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Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science

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Abstract. The underrepresentation of non-White students and girls in STEM fields is an ongoing problem that is well documented. In K-12 science education, girls, and especially non-White girls, often do not identify with science regardless of test scores. In this study, we examine the narrated and embodied identities-in-practice of non-White, middle school girls who articulate future career goals in STEM related fields. For these girls who desire a STEM-related career, we examine how their narrated and embodied identities-in-practice interact and inform one another (or not). Drawing on interview and ethnographic data in both school and after-school science contexts, we examine how STEM-career minded middle school girls articulate and negotiate a path for themselves through their narratives and actions. We present four modes of interactions, each with a representative case study highlighting the kinds of interaction between girls' narrated and embodied identities-in-practice: 1) Partial overlaps, 2) Significant overlaps, 3) Contrasting, and 4) Transformative. The implications of these interactions with regards to both hurdles and support structures that need to equip and empower girls in pursuit of their STEM trajectories are discussed.

Key words: identity, gender, sociocultural, science education

Over the last two decades it has been shown that more girls in the U.S. are taking high-level math and science classes in high school then in previous years (National Center for Education Statistics, 2009a). Recent data also show that girls, in general, are performing equal to or better than their male counterparts on math and science state and national assessments at both the middle and high school level (National Center for Educational Statistics, 2007; nces.ed.gov, 2010). In addition, girls are pursuing post secondary education at rates much higher than their male counterparts. For example, in 2007, women received nearly 60% of all bachelor degrees in the United States (Digest of Educational Statistics, 2009b).

However, a closer look at these changing trends indicates concern. As noted by Buchmann and DiPrete (2006), despite the reversal of the gender gap in educational attainment of women, a significantly higher percentage of boys pursue post secondary STEM degrees and careers in STEM fields. In 2008 and 2009, while women were the majority of bachelor and associate degree recipients, they represented fewer than 30% of the total STEM field degrees awarded (National Center for Education Statistics, 2008- 2009). If we break down the STEM areas, it is clear that the largest gender gaps are in the physical sciences and engineering. The American Institute of Physics (AIP Statistical Research Center, 2012) reports that only one-fifth of bachelors degrees in physics go to women, and only 7% are African American and Hispanic (combined). In 2010, only 18.1% of four-year engineering degrees were awarded to women (Gibbons, 2011). In the same year, while women made up 58% of two-year college enrollment, they received only 15% of the associate degrees in engineering technologies (Milrgam, 2010). The rates of movement into the STEM pipeline are even more limited among girls from nondominant backgrounds (linguistic, ethnic minority and low-income).

In recent years the United States has begun to make students' exposure to STEM experiences and pursuit of STEM careers an educational priority. However, despite one of the three goals of President Obama's "Education to Innovate" campaign being to "expand STEM education and career opportunities for underrepresented groups, including women and girls" (whitehouse.gov, 2012), the statistics presented above *clearly indicate a disconnect between girls' science achievement and their desire to pursue STEM careers*. In K-12 science education, girls, and

especially non-White girls, often do not identify with science regardless of test scores (e.g. Sadker, Sadker & Zittleman, 2009). Part of the reason for this disconnect is that while we have spent decades addressing the academic achievement gap between girls and boys, very little time has been spent addressing the *science identity gap*. We argue that it is in part because of this science identity gap that girls' participation in science beyond secondary schooling is limited.

In this study, we are interested in better understanding the disjuncture in girls' academic performance and pursuing STEM related careers through the lens of identity. All students, including girls, engage in identity work while participating in science, whether such work is intentional or not (Calabrese Barton, Kang, Tan, O'Neill & Brecklin, 2013). In this study, we are interested in the kinds of identity work among *girls who do well in and articulate an interest in future STEM careers* over the course of middle school across school, after school and home. We are interested in making sense of the kinds of experiences that shape the identity work of the STEM minded girls in ways that support or work against future STEM trajectories. Our research questions include:

1. What science identities do middle school girls narrate with respect to who they are and who they want to be in science?
2. What actions do girls take in support of their developing science identities? How are these actions informed by contexts, in particular the people and resources that make up those contexts (school science, after school science, and home)?
3. In what ways do girls' narrations of their science identities relate to the actions they take? What are the interaction mechanisms that exist between the narrated and embodied identities, and what role do contexts play in these mechanisms?

Theoretical Framework

Identity construction: Situated learning, figured worlds & identities-in-practice

Lave and Wenger's (1991) framework of situated learning emphasizes the ineluctable link between learning and identity formation. To learn in a particular community means to become "a different person with respect to the possibilities enabled by these systems of relations" (p. 53). Lave and Wenger use the phrase "identities-in-practice" to emphasize that identities take shape as one engages in the practices of a community, and learns the ways of talking, knowing, doing and being of that community. Identity is not merely a label to describe oneself. It is not something one brings to learning or that is a result of learning. As Lave and Wenger (1991) suggest, learning "implies becoming a full participant, a member, a kind of person. . .Who you are becoming shapes crucially and fundamentally what you 'know.' 'What you know' may be better thought of as doing rather than having something" (p. 53 &157). In other words, authoring identities in practice is the work of learning.

A science classroom can be construed as such a community of practice. Students are continually authoring identities-in-practice and developing certain ways of being in the science classroom, while engaging in activities and tasks in relation to the teacher and their peers. These identities-in-practice are related to who students are, who they can be, and who they want to be, as sanctioned by the norms of the classroom. For example, a science teacher may expect a successful student in her class to be a good collaborator, copy neat notes from teacher lectures, and maintain at least an A- grade. Another science teacher may consider students as successful in science if they are curious, asking questions, and designing experiments, regardless of their letter

grade. Learning science is thus manifested through the transformation of "identity-in-practice" in the science classroom (Carlone, Haun-Frank & Webb, 2011).

In earlier work we have shown that girls do not merely author a singular identity-in-practice but rather author multiple, fluid identities-in-practice in the science classroom (Tan & Calabrese Barton, 2008a, b). We have also pointed out that while the science classroom can be considered as a community of practice, the different ways in which science classroom activities are set up and carried out creates different "figured worlds" within that community of practice (Holland, Lachiotte, Skinner & Cain, 2001). Each of these figured worlds has its own attending norms and rules for participation that may afford distinctly different opportunities for students' participation in science and identity authoring. Figured worlds are socially situated, and "[are] peopled by the figures, characters, and types who carry out its tasks and who also have styles of interacting within, distinguishable perspectives on, and orientations towards it" (p.51). An example that Holland and her colleagues use as an example of a figured world is Alcoholics Anonymous (AA), where members are bound by and subscribe to a specific code of conduct, governed by clearly defined relationships (p. 67).

A science classroom is a compendium of many figured worlds (e.g. whole class teacher-led discussions, small groups with different members, student presentation with peers and teacher as audience). These figured worlds are fluid, have porous boundaries and exist concomitantly with established rules and norms (Price & McNeill, 2013; Seiler, 2013). Thus, each figured world offers girls differing affordances and constraints in terms of resources (human and material) in which they draw upon to author specific identities-in-practice (Tan & Calabrese Barton, 2008a). For example, a small group setting in a science classroom may have established norms such as specific roles and responsibilities for the group leader and note-taker. However, the make-up of different group members and one's relationship with fellow group members create different dynamics that impact how group work can unfold and what identities-in-practice students can subsequently author. While a girl may always be relegated as note-taker with one group of peers, in another group with more supportive peers, she may have opportunities to take on the role of group-leader. This example also illustrates the struggle for agency inherent in carving out one's membership in a particular figured world. On initial entry into a figured world, novices gain social positions that are accorded by the established members of that world. Such "positional identities" (Holland et al, 2001, p. 125) are inextricably entangled with power, status and rank. Alongside positional identities, there is a set of appropriate dispositions. How novices choose to accept, engage, resist or ignore such dispositional cues shape their developing identity-in-practice and determines the boundaries of their authoring space, which is driven by a sense of agency. In the struggle to establish an identity in a new figured world, the other worlds in which one simultaneously inhabits also influence their identity work. The girls in our study are not only science students in school, they are also legitimate members of other out of school figured worlds, and their memberships have bearing on what identities-in-practice they can author in school science. Thus, in moment-to-moment interactions within figured worlds, girls are simultaneously identifying as, and also being identified by other figured world members as particular persons in specific contexts. The relationship between identity work and figured worlds illustrates three important points that we have seen in our work with girls:1) the fluid nature of possible selves (or identities-in-practice one narrates); 2) the influences across figured worlds in which one has concurrent membership; and 3) the dialogic interactions between girls and the power structures of the figured world inherent in contentious local struggles that impact the work of girls' identities-in-practice authoring. For example, we have shown how a Latina 6th grader Amelia's identity-in-

practice as the "fieldtrip girl" in the year-long, informal figured world of Saturday family science field trips steadily positioned her as a student knowledgeable in science, a position she then strategically leveraged to negotiate for new ways of participating in the figured world of formal, whole-class 6th grade science (Tan & Calabrese Barton, 2008a).

In this study, we looked across figured worlds in the science classroom, in the informal science club girls attended, and in (some of the cases) the family and peer settings. Looking across these figured worlds enable us to see how girls' authoring of identities-in-practice is situated in context. It allows us to explore the interactions between the girls and the community members that affected identity construction, and uncover whether identities constructed in specific figured worlds are recruited as resources in other figured worlds. For example, how girls craft an interest in science through participation in their out of- school figured worlds (such as cooking club, recycling club, or Saturday morning family science at the local garden) can impact when and how girls seek to pursue participation in their school classroom. These figured worlds, which exist outside of school science, provide girls with a wide variety of resources and positioning that girls can and do draw upon to author identities-in-practice in science.

History-in-person: Narrated and embodied identities-in-practice

History-in-person. In the previous section we pointed out how the identities-in-practice that girls author occurs in response to context – to the figured worlds in which girls participate and the people and resources available there. At the same time, we further note that while identities-in-practice are authored in the moment, they are also authored against an historical background of both *institutional* and *personal* struggles. For example, Brickhouse and Potter (2001) describe African American girls' struggle in forming a scientific identity in an inequitable playing field where prejudice and stereotyping of their identities in other figured worlds were leveled against them. The girls in their study were not expected to excel in science, and when they did, were treated as anomalies whose success was not acknowledged as enthusiastically by their science teacher. The girls' performance were hampered by the "stereotype threat… [of] being at risk of confirming, as a self-characteristic, a negative stereotype about one's group" (p. 973). Similarly, Carlone (2004) problematized the complexities of "girl-friendly" reform-based Physics curricular when girls' participation were still constrained by both historical and institutional norms that label their success as lesser than boys, as well as by the girls' own struggles about what kind of science learners they are.

