EXAMINING AUTHENTIC TALK AND STUDENT AUTHORSHIP OF SCIENTIFIC IDEAS: PUBLIC PEDAGOGY AND AFFINITY SPACE

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ABSTRACT

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One of the great challenges to teachers both historically and contemporarily is to facilitate a classroom as a *group* of students, while concurrently attending to each *individual* student. As the profession becomes increasingly aware and sensitive to student (dis)abilities, academic giftedness, pressures of athletics and extra-curricular events, and acknowledges the racial, cultural, sexual, economic, gendered identities of students-- the complexity of each individual student becomes ever more apparent. It is a seemingly insurmountable challenge. This dissertation examines how stem cell unit guided group learning while also attending to the individual learning needs of each student.

What makes classroom study unusual in research is that it is completely "usual". This study was not part of a university partnership nor did it take place in an affluent school district. Instead, this unit took place in a large, Midwestern urban high school that was/is often written off as a failing—underscoring that powerful science teaching and learning is occurring in schools society simultaneously portrays as victim and villain in the media.

Using a sociocultural lens, this ethnographic study draws upon two frameworks, Wenger's *communities of practice* (1998) and Hayes and Gee's (2011) *public pedagogy,* to examine how participation in a debate individualizes and personalizes student knowledge and participation in science. The primary use of a *community of practice* framework allowed for analysis of the norms, rules, practices, and routines of Classroom 507—to establish the nature of the *community* of learners in the study. A secondary framework, *public pedagogy*, allowed for

deeper understanding of the practices drawn upon in the classroom through consideration of the design, resources, and an emergent "affinity space". This hybridized analysis led to further understanding of how students and teacher stand to learn, participate, engage and use a classroom lesson, the debate, to serve their own, unique purposes.

During my observations of biology Classroom 507, the class engaged a three-week unit on the ethics of stem cells which ended in a class-wide debate. I had the opportunity to observe, film, and interview students and their teacher. Through observation, interviews, and film, I began to understand the classroom community (its norms, practices, and routines) but also began to recognize how this unit functioned to teach content but push on student thought creation and development as individuals. In this dissertation, I construct something I call an "affinity story" for four focal students (Mismin, Kevin, Molly, and Michael) and their teacher (Theresa). These affinity stories capture how each of the individuals co-opted the debate space in various ways allowing for engagement and participation in ways that were true to themselves and their social and academic needs.

Implications from this dissertation include: 1) re-considering the importance of how both students and teacher enrich science understandings when public, authentic talk is encouraged; 2) how teachers can design units and draw from diverse resources to enrich the learning experience of the individual; 3) how students and teacher appropriate learning spaces for their own individual social and academic needs; 4) to consider what it means to allow students to follow their *affinities* within the science classroom; and 5) to inspire teachers as they engage in the difficult task we call teaching.

DEDICATION

For mom and dad.

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CHAPTER 1 SITUATING THE STUDY

This dissertation begins as many others have done before by describing the ominous and dismal situation of science education in the United States and the inequities embedded within science education for students of color living in low-income communities. This description and the use of statistics is supposed to situate the dissertation and make the case for the imperative of the study. And in some ways, this seems like a natural place to start (or why else would others start this way?). Inequity exists and statistics can help clarify where they exist.

On the flip side, a list of inequities feels to me like sensationalized journalism, a clichéd movie such as *Freedom Writers*, or a "well-intentioned liberal" attempting social reform involving a fundraiser for "those kids". While some of the harsh realities of high poverty classrooms are not to be ignored nor are they to be trivialized, they are lacking in the humanity and beauty of *people*. This dissertation is about people and the powerful learning experiences happening within a classroom written off as failing. As you read this chapter and think about the "state of science education", keep in the back of your mind that there is more to come and that when students are called upon as resources and leaders, this situation is not so dire.

American prominence (or lack thereof) and preparedness in science education among elite first-world nations has sparked cause for concern for educators and government alike. Historically, United States eighth graders do not typically rank in the top-ten nations scoring on the Trends in International Mathematics and Science Study (TIMSS)[1]—trailing behind Singapore, Chinese Taipei, Japan, Korea, England, Hungary, Czech Republic, Slovenia, Hong

[1] One anomaly: the U.S. appeared in 2003, ranking 9th

Kong, and Russia (National Center for Education Statistics, July, 2012). In scientific literacy, the U.S. performs at an average ranking; according to the 2009 Program for International Assessment (PISA), "The average U.S. science literacy score (502) in 2009 was not measurably different from the average score of the 34 OECD countries (501)." While these scores indicate that U.S. eighth graders perform slightly over average and have out-performed 35 out of 46 countries, the U.S. is no longer an elite, competitive player on the global science playing field.

