills, 2003 p.104). In order to achieve the goal of making the data dependable, the teacher interview data were transcribed verbatim and reviewed by individual research team members before coming together for collective discussions. These discussions led to generation of themes in reference to teachers' pedagogical change in terms of locus of control. This is what Vayda (1983) calls progressive contextualization. Progressive contextualization involves focusing on a specific activity and then explaining it in progressively wider or denser contexts. For example, in order to understand the

teachers' conceptualizations of their pedagogical transformations as resulting from the students' learning experiences, the teachers' conversations on students' learning experiences of the reformed contextualized science curriculum were drawn upon. Thus, the teachers' narratives of the students' learning experiences were then extrapolated into the larger discourse on their pedagogical transformations. This was done consistently with the objective of the study (Miles & Huberman, 1994; Yin, 2003). Analysis of interview data sets from different focus groups involved comparing within and across the sets to further clarify and interpret the qualitatively determined teachers' pedagogical transformations that resulted from the students' learning experiences of the reformed contextualized science curriculum. Informed by the literature reviewed and coding process, we were able to interpret the participating teachers' pedagogical transformations that were seen to be a result of the students' learning experiences.

1.4 Results and discussion

The analyzed interview data corpus exhibited five key pedagogical transformations which indicated that teachers had been: 1) changed from teacher-centeredness about science content knowledge and pedagogy to continued learning in response to active emancipated learning; 2) emancipated from syllabus controlled teaching to student driven teaching; 3) emancipated from seeing the classroom as the only source of knowledge and pedagogical practice to classroom-real world environments as sources of knowledge and pedagogical practices; 4) emancipated from being disseminators and oracles of content knowledge to a teacher-student collaboration with respect to learning including "reasoning together", and 5) influenced to relinquish control manifest in solitary teaching to collaborative team teaching.

These transformations resulted in changes in loci of control whereby teachers changed or surrendered their traditional powers in response to transformations in their students' contextualized learning following curricular experiences that integrated classroom-local environment teaching and learning activities. According to Hull (1993) contextualized learning refers to learning that occurs when learners process new information in ways that make it meaningful for their frames of reference. Hull (1993) asserts that during the process of learning our minds naturally seek meaning in a context by searching for relationships that make sense and resonate with our real world experience. In this study, contextualized learning experiences

provided students with opportunities to engage in real world problem solving activities consistent with Karweit's (1993) perspective on localized, relevant and meaningful learning.

Moreover, as Resnick (1987) has noted, decontextualized science lacks relevance outside of the school. In fact, according to Gay (2002), when learning is situated within the lived experiences and frames of reference of students, it becomes more personally meaningful, has higher interest appeal, and is learned more easily and thoroughly. The consequence of this is improved achievement given that everything gets understood through one's own cultural and experiential filters (Au & Kawakami, 1994; Gay, 2000; Hollins, 1996; Kleinfeld, 1975; Ladson-Billings, 1994, 1995). This is what might probably have influenced the pedagogical transformations experienced by the current study's participating teachers.

1.4.1 Changed from old ways of teacher-centeredness about science content knowledge and pedagogy to continued learning in response to active emancipated learning

A shift from the traditional teacher-centered way of teaching and learning science to an emancipated way of learning was identified as one of the most notable pedagogical transformations. For instance, a teacher had an experience with her learners following the Jua Kali visit in which students questioned the reasons behind an observation concerning the shape and design of jikos[2] created by Jua Kali artisans as the she states:

> There was this time we were learning about energy, […] and we were looking at conservation of energy and a group of students were asking me about the different energy saving Jikos that they saw at the Jua Kali setting. And particularly they were curious about the types of designs that were there. Traditionally, we have the cylindrical ones [Jikos], then they saw these that are cone-shaped and they were really asking why this design? Why are they moving from the traditional cylindrical to this cone design? I was really challenged. I had to do some research to find out why we have these types and yet the traditional vertical cylindrical ones can be cheaper to make. And I thought that was a big challenge. So, I went

[2] Jiko (or jikos for plural) as mainly known in East Africa is a locally made metal or clay stove that uses charcoal or small pieces of wood for cooking.

