Hidden Currents in the STEM Pipeline: Insights From the Dyschronous Life Episodes of a Minority Female STEM Teacher

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Hidden Currents in the STEM Pipeline: Insights From the Dyschronous Life Episodes of a Minority Female STEM Teacher

In this article, I use the idea of dyschrony to describe the multiple disjunctures experienced in a Hispanic woman’s life as she struggled to gain full membership in the STEM (science, technology, engineering, and mathematics) community. Despite having earned a doctoral degree in chemistry and a teaching position in a STEM school, she was cognizant of how gender and race had marginalized her and her minority female students, making them feel like border members of the STEM community. She had formed a solidarity group within the STEM school. As I apply the construct of dyschrony to analyze the in-depth interviews with the teacher, I illuminate tensions in the STEM pipeline and suggest that one should be critical about the promise of social mobility. The forming of solidarity groups may contribute to positive experiences of minority girls in STEM schools. Dyschrony may be used as a helpful analytic construct to unpack the forces contributing to minority women’s struggles in STEM fields and understand why they might leave.

Despite signs of increase in the number of women in science (National Science Foundation [NSF], 2006) research continues to show an underrepresentation of women in science, technology, engineering, and mathematics (STEM) fields in the United States (American Association of University Women, 1992; NSF,
Interestingly, many girls who take advanced science courses in high school do not continue to study science in college. At higher levels of STEM education, the percentage of women declines, and more so for minority women across all STEM fields. This phenomenon is not unique to the United States. In the United Kingdom, 29.8% of female STEM graduates are employed in science, engineering, and technology occupations, as compared to 50% of male STEM graduates (Kirkup, Zalevski, Maruyama, & Batool, 2010). This phenomenon has been metaphorically described as “the leaky pipeline” (Blickenstaff, 2005, p. 369).

Blickenstaff’s (2005) review of the existing literature brought to the surface the following explanations for women’s exit from the STEM pipeline: biological differences between men and women (e.g., brain size and its correlation to intelligence levels); girls’ lack of academic preparation (Seymour, 1995); poor attitude toward science; lack of positive experiences with science during childhood; a lack of critical mass of female faculty, scientists, and engineers as role models (Etzkowitz, Kemelgor, Uzzi, & Neushatz, 2000); perceived irrelevancy of science; chilly climate in STEM settings (Hall & Sandler, 1992); cultural pressure to conform to traditional gender roles (Williams, 2001); and inherent masculine worldviews about science.

Some possible ways to increase women’s representation in science include introducing initiatives that ensure all students have equal access to the teacher and classroom resources (Blickenstaff, 2005), eliminating sexist language in printed materials and behaviors (Bazler & Simonis, 1991; Jones & Wheatley, 1989; Kahle, 1985; Mason & Kahle, 1988), having special classes for minority girls to support them in their academic work, providing role models, engaging in group work, and making career information available to them (Mulkey & Ellis, 1990).

Although programs to improve girls’ participation in science, science achievements, and attitudes toward science have been implemented, there are limitations to such efforts. For example, even though role models help students think about career possibilities in science, they may not have role models at home or in their community to reinforce these thoughts (Brickhouse, 1994). They may resist accepting the canon of science if they perceive such acts to be adopting ideas unconnected to the conditions of their lives (Brickhouse, 1994). This suggests that issues attributing to the leaky STEM pipeline may be more complicated than they appear. These findings are alluded to in my interaction with a Hispanic female teacher at a STEM school that I describe in the following.

**Encounter With a Hispanic Female STEM Teacher**

During the time I was doing my doctoral research at a specialized STEM high school in the Midwestern United States, I became acquainted with a Hispanic female chemistry teacher, Rosalinda (a pseudonym), at the school. I was researching Rosalinda’s colleague, who is White and male, and was reforming an advanced chemistry course. Rosalinda helped in the curriculum rewriting and teaching of the course, so I interviewed her for data triangulation on the processes and outcomes of the reform work. Incidentally, interviews with Rosalinda yielded personal information about her previous experiences, mostly related to her race and gender identity and teaching profession. The struggles and tensions she and other minority girls in the school had to overcome as border members of a STEM community were illuminated. As the only Hispanic and female science teacher in the school, she represented a successful role model as a minority female in science. Her photograph was used in the school propaganda material to showcase diversity within the STEM school. However, underlying the jovial image are real life episodes of racial discrimination that continually marginalized her and other minority girls in STEM communities.