Holland and Lave would refer to this collision between historical, institutional struggles and historical, personal struggles as the "history-in-person" that one carries across with them over time and place. They argue that one is never completely "free" in authoring their identities-in-practice. Rather, such acts of authoring are always enacted within the limitations and subjectivities of times, spaces and relationships (Carlone et al, 2011) – the norms and regulations of figured worlds grounded in power dynamics that have been constructed and reinforced over time. We find the idea of history-in-person helpful because it allows us to explicitly incorporate equity concerns – to help us to make sense of how girls from non-White backgrounds author identities-in-practices in response to the power dynamics that shape their experiences. It also helps us to understand the worlds themselves where girls' identity work takes place. Margaret Eisenhart and Elizabeth Finkel, drawing upon practice theories and figured worlds in her research on women and science, unpacks the ways in which the identities of woman scientists are authored locally in time and space. She argues that the identity work of women in science is grounded both in the positions individuals take up (or are assigned) as well as in the tools, relationships and

practices available within any given figured world. For example, women who worked as scientists in a small conservation corporation were as equally valued and respected as the men scientists, however, this professional validation came at the cost of low pay and less academic power as compared to higher status sites of science.

Just as in the professional work experience of women scientists, the relationship between identity development and figured worlds is also central to unpacking the patterns of interest, participation and the practices girls engage in science among school-aged girls. Girls can, and do, expand their school science identities-in-practice as they engage in practices that afford them with more agency for participation. A normally quiet, non-participatory girl in science class may have an unexpected positive learning experience in an after-school science club which then leads to her acquiring a different identity in the science class, i.e. a more interested participant. Non-White students may also reject certain discourses and practices in the science classroom to signal their affiliation with a particular group (Brown, Reveles & Kelly, 2005), highlighting the negotiations non-White students have to contend with between their ethnic and academic identities (Nasir & Saxe, 2003).

Narrated and embodied identities-in-practice. Authoring identities-in-practice involves both narrative and performative work. The identities-in-practice that individuals author are made up of narratives one tells about who one is and might be and the embodied performances or actions one takes, and which exemplify who one is and might be (Goffman, 1959). We think that this distinction between narrating or "telling who one is" (Sfard and Prusak, 2005, p. 14) and performing or embodying identities-in-practice is important because it allows us to more precisely make sense of the identity work that girls do over the course of middle school.

In telling stories, or "telling identities" as Sfard and Prusak (2005) describe it, one authors specific identities by deciding what events and experiences to include or omit in describing who one is in response to a specific moment in time, reflects on one's past actions and also possible future trajectories. In considering history-in-person, however, we argue that narrated identities are not so much "telling who one is" as it is "telling who one is within the constraints of specific contexts." Rather than stories equating to identities, we equate stories told to "how one views oneself in context." This perspective brings to the forefront that girls' stories about themselves and who they are, are always grounded in space and time. In narrating their identities-in-practice, girls are always narrating against the backdrop of contentious local struggles embedded within history-in-person. As such, within one's narrated identities-in-practice, one's "actual identity" and one's "designated identity" are neither static or final, but open-ended and evolving, as well as bounded within the constraints of local struggles. When considering narrated identities-in-practice, we include the girls' accounts of who they are in science, who they can be in the future in science, and (for some girls) the pathways they describe to get there. Who girls are in moments in time and want to be are contingent on both girls' own agentic identity authoring acts, expectations of others with more power (such as parents, teachers and peers), and the recognition of their identities-in-practice by members of the figured worlds. How girls perceive "what is possible" is also tied to available resources and recognized capabilities in the moment.

In narrating who they want to be in science, girls are constructing possible selves (Markus & Nurius, 1986) in science, the selves one believes one might become in the future. Oyserman, Bybe & Terry (2006) have shown that when possible selves are linked to specific strategies and shown to be compatible with one's salient social identity, low-income and non-White youth are more successful with moving forward towards academic goals linked to a successful possible self. These findings are echoed in other studies that show how the design of the learning environment,

including how expertise in science is defined and enabled is tied to identity work (Rahm, Martel-Reny & Moore, 2010).

If narrated identities-in-practice is *telling* how one views oneself in specific contexts, embodied identities-in-practice is *performing* who one is in specific contexts through one's actions and interactions with discourse, tools and resources within social contexts. This includes how girls are creating experiences in science, as they choose to participate across the figured worlds of school science, informal science club, and in their home life, within the affordances and constraints of each figured world. We contend that configuring girls' identities-in-practices necessitates attending to both narrated and performed self(s), although little is known about how narrated identities interact or are related to embodied identities. In her work with young African American students, Justine Kane (2011) found that the young students' performed (what we term "embodied") identities were consistent with their narrated identities. For example, one of the students, Joe, acted in science class in exactly the same way as he described himself in interviews – by listening and learning, and asking questions in demonstration of his "good scientist identity" (p. 26). With our case study girls who narrate a possible future identity as a STEM-related professional, we are keen to explore the relationships between the girls' narrated identities-in-practice and their embodied identities-in-practice, across figured worlds.

We believe a close examination of girls' narrated and embodied identities-in-practice (including the ways in which they inform each other) will enable us to better understand how STEM-minded girls from non-White backgrounds take up identities-in-practice that support or inhibit progress towards this goal. Figure 1 shows how we conceptualize the interactions between girls' narrated and embodied identities-in-practice in science, in relation to their narrated career goals in STEM-related fields. In their narrated identities, girls reveal their identities as informed by their grades in science, who they are in science, and who they want to be in the future in science. Their embodied identities in both formal and informal science figured worlds reveal the experiences and practices they are engaging in science and the reception of their actions by community members. While it is heartening when non-White middle school girls narrate future STEM-related identities, we want to explore how these narrated identities-in-practice interact with their embodied identities-in-practice in two science figured worlds (formal and informal). Specifically, we want to explore what these interactions are and what they can mean for middle school girls as they consider and negotiate a possible STEM-related trajectory with a STEM-related career goal.

Insert Figure 1 here.

Methodology

We employed a critical ethnographic case study approach (Anderson, 1989) to account for what it means for non-White, middle school girls to pursue a STEM related career, paying particular attention to the power dynamics involved in their identity work. This is a part of a larger project that has studied middle school girls' science learning at four different research sites from January 2009 to March 2012. (These research sites are two small Midwestern cities, one large east coast city, and from a Pacific Ocean city.) In the larger project, we have followed 36 girls into formal science classes, informal science spaces (e.g., science club family science nights), and other informal spaces (e.g., home, community, cafeteria), to document how they have participated and perceived themselves in science, and were recognized by others across time and spaces. In this study, we focus only on the 16 girls *who articulated a desire for a future STEM*

related career to study how non-White, middle school girls articulate and negotiate between their narrated and embodied identities-in-practice in considering a STEM trajectory.

Research Context: Schools and Afterschool Science Club

The four schools across four research sites located at urban areas had large populations of students from underrepresented racial, ethnic or linguistic backgrounds, and lower income households. The instructional approaches of the observed science lessons that the case study girls attended were fairly typical showing some mixture of lecture, hands-on activities, and filling out worksheets. Despite significant variance in kinds of activities observed in science classrooms, in general, a science teacher held epistemic authority in the classroom communities in that forms of knowledge and outcomes of learning were determined and presented by the teacher. The students were expected to complete their work either individually or as a small group to get the full credits following directions.

All the case study girls participated in afterschool science clubs in the 6th grade, although not all of the girls remained in after school science clubs (an initial requirement for participation in the study). Two science clubs at two research sites were organized by cooperating science teachers, and took place during lunch period (science lunch club). Generally club activities were co-selected by both the cooperating teacher and case study girls within the constraints of time and material resources. Some examples of activities included planting seed, the explosion of mentos in diet coke, that can be characterized as one-time, stand-alone activities. At the two other sites, the science clubs of the other two research sites took place after school, either as part of after school activities at the school or in a local community center. The activities were co-selected drawing on local resources within a theme, such as "making a difference using green energy technologies." The case study girls of these clubs participated in a thread of investigations appropriating various roles while positioning themselves as community science experts.

Data Collection and Participant Selection

Most of the data were collected during the 2010-11 and 2011-12 school years, although we continued to follow some of the girls into the 2012-2013 school year, as contexts allowed. For each case study we conducted *per year*: a) interviews (2 hours/girl), b) 56-90 hours of observation per girl across the three sites (school, club and home), c) science artifacts from across the three sites, and d) yearly digital "science and me" stories (see the detail of data generation method in Table 1). We also conducted interviews with the teachers who worked with the girls in school and/or afterschool clubs, and with the parents who we could approach during the data collection either formally or informally. To understand how non-White girls narrate and negotiate their STEM related career trajectories, the sixteen girls who expressed their interest in pursuing STEM related careers were selected (see Table 1). These were non-White girls who talked about considering a STEM related career during interviews at some points of their middle school years.

Insert table 1 here

Data Analysis

Data were analyzed iteratively and collectively over six months by the researchers who, themselves, had different cultural, ethnic, and linguistic backgrounds. We believe the diversity of our research team is essential in helping us to tease out our own subjectivities in data interpretation with respect to how culture and context mattered for the girls in our study. For the analysis of narrated identities in practices, girls' stories in the interview transcripts and yearly digital stories were used as the primary data sources. We identified segments of data that included each of case study girls' stories about herself and science. Those stories were coded with respect to: a) each girl's perception on current self (how I think of myself in and with science) and b)

future possible selves in science (what kind of job I would like to have when I grow up and why, whether I am interested in participating in science-related activities in the future). This analysis allowed us to configure a girl's narrated identities-in-practice—through stories of who she is, who she wants to be, and how a girl views herself in specific contexts. Next, each girl's embodied identities-in-practice was analyzed by examining how a girl perform who she was, in and with science across figured worlds. Field notes generated from the observation, interview transcripts with girls, teachers, and other important members, various artifacts including student work, videos, photos, worksheet, and transcripts, and girls' digital stories were used as the source of data. Specifically, we first identified 3-5 focal events where girls' salient identity work took place both at school science and afterschool at each grade. Initial analytical portraits were constructed with respect to each focal event. The portraits were discussed and iteratively revised at the research group meeting. Guided by the conceptual framework, the portraits were coded with respect to: a) how a girl *positioned* (or was positioned) upon participating in activities in each of figured worlds, b) what *roles* a girl played in their participation and the ways in which they assumed the roles, c) *leveraged resources* for participation and showing themselves, d) how a girl's participation was *received and responded* to by other important members, and e) how a girl and her participation were *recognized* (or not). Data was coded across the case study girls after individual case analysis. As each case study girl's narrated and embodied identities-in-practice were configured, we analyzed the relationship between narrated and embodied identities-in-practice and its interaction mechanisms. We examined case study girls' narrated and embodied identities-in-practice over time and space focusing on: a) the nature of the interactions, b) any changes or shifts in either form of identities-in-practice. The analysis led by the first author was shared over six months at weekly group meetings, and discussed and debated until consensus was reached. The recognized identities-in-practice, relationship and feedback mechanisms between both identities were triangulated by analyzing multiple sources of data.