> around looking for the information and later on I agreed that it has to reflect back [concentrate] the heat energy so that we do not lose it. And, I thought it really touched me because they [the students] had an idea they were curious to find out. It challenged me to be broad, to look for information.

In particular, this incident both touched and challenged the teacher. We speculate that the teacher was touched because she noticed the students breaking free from the traditional passive and non-questioning learning mode, to an active, inquisitive and questioning mode drawing on the knowledge and experience obtained from outside the classroom setting (Jua Kali). The challenge was characterized by the fact that: (a) an actively emancipated curious learner confronted her by questioning beyond the limits of her (the teacher's) traditional curriculum boundaries and (b) she (the teacher) did not have the content knowledge at that moment to effectively answer the student's question. This collectively challenged and confronted the teacher to appreciate that her own content knowledge was limited by her traditional curriculum boundaries, and that faced with this kind of learner, the limits of her traditional practice needed to change. In the same way, the expert authority orientation (French & Raven, 1973) was confronted.

Further evidence of this is demonstrated by her colleague's assessment of the new emergent classroom culture in which students are actively curious, research the curriculum topics before coming to class, and feel very confident and free to question the teacher's proposed explanations:

> To add on to what "Mwalimu" [my teacher colleague] has said; from that day, this class has really become very actively involved, in a sense that when you have to go to teach you do not just wake up and go. You must read, read well get well informed about what you are going to tell them, otherwise they will stop you. They will say, "No, I read somewhere and it says this. How come you are saying that?" You see. It means that you as a teacher also don't know it all.

From these excerpts, it is evident that there was a change in the locus of control resulting in a pedagogical transformation instigated by a changed student culture of learning. Traditional teaching models where the teacher held highly centralized expert authority orientation and

control of content knowledge and pedagogy is typically restrictive of active emancipated learners. However, in the instance of these science classrooms, emancipated learners confront this locus of control, which leads to change in teacher practice.

1.4.2 Emancipated from syllabus controlled teaching to student driven teaching

Testimony of this pedagogical transformation was declared during the focus group interviews when we invited the teachers to reflect back on and share their teaching practices before and after the students' experienced the contextualized science curriculum. All teachers who participated in this study concurred that there was a significantly noticeable change from a *syllabus-controlled teaching* to *student driven teaching*. This was better expressed by the teacher who said:

> A great change there is; because many a time, you would like to teach and finish the syllabus so you go through very fast. But, now [this year] you want to involve students, let them also display the skills they have, the ability to do something. Now, instead of letting it come every time from the teacher, it is more of a student-teacher interaction. So, now you involve the students other than just the teacher dominating in the teaching.

When asked further if there was any way they could measure themselves to compare teacher-centered way of teaching and the student driven, one of the teachers said:

> Yes I would, [in particular] the aspect of syllabus coverage so that you finish and do so much. But you are not conscious about the learner, of about how much knowledge you have imparted, how much has been retained because you want to do much, so you ignore the learner and it becomes teacher-centered. But from the Jua Kali [experience] they [the students] can even put up their hands and say, "you know madam, this is what we saw". They interject, they intervene, and they want to narrate. So it has helped them to actively participate in the lessons unlike before when they only listened to the teacher.

Like most Kenyan science teachers today, the demands and pressures of a prescribed and didactic curriculum enslaved the participant teachers we investigated. In this sense, the external locus of control, which drives pedagogy, seems not to be in the domain of the teacher's discretion, disempowering them to decide what and how to implement in respect to the curriculum. Furthermore, the locus of control is independent of the concerns and needs of the learner. However, the teachers who participated in this study declared a significant change in their pedagogical practice since their experience of implementing a contextualized curriculum.

Prior to the contextualized curriculum, teachers were solely driven by need to complete the curriculum within a prescribed and externally mandated time frame. But after enacting the contextualized curriculum, the needs of the learner and how the curriculum ought to be enacted for the benefit of the learner gained prominence in the teachers' concerns. Moreover, the students' experience of the contextualized curriculum had empowered them to be engaged emancipated learners, which subsequently impacted the teachers' pedagogical practices. In this sense, a change in the teachers' locus of control was clearly evident. Teachers once enslaved and "controlled" by the pressures and demands of the prescribed and externally mandated curriculum were now freed from these *shackles* by their own students' transformation. Moreover, their position/legitimate controls are taken over. The centralized teacher-centered role was surrounded to give place to student driven teaching.