Unpacking these statistics, students of color are performing markedly lower than their White and Asian counterparts and indicants of the lack of educational preparation for students of color in the sciences. Data from the 2006 PISA test showed a measurable difference throughout races in scientific literacy: Blacks and Hispanics scored lower than Whites and Asians (noting that Hispanics scored higher than Black students) (PISA, n.d.). This pattern of inequity follows American students as they further their education and pursue careers in Science, Technology, Engineering, and Mathematics (STEM) related fields. According to Slovacek, Whittinghill, Flenoury, and Wiseman (citing Astin, 1993; Brown & Campbell, 2009; Schneider, 2000; Swail, 2003),

> The chronic underrepresentation of [Hispanic, African American, and Native American] students in the science and engineering field has been linked to a number of factors, including inadequate preparation for science and math degree programs in high school (2012, p. 199-200).

Further, the National Science Foundation (NSF) reports, White men make up 55% of the workforce in STEM careers, followed by 18% of White women. However, Black men (2%), Black women (1%), Hispanic men (3%) and Hispanic women (1%) only make up 7% of the STEM workforce collectively (2011). These data do not match US population data (2011)—

demonstrative of the fact that White men and White women are overrepresented in STEM fields. Science education echoes the same patterns:

> While accounting for approximately 28% of the population and 24% of incoming college freshman, the proportion of Hispanic, African American, and Native American students earning bachelor's degrees in the sciences is only 17%. The prospect for completion of science doctoral degrees is even bleaker; only 8% of all doctorates awarded in the sciences are awarded to Hispanic, African American, or Native American students (Slovacek et al, 2012, p. 199).

Achieving equity, however, is easier said than done.

In November of 2008, when Barack Obama became the first president of color—media commentators and citizens alike declared America a "post-racial society". Surely, many cried, if the country can be led by a person of color, years of slavery, Jim Crow, and vigilant fights for civil rights are behind us. While this sentiment is far from the truth, it is even more disturbing when considered with the achievement gap and racial predictability of students of color and students from low-income homes engaged in the sciences.

Poverty is yet another predictor of success in the sciences: 81% of eighth graders attending *low-poverty* schools performed at or above the "basic" level on the 2011 National Assessment for Educational Progress (NAEP) and 46% performed at or above "proficient." These numbers drastically decline for students attending *high-poverty schools*: 33% of these eighth grade students reached at or above "basic" and only 8% scored at or above "proficient" (NCES, July, 2012). Again, when compared to White and Asian students, Black and Hispanic students are more likely to attend a high-poverty school. 2009-2010 data shows "…higher percentages of Hispanic (37 percent), Black (37 percent), and American Indian/Alaska Native

students (29 percent) attended high-poverty schools than did Asian/Pacific Islander (12 percent) and White students (6 percent)" (NAEP, 2011). Given that neither race nor poverty inherently determine intelligence, one must ask why it is that Latino and Black students are constantly faring worse in school than White and Asian students.

There are many factors (beyond and inclusive of systemic racism) when considering this complex question. Traditionally, entrée to these forms of capital has been guarded through various gate-keeping mechanisms such as standardized tests, resource allocation, lack of instructional congruence (Lee & Fradd, 1998), dissonance between student lived worlds and those of school (Lim & Calabrese Barton, 2006), and scientific Discourse as a foreign language (Gee, 2008) among others. For example, science, as a content area and as a practice, requires several different forms of social, cultural, and academic capital in the form of skills, scientific content knowledge, discourse, practices, and processes. As another example, Brown, et al (2012), discuss the problematic nature of limited access to role models of one's own race; the majority of all full-time teachers in the US are White (83%), and only 7% were Hispanic and 1% Asian (true for elementary and secondary) (NCES, July, 2012)—decreasing the opportunity for students of color to have a role model and educator in the sciences who is of his or her race. With access and role-models, students have opportunities to see themselves as scientists and future possibilities for scientific careers.

Historically, access to scientific capital has been inequitable, at best—marginalizing women, people of color, and families with low SES. Thus, the discussion of how schools and teachers (and perhaps additional thought towards White teachers and the demographics of the teaching force) provide access to valuable scientific capital is vital to shifting the imbalance of who takes up careers and studies within the sciences. Thus far, I have painted a rather bleak

picture in only presenting the negative: low American standing on the global STEM scene—even further problematized by looking at how demographic characteristics, such as race, SES, and gender, not intelligence nor ability, systemically marginalizes and discourages people of color, women, and people of lower SES, from entering the STEM workforce.

Situating this dissertation is not only the recognition of the continued low-performance of the United States as compared to other industrialized nations in STEM fields, but also acknowledging the disconcerting vast disparity between races, genders, and SES within American students and citizens. This disparity established by historic, systemic colonialism that needs remedying in present day.