Findings

We identified four different interaction mechanisms between girls' embodied and narrated identities-in-practice which help to explain their middle school STEM trajectories. The four different interaction mechanisms include: 1) Significant overlaps; 2) Partial overlaps with no significant interaction; 3) Contrast and 4) Transformative interactions. Table 2 shows the distribution of interaction mechanisms across 16 cases and sites. In this section, we present one case per each interaction to illustrate the kinds of negotiations and insights pertaining to the interaction. The four cases were selected because they are representative and robustly illustrative of the different types of interactions. By focusing on one case per interaction type, we intend to provide the rich pictures of the nuances of the interactions with particular attention to context. We also deliberately chose two of the cases (2 & 3) from the same classroom in order to delve more deeply into the key role of the science teacher in the girls' identity work. Each case begins with an overview of the interaction type, followed by an introduction of the case study girl. Then their narrated identities-in-practice (RQ1) and embodied identities-in-practice (RQ2) are presented. Each case ends with analysis on the case's interaction type. We then take up RQ3 more thoroughly in the discussion section.

Insert Table 2 here

Interaction type 1: Significant overlaps between girls' narrated and embodied identities-in-practice

Overview. In this section we look at interaction type 1: significant overlaps between narrated and embodied identities-in-practice. As we illustrate with the case of Meg below, this interaction pattern suggests that there is great symmetry between who the girls say they are and want to be in science and how they practice who they are and want to be in science. For the girls who fall into this category, we note the following characteristics:

- First, in terms of perceptions and recognition, the girls in this category *view themselves* as good in science, both in and out of school, and are *recognized* by their teachers and peers as good in science.
- Second, in terms of priorities and performances, all of these girls place a strong emphasis on getting good grades (e.g., getting good grades matters more than actually understanding the material). They play the role of the "good girl science student" in the classroom and in the informal science space as well. In terms of traditional measures such as grades and completion of tasks and assignments, they perform well in both places. These girls typically do not step outside of the designed task to challenge or bring something new/different to it.
- Third, in terms of movement of resources and practices across spaces, the girls in this category tend to keep school science and informal science as discrete activities, not bringing one to bear on the other in obvious ways.
- Lastly, the interactions between narrated and embodied identities-in-practice are primarily *sustaining*. That is, the interactions between these identities-in-practice help the girls to maintain interest in science over the course of middle school. Indeed, each of the girls in this category enters and leaves middle school with a strong interest in science. However, (in our view), these overlaps are not always productive in what we hope for the girls – that is, these girls are somewhat passive receivers of science and more focused on getting work done and getting the grade, rather than deeper engagement in science.

Introducing Meg –who aspires to be a veterinarian. Meg is a slight Asian girl who lives with a single mother and one younger sister. Meg and her sister were adopted when they were young, and her mother is a special education teacher in a nearby elementary school. Meg is neither vocal nor outwardly confident, but she likes directions to be clear and always makes sure to get things done. Meg's science teacher, Mrs. D knew Meg's mother well through several conversations over both face-to-face conversations and phone calls. Mrs. D told us that Meg's mother is "very supportive." Her mother could afford to give her a National Geographic science kit when Meg was little and she had experiences of playing with a telescope. Meg likes dancing, and spends her time after school practicing dancing. Meg's younger sister plays violin. During the 7th grade science family night, there was an "egg drop challenge" where students design protective coverings for a raw egg that has to be dropped from a certain height. Meg, together with her mother and sister, came with designs that she and her mother had researched about online that they thought would work well, although she did not end up winning the contest. When we asked Meg what prompted her to research designs on-line she indicated that the designs would be more likely be successful than if she just came up with one herself. She also said that she did not test her design because she figured it would work just as described on the website.

When we first met Meg in the 7th grade, Meg seemed to be more interested in hanging around with Linda, her only close friend, than doing science at the science lunch club. Meg joined the science lunch club because her mother told her "it would be good to have more science afterschool." While Meg liked science, mathematics was her favorite subject because the answer is always clear. Meg was the only 7th grade girl in the school who went to the district mathematics competition as one of school representatives. Getting good grades in both mathematics and

science was important to Meg because she wanted to be a veterinarian and those are the subjects required to pursue a veterinarian career. Meg stopped coming to science club in the 8th grade as she grew apart from Linda. Across 7th and 8th grade, Meg consistently narrated a future career identity as a veterinarian.

Meg's Narrated Identities-in-practice. Meg's science identities-in-practice merged science and school science. For Meg, doing well in science is all about test scores and grades. It is not so much related to the work one does in science or what one understands. Meg elaborated that science is important to her because she needs good grades in science for her future job as a veterinarian. She also noted that, according to a job description for veterinarian that she saw in her 6th grade, she also needed to have advanced math. In her digital science story of "science and me" Meg stated, "Science means a lot to me. Since I want to be a veterinarian, I need to know a lot about science." Meg mostly talked about her school science experiences, rarely mentioning any science-related experiences outside school. Meg thought that science class gives her a good look into what "real" science is. She got good test scores, especially when the tests are multiple-choice questions. Meg stated that she preferred multiple-choice questions over open-ended ones because she received better grades on these kinds of exams. Meg narrated, "science is interesting if that catches my attention." But at the same time, science is "hard sometimes if we have to do test [for] the lesson that I don't understand." Science is boring sometimes "if we just read a lot of books, packets, and we don't do anything." Even though Meg consistently achieved an A+ grade in science throughout the marking periods for 7th grade, she did not rate herself 7 out of 7 for science. Instead, she talked about other classmates, including Rachel, who "gets lots of As and Bs" in science.

Meg's Embodied Identities-in-practice. In our observations of Meg in the science classroom, she consistently embodied her narrated identities-in-practice. They were the same to her – being on task, doing the work well to make sure she got the best grade, which were also norms of her 7th and 8th grades science classes. In every lesson we observed, we saw her working on worksheets properly and quickly, so that she could either spend the rest of the time doing extra credit work, or work on some other assignment from another class, which Mrs. D allowed for. Meg did not engage in idle chatter with her friends, she was always working on something. Interestingly, even though she was an A+ science student, Meg did not always show understanding of the lesson material. One episode that stood out was a lesson on invasive species. Mrs. D had the students research local invasive species and explore how they tilt the balance of local ecosystems. The students had to write their explanations down on a worksheet. Meg was one of the first to finish after which she quickly turned her attention to extra-credit work (which usually consist of more worksheets). She correctly organized all of the material, and received a grade of 100 percent. However, immediately after the assignment when we asked her what she learned, she shrugged her shoulders and said "I don't know. Invasive species?" When pressed for more information Meg was unable to elaborate on the different invasive species of the nearby Great Lake covered in the assignment or why it mattered. This stood in contrast to some of the other girls we interviewed after this assignment (e.g., Diana, Interaction Mechanism 3).

Meg's concern for the right answers and getting the best grades was clearly displayed in another class episode. The class was learning about weather precipitation and Mrs. D had them analyze some data on a worksheet and they had to calculate the snowfall during specific months of the year. Meg, who had the identity of someone very good in Math, did her calculations very quickly. She was very confident and even helped one other classmate re-do her calculations after she concluded that her classmate was wrong after checking their answers. Without any questions,

Meg's classmate changed her answers according to Meg's suggestion. Meg then turned both their worksheets in, far in advance of the rest of the class. On her way back to her seat, Meg decided to check her answers with a "smart boy" whom she had ranked, during an interview, as someone who would score 7/7 for performance in science. When she realized that her answers were not the same as the boy's, Meg quickly retrieved both hers and her friend's worksheets from Mrs. D's desk and recalculated the measurements. She realized that she had made an error and that the boy's answers were correct. Meg ensured that her friend also corrected the answers before returning both worksheets to Mrs. D's table, and turning her attention to extra credit work.

In the science lunch club that was run by her science teacher, Meg always sat next to Linda, and participated in conversation and activities following the instructions. The club activities were often decided by the girls based on their interests, such as testing the effect of water vs. soda on flowers. Meg did not suggest any activities that she would be interested to do in the club although she always did what she was supposed to do.

Interactions between Meg's narrated and embodied identities-in-practice. From our observations, Meg's narrated and embodied identities-in-practice aligned quite well (see Figure 3). Meg is very test score oriented, and seems to see science as a means to an end – her career goal as a veterinarian. She professes to like animals (included a clip of her feeding turtles in her digital story), but does not seem to genuinely participate or enjoy science in class or in the science lunch club. For example, compared to her participation in Math class where she was clearly more animated, raising her hands constantly to ask the teacher questions and volunteering answers, Meg was quiet and more "business like" in science. We conjecture that because she did not get graded for the science lunch club, she was not motivated to do well in it by actively participating. In 7th grade science class, she did not ask the teacher any content questions (versus in math class), only procedural questions related to testing. Even though she said science could be boring or interesting depending on what they were doing, she consistently displayed a neutral, get-all-my-work-done-and-get-the-grade stance throughout the year. When it came to doing something in science such as hands-on experiments, Meg was driven by writing down the correct answers rather than by carefully carrying out the experiment and asking genuine questions. It seems that the context of science does not really matter to Meg, she simply wants to achieve the best grade possible and whether she learns something of interest to her or not is of secondary importance. Figure S1 provides a visual representation of interaction pattern 1.

Interaction type 2: Partial overlaps between narrated and embodied identities-in-practice.