1.4.3 Emancipated from seeing the classroom as the only source of knowledge and pedagogical practice to include real world environments as sources

In the traditional Kenyan science classroom, as in many classrooms in the world, the common practice is that science can only be taught in formal school science laboratories using sophisticated apparatus as the resource materials. After teachers utilized out-of-classroom science based experiences at the Jua Kali setting, as the reference point for explaining the scientific concepts, students formed the conceptions more easily and teachers appreciated the power of real-world and local examples to mediate more effectively the science curriculum and student learning. This was revealed when teachers were sharing reflections about how students'

experiences of the contextualized curriculum in turn impacted their beliefs about teaching science as one of them expressed:

> One thing I discovered from the experiences that the students had was that they appreciated the Chemistry we are teaching, and I think you heard them talk about the stove [Jiko]. They could not understand the reactions that take place when we burn carbon. But using the stoves in the Jua Kali [as practical examples], they could see in the [chemical/physical] stages where the reactions take place, and I realized that whatever we do in class, they could see it outside. So, that one was just too good. I felt good as a teacher. I was impacted the same way it impacted my students, how they felt, what they saw, and how enthusiastic they were. It also motivated me to tell me that I don't have to stay in the class; I can go outside and teach more.

In the exemplar case above, this epiphany moment of both the students' learning episode and the teacher's realization of the power of contextualized science caused the *scales to fall from her eyes* and catalyzed her pedagogical transformation. Across the teacher cases in the study, all similarly had epiphany moments and started emphasizing relating classroom science to activities in the local Jua Kali context. We see this as a change in the teachers' locus of control from a narrow construction of the sources of science curriculum to a broader and emancipated perspective from whence science curriculum can be drawn.

1.4.4 Emancipation from being disseminators and oracles of content knowledge to a teacher-student collaboration

Normally the teachers perceive themselves as owning knowledge, which they impart to students in an authoritarian teacher-centered manner. Based on the behaviourist tradition, Kain's (2003) observation that a teacher-centered approach assumes that it is the role of the teacher to create an environment that stimulates learning in students was clearly the motivemost participants had, but until participation in the study, they came to appreciate the need for student ownership of learning. Also, accordingly, what Dupin-Bryant's (2004) describes as teacher

centered teaching in which the teacher "directs how, what and when students learn" (p.42) was undermined. After enacting the contextualized curriculum, this teachers' belief of knowledge ownership shifted as they could now see the students as active participants in their own learning. The teacher that better expressed this said:

> It means that you as a teacher also you don't know it all, and sometimes you have to calm down and say [to the class] "let us reason together". I might say to the students "Your view is this, why do you think it is this way?" [As the teacher] I am saying mine [explanation] is like this and may be these are the reasons I have. So you now make them think further as you also think about it and do more research on the same if you do not have an answer for it.

> So it is a class that has actually kept us on our toes. I don't know whether I am the only one. But you do not just go there [prepared as we have previously done]. They [the students] will tell you "it is not like that; we have done A, B, C, D… We have read, it is like this, why do you think so? Can you tell us something?" Then, I throw it back to them then they again think. So it gives you that interaction. And sometimes, as much as we think it will affect our syllabus coverage, because we are now involving students giving them more time instead of pouring everything to them whether it is right or wrong, we now have to give them attention, after all it does not affect [our syllabus coverage]. In any way, it enables the students to retain more. As you involve them in the discussion, they end up retaining more of whatever they have learned. Also by the end of the lesson you have given them an assignment to take away. If you have not reached an agreement, it now becomes a point of interest for everyone to go and find out more information to come and report back to the class.

The contextualized science curriculum changed the students to become active emancipated curious learners who intrinsically wanted to question and understand the science they are studying. This transformed student culture could not exist alongside the teachers' traditional pedagogical approaches. As a result of students' becoming active participants in

class, asking challenging questions, requiring detailed explanations for different phenomena, teachers realized their previous pedagogical approach could no longer work. Hence, this compelled a change in their locus of control in which they relinquished their position/legitimate control orientation, which was highly centralized authority and pedagogical power, embracing a teacher-student pedagogical collaboration. This teacher's paradigm shift from a teacher-centered teaching approach to a student-centered one is in agreement with Kain's (2003) student-centered approach which posits that the construction of knowledge is shared and learning is achieved through students' engagement with various activities. This is what Dupin-Bryant (2004) referred to as responsive instruction that is collaborative, problem solving and democratic, in which students and teachers together tacitly "decide how, what and when learning occurs" (p.42).