Eight months after my interview with Rosalinda, I interviewed her again. This time, she revealed more about her past experiences. I realized that she was not simply recounting what really happened, as this would mean that there
is one single and universally accepted account of events. Her narratives were juxtaposed and interwoven with interpretations, biases, and subjectivity emanating from her personal lens. She was selecting and putting together pieces from the “stock of stories” (MacIntyre, 1981, p. 201) that existed in various sociocultural contexts in Puerto Rico, North American, and elsewhere. She had a mix of affirming and disaffirming experiences that drew her away from entering the STEM community.

**Dyschrony**

I use the idea of dyschrony to describe the conflicting experiences caused by the various forms of marginalization—by virtue of her being a minority woman in science—deterning her from gaining full membership into the STEM education community. The concept of dyschrony, inspired by McCarthy’s (1993) idea of nonsynchrony, is used metaphorically in this article to unpack the complexity and interconnectedness of gender, race, class, and STEM schools.

According to McCarthy (1933), nonsynchrony refers to the “vast differences in interests, needs, desires, and identity that separate different minority groups from each other and from majority Whites in education settings” (p. 337). In other words, one should not assume identical expression of emotions, ideas, speech, behaviors, and actions based on categorical similarities. Rather, it is important to value the dynamism of interactions of multiple voices and qualities of human subjectivities and identities that are constitutive of variegated and interconnected human relations in school settings and society. The nonsynchrony of events and actions described in this article emerged from the expression of Rosalinda’s struggles to overcome marginalization due to unequal distribution of resources, imbalanced power relations, and structural discrimination. Schools can be sites where the politics of difference are produced when teachers and students are enabled or constrained in the process of acquiring, mobilizing, and utilizing their capital.

Additionally, I use dyschrony to illuminate discontinuities resulting from negative and contradicting viewpoints imposed by others on Rosalinda at her specialized US STEM school. Having a doctorate in chemistry from a top state university in North America and a respectable teaching position in a STEM school did not automatically grant Rosalinda the recognition she thought she deserved. Rosalinda continually struggled to resolve differences in how she thought about herself as a professional in science and how others perceived her. People would express their surprise and doubts on learning that she was a chemistry teacher and not a Spanish teacher at a STEM school. This resulted in self-questioning about her own ability to teach STEM students. She had also developed contradicting viewpoints about helping minority girls succeed inside and outside the classroom. Personally, I find the resiliency of stereotyped views about Rosalinda—despite her outstanding academic achievement—confounding and destructive. As such, I intentionally use the prefix dys- as opposed to dis-, non-, or un- to underscore the breakdown of the assumption that good academic achievement promises social mobility and a better life for minority women. Clearly, qualitatively improved experiences should parallel the quantitative increase in minority women in STEM fields, or else the “paradox of critical mass” (Etzkowitz, Kemigor, Neuschatz, Uzzi, & Alonzo, 1994) will continue to persist.

The marginalization and resiliency of minority women in science suggest that tensions they experience are possibly more complex and require the unpacking of constraints they experience to understand what hinders them from becoming full members of a community. In the following, I present critical episodes in Rosalinda’s life experience that were dyschronous and contested her acceptance into the STEM community. The interpretations that follow underscore the need to critically examine minority women’s experiences in STEM fields, or else the STEM pipeline will only continue to be leaky” Educators may use the analytic construct of dyschrony to unpack the social forces shaping the experiences of minority
women to understand why they continue to be underrepresented in STEM fields.

**Critical Episodes in Rosalinda’s Life**

Rosalinda is a Hispanic woman from Puerto Rico, in her 40s, and the mother of two teenage girls. Trained as a physical chemist, she has a doctoral degree from a large Midwestern university in the US. She had previously taught in a community college and a middle school. Currently, she teaches in a Midwestern US STEM school and has been teaching there for 8 years. She mainly teaches the first year (grade 10) science course on science inquiry. Additionally, she also teaches the advanced chemistry course for 11th graders.