Overview. In this section we look at interaction type 2: partial overlaps between narrated and embodied identities-in-practice. As we illustrate with the case of Jana below, this interaction pattern suggests that there are critical gaps between who the girls say they are and want to be in science and how they practice who they are and want to be in science. For the girls who fall into this category, we note the following characteristics:

- First, in terms of perceptions and recognition, the girls in this category *view themselves* as good in science, both in and out of school, and are *recognized* by their teachers and peers as good in science.
- Second, in terms of priorities and performances, the girls in this category prioritize getting good grades but not at the expense of learning and understanding the content. These girls will seek out help and ask questions if they do not understand, even if that slows down their efforts or positions them as not knowing. They tend to be fairly quiet in school and often but not always play the role of the "good girl science student" in school science. However, they play

much stronger leading roles in informal science and will sometimes bring ideas that may challenge or change the out of school task so that it is more interesting, relevant, etc. suggesting a desire to engage meaningfully in science

- Third, in terms of movement of resources and practices across spaces, all of the girls in this category actively bring in out of school science knowledge and experience to the science classroom, even though it is not always recognized by the teacher. This seems to be a major mechanism for some of the girls in this category to work on closing the gaps between narrated and embodied identities-in-practice.
- Lastly, the interactions between narrated and embodied identities are primarily *sustaining*, as was also the case in the first interaction pattern, helping the girls to maintain interest in science over the course of middle school. However, we also noted that the girls in this category developed deeper interest in exploring new areas of science than the girls in the first category. We noted that the gaps between the narrated and embodied identities-in-practice appear to more productively support the girls in being more active in their science learning (unlike interaction pattern #1). That is, the gaps between narrated and embodied identities reflect differences in how the girls experience and enact science in the focal figured worlds (school – girls being good girls, and out of school—girls being active scientists and science experts). The kinds of cross over sometimes seen between informal and formal science almost always further help to position the girls as smart and capable.

Introducing Jana – who aspires to be a singer and an environmental engineer. Jana is a vivacious African American girl who is tiny in stature but exuberant in personality. Highly enthusiastic, Jana is a model student in school, one whom her science teacher described as a student to "clone" and a student who "has it all." Although her parents are divorced, Jana and her sister spend an equal amount of time with both parents.

When we first met Jana in the 5th grade, she was excited about science, and she remained excited about science through middle school. In particular, she was interested in learning more about different technologies, such as electric cars, for helping to make the environment better, and to create jobs in her community. According to Jana, science and jobs went hand in hand because through science new ideas can be used to build new things. She refers to herself as hardworking, and "an educated person who cares." However, when asked about science in school, Jana referred to it as a class she needed to meet her future career goals, which were to be an engineer "maybe for a car company," an environmental lawyer, a doctor, or a singer. She had to do well – "get all As" – if she was going to get a scholarship for college and be ready for the science classes there.

For a young person, Jana is confident, serious, and wise for her age. Her father is an elementary school teacher, which might help to explain the importance she places on school. Her mother is a secretary in the city's transportation department. Jana is also matter-of-fact and shows depth of thought and conviction in her opinions. For example, when talking about reducing one's carbon footprint as related to family size in Green Club (a community-based science club), Jana opined that people should "think seriously before they have children, especially if you['re] not gonna spend time with them."

Jana's narrated identities-in-practice. Jana narrates an identity in science that sometimes, but not always, distinguishes between "science" and "school science." She has a vast interest in science, describes it as part of her future, and has told us that what she learns in class is essential to meeting her goals. The overlap appears to have more to do with the content of what she is learning in science, whereas the non-overlap has more to do with purpose or outcome. For example, Jana often told us or wrote about the overlaps between what she learned outside of

school and school science in ways that were oftentimes synergistic for her science future. In a reflection she wrote in the 8th grade on science learning, she wrote that "[after school science club] helped me with measuring and finding area, which I did not know how to do before [I joined the club]. In science, it helped me with understanding the atmosphere and the importance of carbon dioxide. This year in school, we are talking about the hydrosphere, the geosphere, and the atmosphere, and I feel like I already have a handle on that because of [after school club]." Jana rated herself a 6 out of 7 for science, noting that she did not always do well on the tests, even though she completed all of her work.

Jana's Embodied identities-in-practice. Jana embodies the traditional good girl student identities-in-practice in her school science classroom. She enacts and is recognized as a very good science student, a hard worker, and a smart student. Jana's science teacher, Mrs. C, is thrilled with her. Mrs. C told us, "If I could clone her, I would." In our observations, Jana was consistently one of the target students Mrs. C called on for answers and with whom she had extended discussions with, in a whole class context. For example, in a class where the students were learning about infectious diseases like leprosy, Jana participated in the following ways: She shared a story about being out with her dad and meeting a man with a condition that looked like leprosy; when asked by Mrs. C about what stood out to her in the article they were reading about the disease, Jana talked about how interesting it is that the armadillo is a vector for the disease, and the fact that the article was talking about leprosy "in the 1600s, not today. That was a long time ago." Later, Jana discussed with Mrs. C why she thought people with infectious diseases should not be excluded from society:

Mrs C to class: What do you think about people being quarantined?

Jana:I don't think people should be quarantined because we are all humans. Plus the evidence in the book said most people don't get it from others.

Mrs. C: Ok, would you be ok sitting next to someone with an infectious disease?

Jana: Yeah, the book said 90% of people are immune to it. It is not fair to remove all the people.

Mrs. C: What about chicken pox? If you had an infectious disease that could be cured, should you be quarantined until you are cured and no longer contagious?

Jana: I think yes and no. Yes because it is a short period of time. I said no because just because you are sick you shouldn't have to stay away from people.

Although she is sociable and has many friends in school, Jana often chooses to do independent work in the classroom. She is meticulous and always on-task, often working quietly by herself until the teacher calls the class together again.

At Green Club however, Jana seems to be bolder in asking for different forms of participation, and always chooses to work in a group with friends. For example, Jana's after school club hosted a community forum on alternative energy, which was attended by several experts on renewable energy and green jobs. The purpose of this forum was for youth in the after school club to learn more about what was going on in their own community related to green energy. Before the session youth were asked to construct questions for the experts, so that the questions could be sent to the experts in advance, helping them plan on what to say to the youth. When the day of the forum arrived, Jana decided she had more unanswered questions. She picked up a note pad and immediately began to construct her own question. She raised her hand and interjected her question to the experts in the following exchange:

Jana: Why do you think green energy is so important to the earth and the economy?

Kyle (Wind expert): Which question number is that [in reference to the list of prepared questions]?

Teacher: Jana just added that.

As Kyle and the other experts began to answer her question, Jana interjected again, and the following exchange took place:

Jana On the news they're talking about the car industry (inaudible) bankruptcy and people from Michigan are trying to go to Washington (inaudible) bail them out. Do you think that since the GM and Chrysler ... do you think because of the machines they put in to take away people's jobs and they cost money, do you think that's part of the reason why they're going into bankruptcy and that's why people don't have a lot of jobs?

Leroy (Energy Expert) Well, that might be part of it. I also think that cars (inaudible) cars that are selling right now are like electric hybrids

Dennis Fuel efficient cars

Leroy How do we do it? Exactly what you guys are doing. Making PSAs. Doing what you're doing. Especially students, like you guys. People don't necessarily have the time to make those calls. You know what you want? Get the phone number and call. And keep doing those PSAs.

Leroy So think out of the box.

Jana I was gonna ask you, do you think after like, well, after, do you think, do you think that the people like at GM and stuff, do you think that like if they do get this bailout, do you think they're gonna start paying more attention to the economy and build more fuel efficient cars or do you think they're just gonna take the money?

Then later, after the session, Jana sought out Leroy to learn more about the auto bailout and how it was impacting the auto industry and their ability to invent newer, greener cars. And, at the next after school club session, Jana arrived with a letter she had composed to Leroy and that she had asked the teachers to mail for her. A portion of letter read as follows: "I am interested in the car industry. I am worried that if the car companies fail, alot of people will lose their jobs. But on the other hand, if we do give them the bailout will they build fuel efficient cars or will they stay the same and not improve on the fuel efficiency of the car. I have question to ask you: Do you think that we should give GM, Ford, Chrysler the bailout? Why or why not?"

This is not an isolated incident for Jana. She was instrumental, for example, in persuading two peers to conduct a light bulb audit of her school to determine if switching from incandescent to compact fluorescent bulbs would save the school enough money to keep their after school programs running. She and two other girls created a short video about their audit, arranged to share their video with the student congress at their school (with the help of the school principal), and got every member of the student congress to sign a pledge that they would get their school's bulbs changed. She suggests that these investigations, and resulting science movies, provide others with the evidence they need to persuade them to make a change. As she told us: "What you have to do is to convince people. First of all, you have to have a plan and you have to stick to it and be determined. After you have that figured out, you get the proof, then make a video and then back it up with information, and then show it to the highest people in charge."

At Green Club, Jana's embodied identities-in-practice include leader, community science expert, creative Green Club member, and very smart girl. In addition to engaging in practices that author these identities-in-practice, Jana is also recognized by others at Green Club (and the Boys and Girls Club) as a youth who embodies these identities.

Interactions between Jana's narrated and embodied identities-in-practice. While Jana is rather assertive in after school, taking up a position as a science expert who can converse on a level field with scientists in her community, she is rather quiet at school, carefully taking notes, and offering ideas in class that contribute to (rather than challenge) the teacher. This suggests to us that after school has provided a space for her to enact an identity that is more commensurate with her narrative descriptions of herself. While she made this connection between doing well in school and learning science content as a part of who she desired to be, she did not always connect her big ideas for using science to make a difference in the world with what she learned in school. In fact, Jana noted that one big difference between school and after school was the opportunity to do "science that matters," "science that is real" and "research" that she can share with others. This is different from school where her work focuses on "just learning." She also felt that her after school club made science more real because she met "people in different careers, and really just see all the different ways the environment and engineering are involved. The Surplus and Recycling Center, the hydroelectric power plant in Ludington, the solar panels and wind turbines. I got to see how all of this green energy stuff is happening right here." These real connections between science and her life in her local community gave science an authenticity that had deep salience for her. Figure S2 provides a visual representation of interaction pattern 2.