1.4.5 Relinquished control manifest in solitary teaching to collaborative team teaching

Surrender of control manifest in solitary teaching to collaborative team teaching was discerned from teacher narratives. Here, teachers recognized and realized that the students had changed as a result of the contextualized science curriculum. Students' "becoming very sharp and very smart" - learning transformations that subsequently exposed teachers content knowledge vulnerability and later led to changes in their pedagogical practice characterized this change. One teacher better expressed this when she said:

> I think I also have an additional point about how this Jua Kali changed us in our department as science teachers because we realized that these students are becoming very sharp and very smart. So, it forced us to employ team teaching such that we teach a class with more than one teacher. Formerly, I have been alone in a class. But now we realize one teacher cannot know it all. The students are becoming more broad thinking. So we have divided the class such that if you [fellow teacher] are smart in one topic you come and teach it for me, because the students are likely to challenge me there where I am not good in the topic. But the topics I like most I will teach them because I am able to handle the students. So I think it has really enhanced teacher teamwork and cooperation among members of the department across the three subjects. Like my biology class we teach it

three teachers – the topic I am not very sure about I will give her (pointing to her colleague), the topic we are not sure we shall give to somebody else.

It was evident from the narratives that contextualized science experiences that integrated classroom and local Jua Kali activities impacted these teachers' ways of understanding teaching and realizing that other colleagues through team teaching could comfortably fill their content knowledge shortfalls. In his study on team teaching and academic achievement, Amstrong (1977) indicates that team teaching permits teachers to take advantage of individual teacher strengths both in planning instruction and in working with the students. However, research indicates that a larger amount of literature on team teaching merely provide lesson plans that demonstrate which teacher will speak on what topic or lead a particular activity within the same subject lesson which demonstrates retention of one's locus of control to a certain extent. On the contrary, in this study the teachers went to the extent of abdicating to their colleagues entire topics that they considered difficult to handle, which in a sense demonstrated the teachers' determination to relinquish their locus of control

We regard this change in locus of control to be significant for several reasons: (a) teachers' jealous territorial control over their classrooms rarely or never admit fellow teachers into their sole domains for team teaching; (b) there is no tradition in the Kenyan education system for team teaching; (c) institutional structures within schools, such as time-tabling, heavy teacher workload and under-staffing do not favour team teaching practices. As such, for this to occur, the pressure teachers experienced from the transformed students must have been significant enough to overcome the aforementioned barriers. In addition, the teachers surrendered their traditional authoritarian teacher-centered practices after being confronted by now broad-thinking students who challenged the limits of their content knowledge. As such, this vulnerability is resolved by team teaching, which has been seen by the teachers as a remedy to addressing their emergent deficiencies and restore a sense of control.

1.5 Conclusions

The study demonstrates how the power of student learning influences transformation in teachers' locus of control and pedagogical practices in general, but particularly, in the change of

expert and position/legitimate authority orientations. Thus, the impact of the contextualized curriculum on students' transformations subsequently influenced teacher pedagogical transformations. The study notes that the nature of intervention is critical for effective teacher change in a sense that a student-focused intervention effectively impacted the teachers to positively change their pedagogical approaches for better student learning. In addition, the study revealed that comfort, stability and security vested in teacher traditional pedagogical practice over which they have established control was threatened/disrupted by students' transformations resulting in teacher vulnerability. This caused the teachers to re-evaluate their established pedagogical controls and to seek out / formulate new/ alternative pedagogical strategies, which were more stable with less teacher control. The new locus of control yielded higher levels of teacher satisfaction concerning their practice.

Given the above observations, there is always a potential for teacher change. The magnitude of students' transformations on teachers' pedagogical change was sizeable in comparison to other attempted interventions on teacher change. We speculate further that the size of the transformation in students was so great that the rarely considered change occurred in teachers pedagogy – changing from solitary to team teaching.

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