Despite having a doctoral degree in chemistry and a teaching position in a specialized STEM school, Rosalinda experienced discriminatory treatment in her acquaintance with people. She described a common experience:

> When people meet me, you know, I say that I teach; 99.9% of the people assume that I teach Spanish, just because of my accent…. And when I finally say that I teach chemistry, they go, “Really?” You know, like, that’s really different. Because people like me don’t go into the sciences. It’s a stereotype. (Rosalinda, interview, September 17, 2009)

This excerpt illuminates episodes in Rosalinda’s experience that made her second-guess how others viewed her as a STEM professional. Her accent, and possibly physical features, had led people to guess that she was a Spanish teacher in the STEM school. The tone they used to express their surprise at hearing what she taught led her to think that they had stereotyped minority women, as it was rare to find a Hispanic woman teaching science, particularly in a specialized STEM school. Rosalina felt the tone in which “Really” was said was used to interrogate her professionalism—a rising tone implied “Are you sure?” and a descending tone meant “Good for you” (Rosalinda, interview, May 21, 2010). In both cases, people denied Rosalinda’s right to equal social status.

Rosalinda noticed that minority students in her school, and especially the minority girls, had difficulty assimilating into the school. Her knowledge of this and experiences such as the one previously mentioned led her to wonder how her school administrators and students thought about her. This incited her to ask the school principal if he had thought that she was less capable but he said, “No, Dr. Rosalinda; no, because you have an education.” Rosalinda thought, “Oh, good. So they think they can make you the same as other people regardless of what you look like or sound like” (Rosalinda, interview, September 17, 2009).

Rosalinda’s experiences resonated with her minority students’ experiences in school. She wondered if school administrators, colleagues, students, and students’ parents thought less of her, as compared to nonminority colleagues. Although her principal had reassured her, she was displeased that her “difference” was not valued as an asset. She argued that she was better traveled and had developed closer relationships with minority students than other teachers in the school (Rosalinda, interview, May 21, 2010). The dyschrony of wanting to be acknowledged as equal, and yet different at the same time, illuminates the tensions Rosalinda felt in being the only minority female science teacher in the school.

In Rosalinda’s view, “everybody is a teacher.” This view contradicted some of her colleagues’ viewpoints, as illustrated at a school meeting. Rosalinda recalled an episode:

> We have a meeting at the beginning of the school year. The whole staff goes. Everybody, you know. The custodians; it’s everybody. So Daniel [the President] talked about us being a community of teachers. And some of my colleagues were really offended because they say, “Well, don’t you get offended if he compared you with a custodian about being a teacher?” So I say that, “In order for a community to teach, and I just … We just happen to have the opportunity to learn more about something. That doesn’t mean we know everything about...
Rosalinda attributed the different viewpoints to differences in culture. In her culture, everyone could be a teacher, as they contribute to the overall development of students. As such, she did not see any power or status differences between the nonteaching staff and teaching faculty in the school system. However, some of her colleagues—about 50% have a doctorate degree in this school—thought otherwise and argued the need for social hierarchy in education, where people served different roles. The symbolic meaning that a doctorate degree afforded to Rosalinda and her colleagues was clearly different. It would seem that this difference was due to not cultural differences alone, but to an interplay of race, gender, and class differences that distinguished Rosalinda from her colleagues.

Rosalinda’s concern for students extended beyond the classroom, but in the context of chemistry teaching, she took a contrasting stand. She would provide personal coaching to minority girls on weekends at the school dormitories. These girls were members of an all-girls club she sponsored to provide safe spaces for minority girls to do things together and talk about their personal problems without fear that they might be judged. The girls would take the lead in organizing events such as Take Back the Night to share personal stories (e.g., stories about family abuse and personal experiences with violence). Rosalinda would share her personal story about being abused and encourage the girls to stand up for themselves.

But, in Rosalinda’s chemistry class, she did not want to be taken for granted as a “baby sitter” (Rosalinda, interview, September 17, 2009). Although she cared for the minority students, she underscored the fact that she did not treat them differently in class. She said:

So I don’t think that I treat my students different because they are from different races. Because I don’t like when people treat me differently because I’m from a different race. So it’s about working hard but if you come to me, I tend to be a little bit more emphatic. I don’t just give them a break because I’m like them. But I might be able to approach the subject in a different way because I’ve been there and I’ve done that. (Rosalinda, interview, May 21, 2009)

The dyschrony in her treatment of students in the formal and informal curriculum space was driven by her belief that one could work hard to gain social mobility even if some students were disadvantaged before they came to the STEM school. She felt that she had succeeded through this means and, thus, the minority girls should be able to achieve likewise if they had worked hard.