Interaction type 3: Conflicts between narrated and embodied identities

Overview. In this section we look at interaction type 3: conflicts between narrated and embodied identities-in-practice. As we illustrate with the case of Eunice below, this interaction pattern suggests that there are significant differences between who the girls say they are and want to be in science and how they practice who they are and want to be in science. For the girls who fall into this category, we note the following characteristics:

- First, in terms of perceptions and recognition, the girls in this category *view themselves* as good in science out of school but are mixed about their in school performances. They are rarely recognized for what they know and can do in science in school settings, even when their performances suggest such recognition is warranted.
- Second, in terms of priorities and performances, all of the girls in this category are fundamentally interested in how the world works, enjoy science for how it allows them to use their curiosity and to figure things out. These girls prefer to spend time and value figuring things out more than getting a good grade.
- Third, in terms of movement of resources and practices across spaces, the girls in this category contributes significantly to after school and school science when they find a personally relevant connection, although these contributions are often missed by the teacher or not used to position the girls as experts.
- Lastly, the gaps between narrated and embodied identities are fairly broad, and neither the teachers nor the girls appear to have the tools to close the gap. A particular challenge here is that these girls tend to eschew being a good girl (doing the work as required for the good grade) in favor of figuring things out. While the girls' embodied identities-in-practice support meaningful engagement in science, the structure and/or expectation of the classroom environments prevents these more authentic actions from positioning the girls as knowledgeable/experts, severely limiting opportunities for recognition work.

Introducing Eunice –who aspires to be a veterinarian, Olympic swimmer or actress. Eunice is a skinny girl from a very low SES family, who self identifies as "mixed race." She lives with her mother, one brother, and two sisters in what she refers to as an old house. Eunice often

looked tired to us, especially in the morning class periods. We noticed that she often sought out the free yogurts and fruit provided by Mrs. D at the science lunch club. Mrs. D brought these snacks in because she worried the girls did not eat enough, as several eschewed the school lunch. Mrs. D was particularly worried about Eunice. She frequently pointed out to us how tired Eunice looked, and wondered to us about the kind of support that Eunice received at home. Mrs. D also took up a collection during the 2010-2011 school year among the 6th grade teachers in order to get Eunice a gift card for a popular clothing store. When we asked why she did this, Mrs. D told us that she noticed that Eunice wore the same clothes day in and day out, and worried about both the social and personal health implications of doing so. We, too, noticed that Eunice wore the same threadbare winter coat all through the long winter season, and then even on warm days in April.

While talking about herself in science in our interview with her in the 7th grade, Eunice said that science makes her "hungry" because some activities of her science class used food, such as candy pretzel chips and M&Ms. Eunice's mother, who was pursuing a degree at a local college, valued education and wanted her four children to do well in school. Eunice said, "[My mom] hates it when we get in trouble [at school]. My brother and sister are grounded right now for getting Ds." Eunice wanted to follow in her mother's footsteps, aspiring to attend her mother's alma mater, a local small college serving nontraditional students. Eunice joined Mrs. D's science lunch club in her 7th grade year, and continued to come in her 8th grade year. She could not attend family science nights because she did not have any adult family member who could come with her. Eunice still managed to achieve all A+ grades in science. In her 7th grade year, Eunice said that she wanted to be an Olympic swimmer, actress, and veterinarian all together because she was interested in all of them. In her 8th grade, Eunice said that she wanted to be an actress.

Eunice's narrated identities-in-practice. Eunice recognizes that her mother wants her to do well in school, and she has been making an effort. She had a clear goal of going to college just like her mother. Eunice opened the conversation with us at the interview while expressing her strong wish to get an A in science. She said, "I am getting a B in science. I'm trying to get to an A, so I'll have five As and one B." Eunice ranked herself 6 out of 7 in terms of how good she is at science because she did not have an A at that point. Eunice picked two other female peers as ones who would be ranked as 7 because "[they] are very smart, and they'd rather do work than watch a movie." Eunice was also a committed group member. She explained in an interview how she was upset when her alarm failed to work and she ended up missing school as she was working on a project with her small group.

Eunice narrates a strong science identity-in-practice as a curious inquirer and careful observer who is impressed by nature. She wrote in her science notebook, "Science to me is universal. It can be about all different kinds of stuff… Rockets, astronauts, scientists more all related to science. As a matter of fact without science there would be no solved mysteries in life. I enjoy experiment in science." In her digital stories in the both 7th and 8th grade years, she is playing a role of a reporter who documents things happening in detail, with her awe of nature. She filmed various kinds of outdoor scenes (including a swan on the lake, her brother's fishing, movement of clouds in the sky, a squirrel and a spider, a burnt house in her neighborhood) while narrating the detailed observation about each phenomenon on the scene for the audience. For example, Eunice filmed clouds observed through the window of her old house in three clips of movie, narrating the changes of its shape, size, and movement: "There we have a bigger cloud, Huge! Look at that funnel! This cloud is big. This is all one cloud, ladies and gentleman!.... No certain changes occur. Just moving and spinning, apparently. You gotta look at it closely, though. As a matter of fact I am zooming in."

Despite her stories describing the "amazing" and "mysterious" nature of science and her exciting experiences outdoors, Eunice also narrated science as "both fun and boring" mostly in relation to her experiences at school. On the one hand Eunice is "always happy whenever [she is] having experiments." On the other hand science is "hard" and makes her "angry" if she "has to read this huge packet and remember what you read."

Eunice's embodied identities-in-practice. We observed Eunice in both her formal science class and informal lunch science club over two years. We also observed her periodically in the lunch room with her peers. Eunice continuously made an effort to be —in the practices she engages in— a student who is good at science and who makes important contributions both in science class and lunch science club. However, in spite of her actions, Eunice was not recognized as a smart science student by her teachers or her peers in both figured worlds. Thus, even as Eunice tried to embody positive science identities-in-practice such as those of a hard-working and inquisitive science student, these embodied identities-in-practice were not validated by other members in her science classroom figured world. As a result, Eunice repeatedly tried to approach the adult authoritative figures, such as teachers or researchers, to let them know the good work she has done/is doing. For example, in one lesson on rainfall, students predicted the number of water drops cotton balls could absorb until the cotton balls began to "drizzle", before the actual measurement. When we came to Eunice, she proudly said that her prediction was closer to the result of actual measurement than her partner's without any prompt from us. In another lesson, students worked in the computer lab to write a paper on the question "How does the sun provide energy to the earth?" After Mrs. D's instructions, students began to work. After a couple of minutes, Eunice called Mrs. D to show her a picture that she found on the Internet. This picture illustrated how water circulates from air to the earth, powered by sunlight. Eunice seemed proud that she found this picture for herself and wanted to show it to Mrs. D. However, Mrs. D, who had already given detailed instruction on how to write the essay at the beginning of the class, was frustrated. Mrs. D told Eunice in a rather stern voice, "How does this picture help you to provide answers?" Eunice did not answer, and Mrs. D said, "Listen. You should answer to the question of the essay topic, not explain the water cycle itself." Eunice deleted the picture from the paper after this conversation. It was the end of the marking period, and Eunice and a few other students asked Mrs. D about their grades. Mrs. D found that Eunice got A+ grades in science and every other subject except social studies, and expressed her surprise. She commented to us that it was quite impressive since she would never expect such stellar grades from Eunice.

Eunice worked hard to make connections between her interest and experiences and what was being studied in the classroom. However, for Eunice, these connections were not always picked up by her teacher or her peers in productive ways. Sometimes, such as in the example which follows, her teacher did pick up on the connection, but in the end ultimately used this connection in a way that (we believe unintentionally) positioned Eunice in a negative way. For example, during the invasive species unit, Mrs. D was describing to the class how the problem of invasive species was "close to home" with some of the problems the Great Lakes were experiencing due to shipping channels. Mrs. D went on to tell a story about a boat coming from Spain to get iron ore pellets from Michigan's upper peninsula. Eunice energetically raised her hand to contribute. When called upon, she told a story about a shark that was let go in Lake Michigan. Many of her classmates laughed at the story. The story was entertaining, but the laughter suggested the students found the story unbelievable. Mrs. D, however, supported Ericka and told the class that Eunice's story was as a good example of how invasive species are sometimes introduced to new environments, even if the shark could not survive in the lake. This

led to further commentary by Mrs. D about why sharks could not survive in Lake Michigan, and why sharks would never be an invasive species in the Lake. Thus, even though Mrs. D acknowledged Eunice's contribution, Eunice was inadvertently pegged as the girl who told implausible stories, instead of someone who could engage in science discussions.

Eunice was an active participant of Mrs. D's lunch science club in both 7th and 8th grades. She was the one who always raised her hand first whenever Mrs. D asked questions or volunteers to help. Eunice shared a lot of science-related stories from her everyday experiences exuberantly, such as dead fishes in the tank that she saw at the local grocery market and hot air balloons that fly up high in the sky. For example, when Mrs. D and the girls in the club were talking about planting some flowers and the function of water, it was Eunice who suggested doing an experiment that would compare flowers in water with flowers in a soda drink, which became a club activity the following week. Despite her persistent efforts to participate, Eunice's stories from her outdoor experiences often ended in silence during classroom conversations. Her stories seemed to elicit discomfort from her peers as they were usually dramatic and dealt with violence, risks and survival (such as almost getting electrocuted on a power line) –issues that featured in her personal life—living in an extremely poor neighborhood that had many burnt houses, spending most of her time hanging around those neighborhood after school time. While Mrs. D tried to create a more student-friendly and informal atmosphere during the club by waiving regular classroom norms such as hand raising and waiting to be called on, Eunice persisted in these school practices rather than quickly adapting to the new practices of the club, which again made Eunice's ways of participating feel odd to the other members.

Interactions between Eunice's narrated and embodied identities. Despite Eunice's persistent attempts, she did not seem to be successful in performing the kinds of identities-in-practice that she narrated across school and her lunch science club. Her narrated identities-in-practice were contradictory to her embodied identities in that no one ever thought or described Eunice as a good science student, nor recognized her excellent performance in science. Eunice was quite knowledgeable about fish, insects, and squirrels as demonstrated in her digital stories. She was also a keen observer and deeply appreciative of her everyday experiences with nature. Her embodied identities-in-practice that were authored through her participation and social interaction with people in her particular school contexts were contradictory in terms of both her actual school performance, interests, and participation. Instead of being recognized as a curious, keen, and high-achieving science student (with consistent A+ grades), she was positioned by both her science teacher and her peers as a somewhat strange African American girl who told peculiar stories and who did not get along well with others. More significantly, and sadly, Mrs. D did not seem to notice Eunice's consistent A+ grades in science.

Eunice's narrated identities-in-practice changed in her 8th grade year along with her embodied identities-in-practice. During the interview in her 8th grade year, Eunice stated that she still wants to be an actress. However, the STEM related career aspiration—being a veterinarian—was not included in her stories any more. Science is still both fun and boring. But Eunice's school performance in science was much lower than her 7th grade year (she got Cs in science in her 8th grade year), and nobody in her school thought that Eunice was a smart science student. Figure S3 provides a visual representation of interaction pattern 3.