Again, bearing in mind that inequity is not a manifestation of *inability* of those who have been marginalized but rather a result of direct, systemic oppression—I now look at some of the ways science education operates as privileged academic knowledge. There is a vast body of science education research that investigates some of the barriers or guarded entrée into the sciences and once these barriers are removed, we begin to see the proverbial playing field begin to level. I focus on just two that are pertinent to this study: the language of science (as a new and second language) and the dissonance of students lived experience and science—considering the importance of drawing from students' lived experiences and knowledge.

The Language of Science

In order to learn scientific discourses and Discourse, Lemke (2001) writes, "In the sociocultural view, what matters to learning and doing science is primarily the socially learned cultural traditions of what kinds of discourses and representations are useful and how to use them…" (p. 298). Science, for example, has its own vocabulary, process of experimentation, guidelines for review, generally accepted ways of interacting and procedural talk explicit to its

Discursive community. The culture of science is described as particular sets of scientific practices, or Discourses (Gee, 2005): skills, knowledge, and ways of thinking specific to science. As such—the entrée into scientific Discourse is vitally important. Gee (2005) emphasizes the importance of distinguishing between "little d" discourses (discussions) and "big D" Discourses or canonical, privileged ways of talking in the discipline. Learning the Discourse of science is not just about memorizing vocabulary terms or identifying the independent variable in a study—these "verbal meanings" (Hayes and Gee, 2010) are only a tool for deep understanding in the sciences. Instead, dynamic use of scientific ideas, such as

> …When [a word] is associated with an image, action, goal, experience, or dialogue, we say it has a situated meaning. Situated meanings are crucial for understandings that lead to being able to apply one's knowledge to problem solving. Verbal meanings may lead to test passing, but the evidence is that, absent situated meanings, they do not lead to real-world problem solving, e.g., in learning science in school (Gee 2004, 2007) (Hayes and Gee, 2010, p 5).

In this vein, an imperative for those being enculturated into academic and professional science is talking science in order to form situated meanings (to situate the concept, term, idea within its larger context). When science is boiled down to a list of vocabulary terms, listing process, and labeling diagrams, students do not have access to situated meaning—only the verbal meanings devoid of context—limiting student real-life problem solving abilities.

Teaching the Language of Science

Studies in which students were encouraged to develop situated meaning showed significant gains. Engaging students in real-life, connected, authentic science has shown meaningful science learning and increased interest in science (Boullion & Gomez, 2001; Fusco,

2001). Discursive abilities such as being able to "access information, form questions, share ideas and analyze data" (Boullion & Gomez, 2001, p. 889) and the "evaluation of data, use of technology, scientific communication/explanations, the development of a plan" (Fusco, 2001, p.870) specifically demonstrated a shift in students' entrée into science.

Other studies note the academic gains from urban teachers from LA and the San Francisco Bay area who explicitly teach the (D)iscourses of science (Brown, 2012; Brown & Spang, 2007) by "disaggregating" everyday talk from scientific terms, creating awareness of Discourses, and then engaging students in "science talk" helped make lived connections to and bridge the two different languages. In a similar example, in an intervention study in a high-poverty chemistry classroom (predominantly African American (50%), Caucasian (20%) and Asian American (25%)), encouraging student talk and communication during large-class demonstrations/common experiences resulted in students' enhanced use of scientific language, more participation and increased engagement (Milne & Otieno, 2009).

Scientific talk is not the only social interaction that is helpful in the science classroom; the emphasis and encouragement of other kinds of talk in the science classroom also supports student learning. Olitsky (2007) noted how the emphasis on talk, norms, culture, and co-creation of learning space deepened science engagement. Actions that created "interaction rituals", such as student side-talk (vs. maintaining a quiet classroom), access to materials that lend themselves to mutual focus, familiar structures of activities, valuing student science contributions, student inputs of emotional energy and cultural capital, and spontaneous student vocalized encouragement of one another—all of these became socially learned traditions within the classroom. With these contributions, it is possible to think about how the social environment both constructs learning and how learning constructs the social environment.

Finally, Elizabeth Moje and her research team observed and interviewed students to determine how their "first world" funds of knowledge from popular culture, their communities, families, and peer groups informed their "second world" (formal institutions such as school) knowledge and skills (Moje, et al, 2004). When these worlds overlapped, or informed each other, the space transformed into a "third space", defined as "...explicitly emphasizing the role of the physical, as well as socialized, space in which people interact" (p. 42). In this "third space" student learning was deeper and misconceptions reduced as students were forced to merge their ideas in meaningful ways.