Hidden Currents in the STEM Pipeline

The purpose of describing critical incidences in Rosalinda’s life is to map out the dyschronous experiences in her journey to become a full member of a specialized STEM school community. These incidences challenged her beliefs that minority students in general, and minority women in particular, could be regarded as equally capable of attaining high qualifications, participate in the scientific discourse, and teach others. This analysis revealed hidden currents in the STEM pipeline (see footnote 1).

The Social Mobility “Myth”

The meritocratic promise of working hard to gain social acceptance and social mobility is often portrayed as a natural outcome. This belief is found to be deceptively simple, as non-merit factors such as the social and cultural capital one inherits, and negating factors such as sexual and racial discrimination, and unequal access to educational opportunities can result in individuals having different starting points in life; McNamee and Miller (2004, p. 22) had termed this a “meritocracy myth.” Rosalinda ascribed to...
the view of working hard to gain social mobility so that she may not be discriminated against. Although this may be true to some extent, her views seemed contradicting, as she had repetitive encounters with people who questioned what she taught and did not acknowledge her for the embodied capital she had accumulated through years of hard work. This illuminates the possibility that even though working hard may lead to greater social mobility, individuals may continue to experience discriminating treatment that may be discouraging. The notion of working hard to gain social mobility should not override efforts to attend to or mask educators’ sensitivity to minority women’s needs, interests, and predicaments in and outside school. Rather, the pursuit of hard work should be accompanied by the development of civic literacy, including cultural awareness—sensitivity in communication with people of diverse cultures, race, ethnicity, age, and so on—so that individuals do not (appear) to impose their dominant and individualistic views to accredit others.

Possibility for Social Change

How can women’s participation in STEM be improved? Lave and Wenger (1991) argued that with fuller participation in a community, participants could acquire more capital and move to more powerful positions within the community. Using the same idea, minority women could acquire various forms of capital—social, cultural, and symbolic—to establish a foothold in STEM fields. They may confront gatekeepers such as biased beliefs, hegemonic social structures, unfair practices, lack of valued capital—knowledge, social connections, credibility, and so on—that may limit their full participation. These gatekeepers could, nonetheless, generate interstitial communities at the margins for minority women so that they could access the STEM community and acquire the capital such as knowledge, skills, social networks resources, and credibility to construct a shared identity. Rosalinda managed the gatekeepers by creating safe social circles for minority girls to form solidary groups. In bringing those interstitial communities into various formal and informal contexts, she had increased, to some extent, the number and frequency of opportunities for such communities to be formed so that dyschronous experiences are minimized and the trajectory of synchronous experiences for minority girls to participate actively in science learning is formed.

In this article, I use dyschrony as an analytic construct to unpack the social forces disrupting a Hispanic female teacher’s navigation into the STEM community. I suggest that this construct may be used by educators to examine how minority women’s experiences are fraught with dyschronous episodes so that different forms of social forces including race, class, and culture contesting constructed beliefs about oneself may be addressed. Dyschrony, for example, can form the theme in the minority girls and women’s conversation at the gatherings in the all-girls club. The school administrators at the school meetings could have also identified the dyschrony in the dialogue among teachers about “who makes a teacher” and address the issue promptly.

Notes

1. The friction between the pipe wall and fluid flowing through the pipe can cause a local eddy current. Three kinds of fluid flow—laminar (adjacent layers of fluid slide past one another), turbulent (erratic flow in the form of cross currents), and transitional (a mixture of turbulence in the center of the pipeline and laminar flow near the edges)—can occur, depending on the frictional resistance of the pipe wall. I use this analogy to portray the complexity of experiences in the STEM conduit that is not usually apparent to others who are not minority women in the pipeline.

2. The STEM pipeline is metaphorically described as leaky when individuals do not continue to pursue postsecondary or college education and careers in the STEM fields. Findings show that, generally, more women than men exit from the STEM pipeline (NSF, 2007).

3. Etzkowitz et al. (1994) talked about the paradox in trying to attain a critical mass of women in academic departments. Segregation among women
in the forming of groups could lead to isolation, deterring the purpose of helping women form solidarity groups.

References