Interaction type 4: Transformative interactions between girls' narrated and embodied identities

Overview. In this section we look at interaction type 4: Transformative interactions between girls' narrated and embodied identities. As we illustrate with the case of Kay below, for the small set of girls in this interaction pattern, we have noted that who girls say they are and want to be (narrated identities-in-practice) and how they practice this (embodied identities-in-practice) informs the other iteratively in positive ways. We also note that the informal figured worlds play a critical role in this transformation. For the girls who fall into this category, we note the following characteristics:

- First, in terms of perceptions and recognition, the girls in this category enjoy science but they do not necessarily view themselves as good in science either in or out of school. Early on in middle school, these girls were rarely recognized for what they know and can do in science in school settings, although they do strive to be recognized. However, over the course of middle school this pattern changed, as the girls became recognized for their out of school performances in science. Most, but not all of the girls are recognized for their success in non-science related activities, such as art, music, sports, or social life.
- Second, in terms of priorities and performances, the girls in this category tend not to overtly care about their grades, although their grades do concern them. They are most interested in doing science "that matters."
- Third, in terms of movement of resources and practices across spaces, the out of school figured worlds serve prominently in supporting the girls science success, and this seems to be because these spaces allow girls to leverage their non-science expertise to address science issues that matter in their community (see points #1 and #2 above).
- Lastly, the interactions between narrated and embodied identities are *strongly productive*, in that they reinforce one another to both sustain and deepen the girls' desire to pursue a STEM-related career.

Introducing Kay – who aspires to be a medical doctor. Kay is an African American girl who was the youngest to join the informal science club called Green Club in the summer of 2007, which was held at her local boys and girls club. She was ten years old when she came to Green Club in the middle of an intensive 5-week program. In spite of being the youngest and joining Green club midway, Kay was neither shy nor retiring. On her first day at Green club, she chose a group of girls to work with and sat down at their table. She immediately turned to one of the teachers and asked purposefully, "So, what are we doing today?" That day, the youth were in the midst of their initial investigation into whether River City was an urban heat island, and were preparing to conduct an ethnographic investigation in downtown River City to ascertain if members of the community were aware of it being an urban heat island. Kay jumped right into the planning on her first day and ended up being the reporter for her group's 8-minute mini-documentary on urban heat islands.

For the past 6 years, Kay has attended an arts-focused middle school that lies adjacent to the Club. It is therefore easy for her to walk to the club after school lets out every afternoon. She describes school as "sometimes interesting but mostly boring." Sociable and vivacious, Kay is popular among the youth at the club and counts many of the youth who attend the club her friends. She is never lacking in confidantes. She can be loud and short-tempered at times, but she is also quick to make up with friends. She is an avid consumer of popular culture, adept at social networking sites such as MySpace. In her second year at Green club, Kay's mother had a new baby whom Kay was expected to help care for. Their housing situation was also in flux at that time and Kay was shuffled between staying at her grandmother's house (which was fairly near the Club) and staying with her mother and siblings wherever their temporary abode may be at the

moment. Her attendance at Green club during this time was more erratic but she made an effort to attend as many sessions as she could. When it became apparent that Kay's mother could not spare her babysitting help, Kay asked the teachers at Green club for help in transportation so that she could keep attending the club. In this way, Kay was able to keep up her participation and engagement at Green club.

During her third year at Green club, the uncertainty in Kay's life increased. Her family experienced extreme upheaval due to the economic downturn and other personal crises. Kay turned to email (using a computer at her school) and text messages (on friends' phones) to keep in touch with Green club instructors. Usually she would ask what was up each week and about rides home from the club. She would sometimes ask for homework help or for help mediating schools requests with her mother (i.e., calling and explaining the value or importance of certain activities, and so forth). Kay's school grades suffered during this time, falling from straight A's to primarily B's, throughout this prolonged time of uncertainty in her personal life (e.g. no stable housing), Kay maintained her enthusiasm and confidence at Green club and towards the value of schooling.

Kay's Narrated Identities-in-practice. Kay narrates an identity-in-practice in school as someone who is bored with science, and bored with school. She feels that she does not do anything interesting in school, or in school science. However, in the years we have known Kay, she has also consistently narrated a future identity as a doctor. Interestingly, she also speaks constantly of the value of schooling (in contrast to the "boredom" speech), and articulates a plausible path towards medical school by first attending a local community college.

In the context of Green Club, Kay narrates an identity of someone who is a make-a-difference expert. In her description, she is such an expert because she creates videos and public service announcements to educate her community about important socio-scientific issues such as energy conservation and the urban heat island phenomenon. Kay opined that the work she is doing, and has done so far in Green Club could be something that students read about in a social studies textbook in her school someday.

Kay's Embodied Identities-in-practice. Kay started off as an 'A' student in school science as a 5th grader. However, she experienced significant upheavals in her personal life, which negatively impacted her performance in school. By the time she was in 7th grade, her grades had slipped to a 'C' in science and a 'D' in math. Kay's science teacher, Mr. A, called her a "big behavioral problem." We describe Kay's participation in a science class that is representative of her participation that year in school science. The class was learning about planets, and consisted of the students independently reading information from a textbook and answering questions.

At the start of class, Mr. A had trouble getting the students to settle down and start work. Students were chatting and not paying much attention to him. Kay was rocking back and forth in her seat and passing notes with a female classmate sitting near her. Mr. A gave a general warning to the class and then singled Kay out with this admonishment, "Ms. Kay, the conversation we had yesterday will go into effect today. No more warnings." Kay was upset that he picked on her and retorted with "Mr. A, why aren't you yelling at anyone else?" The teacher did not reply. Kay then gets into a "you-shut-up" match with a male student.

The class finally settles down and Kay opened her book to work on the questions. She concentrated on working by herself for the next 17 minutes without talking to anyone. Kay gets up to go to the bathroom before returning to continue her work. A boy who uses the bathroom after her starts teasing her rather cruelly, saying loudly, "Damn woman, what did you do in there?" Other classmates laugh at her. Kay, clearly embarrassed, retorted with "Nothing, I didn't

even do anything!" When her classmates continued to laugh at her, she switched tactics and tried to laugh alongside with them before resuming her work, leaving her classmates to continue their jeering. While still working, Kay calls out to Mr. A, " Do you see this?", using her index finger to draw a circle in the air around her desk, thereby asking the teacher to recognize her hard work. Mr. A recognized her efforts with "Yes, you are getting some work done today. I did notice that." Kay then asked Mr. K a question.

Kay: Mr. A, what is Io?
Mr. A: It is pronounced I-o
Mr. A.: [walking over to Kay] Did you find it?
Kay: Yep

After this exchange, Kay then helps a female classmate locate the answer for I-o. The class packs up and gets ready to transition to Mathematics.

At Green Club, Kay was an active participant and part of the core group of Green clubbers. For example, Kay created several science artifacts at Green club, including a mini-documentary on urban heat islands, a public service announcement on the energy crisis (which was shown on a local television channel) and conducted community "needs assessment" surveys on what people know about greening their city, analyzing the results and presenting the results, with recommendations on how to increase public awareness of these issues to the mayor's office.

Kay was especially proud to be one of the presenters at the mayor's office, reporting on a "needs assessment" survey findings regarding community member's energy practices. The purpose of the needs assessment survey was to determine what River City residents knew of the Go Green initiative and to identify some important awareness activities the city might do to help educate River city residents about the importance of the Go Green Initiative. The Green club youth conducted 187 surveys in four locations in the city, analyzed their results using the program Microsoft excel, and then prepared a PowerPoint presentation showing their findings and suggested recommendations for the mayor's office. In the audience were members of the mayor's office and representatives from the public bus company CATA, board of water and light, as well as Granger Recycling services. Kay appreciated being able to be a presenter at a "professional" setting. She said she was "proud to be there", and that she was "nervous" in the beginning but very "excited." She appreciated having met the different adult representatives and felt that what she had to say to them was important. She was especially proud to be the one of two youth chosen to hold the plaque that the mayor's office awarded the Green Club for their contribution towards greening River City.

Kay played key roles in all these Green club projects. Her embodied identities included group leader, investigator, interviewer, script-writer, narrator, researcher, and presenter. In short, Kay delved completely into the scientific tasks at Green Club in her all-rounded engagement and in so doing, authentically authored and embodied the identity of a community science expert.

Interactions between Kay's narrated and embodied identities-in-practice. We first see how Kay had very different embodied identities-in-practice in Green club and in school science. She also narrates her identities-in-practice differently in these two figured worlds. However, she is consistent in her narrated future goal to be a doctor, and we see she is aware that she needs to succeed in school science in order to do that. There are transformative interactions between Kay's narrated and embodied identities (Figure 5). Although we do not see very explicitly how she imports Green club expertise into school science, we do see her trying to get teacher recognition for her work in science, in repositioning herself and authoring a more teacher positive identity to shed the "big behavioral problem" identity. We also see how Kay's narrated

identity as a future doctor causes her to seek out plausible paths forward. At Green club, where outstanding youth has the opportunity to apply for a competitive scholarship to a residential summer science and engineering program at a local university, Kay lobbied hard for why she should be the one chosen to go, even though she may not be the most outstanding Green clubber. Kay made her case so well with the Green club teachers, the boys and girls club President, and the professor in charge of the science and engineering summer program that she did end up being selected for the scholarship. Since she is more obviously successful in the figured world of Green Club versus school science, Kay had more agency to position herself at Green club in seeking for opportunities that will aid her goal in becoming a medical doctor. Figure S4 provides a visual representation of interaction pattern 4.

Discussion

Addressing the identity gap: The importance of paying attention to middle school girls who articulate a future self in science

Previous research has been shown that girls do not identify with science, even girls who do well and achieve good grades in science (e.g. Fordham, 1997). It has been argued that girls choose not to go into science because it is too masculine, clinical, impersonal or individualistic – characteristics that are in sharp contrast to the soft, feminine qualities that girls purportedly value and embody. Many studies have shown that this masculine – feminine dichotomy is too essentialistic and simplistic an explanation. However these same studies argue that we would be remiss to not attend to the very real and pervasive power relations inherent in the culture of school science that often marginalize girls and inadvertently render them as spectators on the sidelines (Eisenhart & Finkel, 1998; Brickhouse, 2001; Brickhouse, Lowery & Schultz, 2000; Kahle, 2004; Carlone, 2004).

Our case studies show girls in middle school with STEM-related career aspirations are interested in and participate in science in many different ways. As part of these aspirations they have narrated a possible future in science that both aligns with and contradicts these stereotypes. We echo Brickhouse, Lowery and Schultz's (2000) call that individual stories "about the diverse roles and paths girls take" (p. 442) need to be told as race, class and socioeconomic status of girls interact in complex ways to influence how they engage in science. The girls in our case studies developed identities-in-practice in science through the stories they narrated about themselves and through their performances. How these stories and performances were recognized by others across the figured worlds in which they have membership was critical to how girls moved forward with an interest in science. Such recognition work was mediated through racialized and classed (as well as gendered) experiences and assumptions of who these girls are and want to be.

Our approach to making sense of the interactions among narrated and embodied identities-in-practice helps to provide more nuanced explanations as to why it may seem that not as many girls are interested in science, or why the girls who are interested may not pursue opportunities to increase their success in STEM trajectories (as evidenced in course enrollment, compensatory experiences, etc). We think this is especially important when considering issues of girls leaving the STEM pipeline at every juncture (Blickenstaff, 2005) and the lack of representation of minority women in STEM and STEM related careers, that we pay close attention to middle school girls who *do* articulate a possible future identity in STEM-related fields.

In many ways, we view this problem as that of an "identity gap." In other words, we believe that our data show that while many girls do well in middle school science and profess an interest in a STEM trajectory, school science has not yet provided the tools or resources to help

girls reconcile who they are and want to be with what they do in science class. Understanding the articulation or lack thereof between narrated identities – who I think I am and want to be, and embodied identities – what I do, is critical to designing better learning experiences for girls interested in science.

Indeed, interest in science has been shown to be a product of student experiences by age 11 (Omerod & Duckworth, 1975). Based on interviews with 116 scientists and graduate students, it has also been reported that 65% showed interest in a future science career before middle school and 30% in middle and high school (Maltese & Tai, 2008). Lindahl (2007), found in a longitudinal study with Swedish youth that their career aspirations were largely formed by age 13, and that it would be progressively more difficult to engage students in science. Such data point to the importance of taking seriously career aspirations articulated by youth before they enter high school or college, if we are serious about addressing the identity gap. It is therefore crucial to understand the formative experiences of youth and their career aspirations between the ages of 10 to 14 and to elucidate how to support their aspirations and interest in science, particularly those of girls (Archer, Dewitt, Osborne, Dillon, Willis & Wong, 2010).

We have worked with just such a cohort of case study girls in this study – middle school non-White girls who narrate a possible future identity in STEM-related fields. In teasing out and juxtaposing their narrated and embodied identities-in-practice in both formal and informal science, we have gained a more nuanced understanding of the interactions between these identities and the implications these interactions surface for us in terms of supporting the girls' STEM trajectories. Below we discuss three important considerations which emerge from our findings: the role of salient figured worlds, the role of institutional narratives, and the significance of contentious local struggles in girls' identity work.

How girls become interested in a STEM-related career – the roles of salient figured worlds

Across the cases, the girls narrate science identities-in-practice such as curious learner (Eunice and Jana), hard worker (Jana, Meg, Kay) and bored student (Meg, Eunice, Kay). They also all narrate possible future identities as a STEM-related career professional – Environmental engineer (Jana), veterinarian (Meg and Eunice) and medical doctor (Kay). The girls developed their STEM-related career aspirations from various experiences not necessarily based in school science. In fact, none of the 16 case study girls invoked any significant experiences in school science that triggered their STEM-related career aspirations. *Inspiration for a STEM related careers for almost all of the girls in our study arose from memberships in other salient figured worlds, not from school science experiences themselves*.

For example, most of the 16 case study girls spoke of the role of family as important inspiration, citing familial role models in their relatives (uncles, mother, sister) who work in science-related fields. Family members with STEM careers serve as role models to whom the girls could ask questions about specific science careers. For example, Markel (a case study student not discussed above) has two uncles who are doctors with whom she spends her school holidays in Ghana. Markel credits her uncles with her interests in science and her ambition to also become a medical doctor.

For girls that fall under the partial overlap and transformative interaction categories, they often cited the role of an informal science club like Green club, where positive experiences have led them to consider possible future identities as green energy engineers. We believe it is the unique affordances and resources in the figured worlds of home and informal science club that helped these girls develop an interest in a possible future STEM-related career. The less

hierarchical, more flexible and youth-centered norms of informal, community-based science clubs like Green Club supported and broadened ways of engaging in science for girls like Jana and Kay. At Green Club, they could sing songs, choreograph dances, write raps, make movies, engage in conversation with adult experts and local government authority figures *while learning and teaching others* about green energy issues. These are the actions they took (and the embodied identities-in-practice they authored), and the context of Green Club supported these actions (and embodied identities-in-practice). Or take Nan, for example, who did investigations with plants in her lunch time science club, and told stories of growing and cooking with traditional Vietnamese (Chinese) greens at home. Over time, she later designated herself as the plant care-taker in her science classroom, and her teacher supported her in doing so.

For these girls (e.g. Jackie & Janis, in addition to Jana, Kay & Nan) who are in the partial overlap and transformative interactions groups, we see a continuous feedback loop between their embodied identities-in-practice, mediated by activities and people at the informal science spaces, and their narrated identities-in-practice as their possible future selves expanded to include careers that merge an array of interests with STEM. For example, Janis (see Table 2, under "Transformative mode"), a very quiet African American 6th grader when she first joined Green Club, had an ambition to be an artist and was not particularly interested in science. Janis joined Green Club at the behest of her mother. However, after using her considerable artistic talents consistently in Green Club projects, Janis blossomed to become a leader in Green Club, becoming more vocal and interested in the science content. Among her many creative Green Club projects (which garnered both admiration and validation from Green club peers and teachers) was a rap she wrote on climate change that won a state-wide competition. In 7th and 8th grades, Janis expanded her career ambitions to include becoming a Green energy engineer, in addition to an artist. Janis also became more vocal and confident in her school science participation, speaking up more often with both questions and answers and asking her school science teacher questions related to Green Club science investigations. It is plausible that Janis's school science embodied identities-in-practice transformed in part due to the science positive, Green Club embodied identities-in-practice she was concurrently authoring. This positive feedback loop was also evident in her narrated identities-in-practice, when she started seriously considering a future career as a Green energy engineer.

Although the school science figured world did not directly inspire STEM-related career aspirations in the girls of our study, it is critical to note that school science experiences played important roles in sustaining the interests of girls if and when the girls' experiences in school science drew upon their out of school interests and experiences (e.g. Jana, Carly) or if the girls viewed the work of school science as important to their career trajectory (e.g. Meg, Lin). However, when school science did not recognize or support girls' identity work, then school science appeared to facilitate STEM minded girls in moving away from their envisioned STEM-related trajectories (e.g., Eunice - conflict), unless they had access to other sources to help them sustain their interest (Kay – transformative). Without additional support for identity work, it is less likely for even STEM minded non-White girls, especially with African American and low SES backgrounds, to pursue STEM trajectories given the current institutional, historical, cultural narratives and limited resources for identity work provided by school science.

The role of institutional narratives on girls' designated identities as future STEM-related professionals

Just as girls narrated identities-in-practice of a "smart girl", "community science expert" and "future doctor" enable them "to cope with new situations in terms of past experiences and helps [them] plan for the future" (Sfard & Prusak, 2005, p. 16), institutional narratives in the forms of grades, certificates or a teacher's labeling of a student wield much power in reifying or supplanting girls' embodied identities-in-practice. We see how Kay's positive experiences and recognition by authority figures (club teachers and President of the Boys and Girls Club) at Green Club served to reify and strengthen her narrated and embodied identities-in-practice, acting as positive reinforcement between what she narrates herself to be and the practices she can actually enact at Green Club, that align and "flesh out" her narrated identities-in-practice. These contextual science identity resource—specific only to Green Club—further serve to encourage her continued pursuit of a future identity as a medical doctor, in spite of considerable obstacles from her unstable home life and the negative institutional narratives in the form of her formal school science teacher's pronouncements of her lack of ability and in her less than stellar grades in school. Kay repeatedly discusses, with Green Club teachers, possible routes to achieve her goal. She plans to attend a community college to take more science classes before transferring to a four-year college. Even as the negative institutional narratives appear to erode her path towards her possible future identity as a medical doctor, Kay is bolstered by the positive institutional narratives from Green club to continually seek out a path for herself. The question is how long she can continue to do that, and to what extent such alternative (non school-based) science experiences can sustain her in persevering with school science, which is the ultimate gate-keeper.

Institutional narratives from school also appeared to have supplanted Eunice's actual embodied identity-in-practice as someone who enjoys science and who is good at science, as well as her possible identity of a future veterinarian. Mrs. D. was surprised when she looked at Eunice's grades to realize that she is an A+ student, and Eunice's peers did not recognize her work and accomplishment in school science or in the lunch science club. Her teacher is consistently worried about Eunice's situation – having no clean clothes and a lack of parent support for school work – but these worries seem to eclipse the teacher's ability to see what Eunice has brought to science class, and what she has done with the few resources she has. Eunice's case is especially troubling because, in spite of her embodied identities-in-practice as a serious science student who is both interested and who succeeds in authentic, inquiry-based science both in terms of how she participates and in the A+ grades she achieves, she remains invisible to both her science teacher and her peers. Without institutional support, it is difficult to imagine how Eunice could sustain and advance her pursuit of a STEM-related trajectory. Oyserman, Bybee & Terry (2006) have found that youth tend to commit to a sustained, self-regulatory effort to a possible self when there are strategies and social context supports working on that possible self. Eunice appears to lack such support.

In Meg's case however, institutional narratives in the form of good grades (A+) and Mrs. D's glowing opinion of Meg seem to obliterate the fact that she did not embody identities-in-practice of an authentic science learner in either formal school science or the science lunch club. By conflating her school-based identity with her school science identity (i.e., not distinguishing between the practices of science as a discipline with other school subjects), Meg authored an embodied identity-in-practice in school science as a student whose sole concern was getting all the answers on a test correct, with or without real understanding of the material. In science lunch club, Meg authored an embodied identity-in-practice as a disinterested participant, probably because no grades were handed out and she was not genuinely interested in the investigations at hand. The cases of Eunice and Meg not only highlight the importance of the impact of

institutional narratives on girls' possible future identities in STEM-related fields, (and their identity trajectories), they also illustrate the insights we gain when we tease apart narrated and embodied identities-in-practice.

In the cases of Eunice and Meg, if we focus solely on the girls' narrated identities-in-practice and the most obvious institutional narrative of their performance in science – their science grades, we would see two non-White girls who both made A+ grades in science and who both aspire to become veterinarians. We may conclude that both girls must be sufficiently equipped, at least at this stage of middle school, for continued success in their STEM trajectory since they are doing well (on paper) in science, and that it is heartening that at age 13, they have STEM-related career aspirations. In reality, Meg seems equipped for success given both her stellar science grades, teacher support and recognition even as she seems to lack genuine interest in science and also deeper knowledge and practices of science. Yet she is considered, and has the narrated identity-in-practice of a successful, science student. On the other hand, Eunice, who as far as we have evidence for, both narrates and embodies (though without validation, and therefore, without success) the identities-in-practice of an authentic science student who actively engages in meaningful science activities, is not recognized nor given any level of institutional support by the same science teacher. For Eunice, excelling in science tests and achieving the top grade is still insufficient to garner her any resources (e.g. teacher recognition) that could position her as a more powerful member of the science classroom figured world.

Eunice and Megs' cases also highlight the importance of not homogenizing them as "minority girls." The school both girls attend is racially-segregated in that students group themselves into affinity groups with other students of their own race and ethnicity, with very clearly defined power dynamics. The dominant group of students is White and working to middle class. Eunice's embodied identities-in-practice as an African American girl from a very low SES household with particular struggles positioned her negatively with her peers and science teacher, who chose to focus on and reify these aspects of Eunice's identities-in-practice rather than the ones of her as an A+ student and a curious science learner. After constantly being sidelined, Eunice seemed to "give up" her possible future of a veterinarian in 8th grade, narrating only a possible future identity as an actress. Why are Eunice's background identities (low SES, African American ethnicity) more immediately visible and dominant, compared to her embodied science identities-in-practice, such that they eclipse her positive science identity work? We suggest that perhaps stereotype threat is at work here. Perhaps to Mrs. D and the other students, it is improbable that a poor, African American girl like Eunice can excel in science. Stereotype threat may also be at work in Meg's case. Meg, who is ethnically Chinese and adopted into a White middle class family, is recognized by her peers and teacher as someone very good in science, possibly due to them subscribing to the myth of the "model minority" (Chou & Feagin, 2008). Being ethnically Chinese, Meg may have the attributes of a model minority ascribed to her, regardless of whether she possessed them or not. Asian model minority identities such as "very hard working", "family values education", "higher I.Q.", "whiz kid" (Lee, 1996) may have been conferred on Meg by Mrs. D and her peers. The perception of Meg, when viewed through a model minority lens, is a high achieving student (confirmed through test scores) whose excellence in science is expected and normalized. Even, we argue, as Meg is *lacking* in the deeper knowledge and practices of authentic science, she appears to have both familial and institutional (school science) support in her narrated possible science trajectory to become a veterinarian.

The significance of contentious local struggles in supporting positive interactions between girls' narrated and embodied identities-in-practice

Across the four interaction patterns we also see how contentious local struggles exert a significant influence on both the nature and the extent of positive interactions between girls' narrated and embodied identities-in-practice. These struggles are made manifest in the tensions between who girls are (as defined by their race and class) and want to be, and the expectations of who they should be (or ascribed to be), according to normalized, institutional scripts. Jana's case illustrates one way in which these tensions can play out. Although Jana maintains her enthusiasm in both Green Club and school science, we see differences in her embodied identities-in-practice in the two figured worlds. Jana's narrated identities-in-science as a hardworking, "educated person who cares" and who is deeply interested in science is embodied in qualitatively different, figured-world specific identities-in-practice, aligned to the norms and perceived expectations of each figured world. In school science where students are expected to adhere to certain behavioral codes, Jana embodies the good girl student to such a high standard that Mrs. C wished she could be "cloned." Jana is thus regarded as the "perfect student" and recognized as such. Such recognition by the authority figure (teacher Mrs. C) reinforces the embodied identities-in-practice Jana authors in the science classroom figured world. While she maintains her enthusiasm, she is careful to "stay within the classroom lines" in her modes of participation. This can be seen in how she chooses to do individual work (which is Mrs. C's preferred mode of student participation) and generally does exactly as she is told. She does embody the identity of an "educated person who cares", as evinced in her discussion with Mrs. C about how society should treat people with infectious diseases. However, we argue that we are witnessing a somewhat diminished version of Jana's abilities and potentials in science as she so carefully hews to the norms of the classroom figured world. The expectations of how a good student should be seem to have constrained the kind of embodied identities-in-practice Jana authors in the science classroom.

We see how Jana's narrated identities-in-practice are embodied differently at the after school Green Club figured world. In this context, there appear to be less of a struggle between institutional norms (at the Boys and Girls Club serving predominantly, >90%, non-White youth) and who Jana can be in Green Club. The culture, rules and norms of being at Green Club are grounded in the values of the Boys and Girls Club, where youth interests and agency are highly emphasized and leveraged upon. It is also important to note that not only in the figured world of Green Club but also in the figured world of the larger Boys and Girls Club (where Green Club is housed), Jana is a youth with much positional authority, popular with both peers and club teachers. With these institutional, relational and positional resources at her disposal, it is not surprising that Jana embodied identities-in-practice at Green Club that are both scientific but also youth-centered, drawing on other talents and interests such as dancing and movie-making.

Similarly, in the figured world of Green Club, Kay was supported in reifying and reinforcing her narrated identities-in-practice through repeatedly authoring embodied identities-in-practice that positioned her as someone capable and knowledgeable in science, who has a possible route to becoming a medical doctor. In the figured world of school science however, Kay had to contend with the other identities-in-practice she embodied –those of an "off task" student, that were difficult to dispel, in spite of her efforts.

Jana and Kay's cases raise the question of why interactive feedback loops between girls' narrated and embodied identities-in-practice look so different between informal science figured worlds and formal classrooms. Connected to stereotype threat previously discussed, it seems plausible that both race and class impacted the nature of interactions between girls' narrated and

embodied identities-in-practice, particularly in the school science figured world. Returning to the cases of Eunice and Meg, we see Eunice, who self identifies as "mixed race" but recognized as "African American" is from a family with a very low socioeconomic status. Meg is ethnically Chinese and comes from a middle-class White family. Both girls make A+ grades in school science, both articulated future STEM-related careers as veterinarians, but only Meg's grades are embodied identity-in-practice as a "good science student" is validated by Mrs. D and her peers. Eunice's struggles to be recognized as a good science student yields no results. Similarly, Kay, who is African American and from an equally challenging family background as Eunice, is labeled as a behavioral problem by Mr. A, at the same time that Kay is engaging in robust science in the Green Club figured world. At Green club, where most of the youth are African American and non-White, Kay's ethnicity and class status may not be so pronounced as to immediately elicit stereotype threat, including race and class based judgments. Jana, who is also African American but who comes from a (divorced but stable) middle class family, garners support from both Green club and school science figured worlds. As these cases illustrate, issues pertaining to stereotype threat, race and class need to be more critically examined as they can severely affect girls' science identity work, contributing to the "identity gap" problem. These cases further challenge us to think about how formal classroom figured worlds, with the specific nature of local struggles, could be transformed into a hybrid space that go beyond reform-based curricular that more readily facilitates girls' cross-leveraging of identities and resources across figured worlds (see Figure 2).

[Insert Figure 2 here]

Conclusions & Implications

In the current climate where women and especially non-White women are under-represented in the STEM fields, it seems particularly important that we pay attention to the science education of all girls, and especially girls who do narrate possible future identities in STEM and STEM-related fields. This study raises two important issues for us that require continued attention. First, in teasing out the interactions between girls' narrated and embodied identities-in-practice, we are better informed on the mechanisms inherent in the contentious local struggles that reflect the particular contexts and histories of each girl that can significantly affect how they are supported in their science engagement and possible future science trajectories. Without uncovering and understanding these mechanisms, these girls who, on paper, make stellar grades and articulate a future career goals in STEM-related fields, could be considered exemplary female science students who are "on track" and who need no special attention, when in fact, they do. This brings us to the second issue. If we are serious about supporting girls in science in both encouraging and keeping girls in the STEM pipeline, it is incumbent upon us as science educators, researchers and teachers to rethink what we really mean by equitable experiences when considering science education reform that support girls. We have to bear in mind the complex and ineluctable entanglements between girls' engagement in science and their racial/ethnic identities, socioeconomic status, personal struggles and how these factors play out daily against historical institutional struggles as girls negotiate for meaningful science participation in their science classrooms and other science-related figured worlds. While it is heartening that Mrs. D showed her care for Eunice with a faculty-sponsored gift card to a clothing store, we argue that it would have been even more empowering to Eunice, had Mrs. D engaged with her in school science in ways that recognized and validated the positive embodied identities-in-practice Eunice was trying to author. We also want to point out that explicitly being aware of, and paying attention to race

and class issues, prejudices and stereotype threats is critical for all students, even those who are seemingly doing very well and fully supported. For example, it would have been immensely beneficial to Meg if Mrs. D had been more observant of her embodied-identities-in-practice and challenged her to engage more deeply in hands-on activities by asking her more scaffolding questions during these activities, in addition to grading the "final product" worksheets Meg is so adept at excelling in. Meg should be held accountable both to the practices of science as well as to content knowledge mastery (albeit narrowly gauged through standardized tests, in Meg's case). For a girl who desires to be a veterinarian, Meg would have been better served if she learned how to engage in authentic science practices in middle school instead of merely questing after the right answers. Such pedagogical support is particularly necessary in light of the New Generation Science Standards (2013) that call for an in-depth knowledge of connected core-concepts, demonstrated in inquiry-based science and problem-solving engineering practices.

To better support STEM minded girls to pursue their career, we recommend that science teachers pay close attention to the institutional narratives created in their own science classroom. It is challenging for science teachers because institutional narratives are not only affected by the norms and expectations of the activities with teachers' pedagogical decisions, but also reflect the historical and cultural practices of sciences that are normalized in a particular way. Attending to and recognizing those narratives, however, provides opportunities for science teachers to shift the discourses at the classroom level. We also recommend science teachers and teacher educators to take recognition work seriously to support STEM minded girls, as girls' identity work necessitates such recognition to be reified. Providing equitable experiences involves both creating porous hybrid spaces where girls leverage various resources from other figured worlds as well as supporting girls' agency to maintain, build, and re-author possible selves in pursuit of a STEM related career.

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