In sum, classrooms in which students engage the socially learned cultural traditions of what kinds of discourses and representations are useful and how to use them— support students science learning by 1) bridging between colloquial language and scientific language, 2) providing opportunities for verbal meanings to become situated meanings (such as engaging "authentic" science problems like grappling with ethics or unsolved problems), and 3) encouraging talk and "interactional rituals" such as side-talk, peer-peer encouragement, and valuing student contributions.

Recognizing and Drawing from Student Contributions

Many researchers have also considered how shifting power dynamics from a teacher playing the role of holder of knowledge and dictatorial enforcer of rules to a more fluid recognition of student knowledge and the need for students to have some power in a classroom. This recognition, according to research, among teachers, community members, and students in urban schools, also promotes student engagement in science. This research foregrounds the knowledge and creativity of students—specifically addressing and debunking deficit models of urban students. For example, researchers studied the academic gains of students when they

engaged “co-generative dialogues” (Elmesky, & Tobin, 2005; Roth, et al, 2004; Tobin, 2005) and the formation of stronger scientific identities when students explicitly co-authored their science curriculum with teachers (Calabrese-Barton et al, 2003; Tan & Calabrese-Barton, 2008a; Tan & Calabrese-Barton, 2008b; Tan & Calabrese-Barton, 2009). Additional literature shows how teachers engage deeper, factual information of content and how teachers balance privileging student and/or traditional science knowledge (Boullion & Gomez, 2001; Brown & Spang, 2007; Calabrese-Barton & Yang, 2000; Calabrese-Barton et al, 2003; Carlone, 2004; Fusco, 2001; Gutstein, 2003; Lim & Calabrese-Barton, 2006; Moje et al, 2001; Tan & Calabrese-Barton, 2008). Each of these researchers grounded their studies, methodologies and findings on the assumption that students enter the classroom with funds of knowledge (Moll, 1992) and approached student knowledge with an anti-deficit lens (Calabrese-Barton, 2003). Thus, much of this ethnographic research depicted what students knew, with the implicit objective to show what is missing when viewing students through a deficit lens.

This body of research cumulatively posits that students enter science settings with deep funds of knowledge pertaining to science. This claim is backed up by various data sources such as classroom (or after-school) observation, focus group interviews, student artifacts, field notes, and student observations to name a few. The diversity of sites researched brings strength to the possibilities of third space or hybrid classrooms in which student funds of knowledge are brought in the classroom space (Calabrese-Barton & Tan, Year; Moje et al, 2004). Students who author their own courses have access to power and authority, thereby disrupting traditional power structures (Boullion & Gomez, 2001; Calabrese-Barton et al, 2003; Tan & Calabrese-Barton, 2008).

With these contributions (thinking about how kids of color are pushed to the periphery, teaching science as language, the classroom environment, shifting power to students, and engaging authentic science), it is possible to think about how the social environment both constructs learning and how learning constructs the social environment. These studies investigate what teachers and researchers have done to promote entrée into science education and STEM-related careers for urban students of color. As research continues to analyze and highlight successful methods of engaging students in meaningful science learning, we expand the repertoire of options for pedagogy.

While there is a vast research base on best practices and pedagogical tools used to enhance students' use of and understanding of science, many science education studies are difficult for the average under-resourced urban teacher to enact. Most studies are either a) conducted in more affluent school districts, b) have a university partnership provided additional materials and resources, or c) take place out of school in informal learning situations. While these studies push our thinking further about how students learn and enact science—I find myself wanting more—and wanting more research that exposes the good work I know is being done in urban science classrooms—work without outside financial support and within the constraints of a traditional classroom. There are very few studies that investigate in situ pedagogies and learning that provide access to scientific knowledge and language specific to traditional urban science classrooms.

This study illuminates what is being done to prepare students for science fields in hopes of tempering negative perspectives of urban schools and to share powerful pedagogy to further spark imagination in our teachers. Juxtaposing current research in science education with research specific to a statistically predictable achievement gap for people of color, women, and

individuals from lower SES—I illuminate what has been done in the research community with what still needs to be considered. Returning to the beginning of this chapter, when students are given opportunities to be resources and leaders in the classroom, powerful things begin to happen.

Framing the Study

This ethnographic study contributes to the literature by examining effective teaching methods, the environment, talk and Discourse, and authentic tasks in a biology classroom. I followed the learning of four focal students and their teacher as they engaged a unit on the ethics of stem cells which concluded with a multi-day debate.

Specifically, this study examines the learning in a high-poverty, urban science classroom led by a White, female teacher who called on students' vast knowledge and encouraged talk and exploration of the ethics of stem cells. The classroom environment allowed for the development of scientific Discourse, student ownership and authorship of scientific ideas, and the opportunity to learn contemporary, cutting edge scientific content: all dimensions necessary for success in science. And, each student was able to do this in ways that met his or her own individual learning needs. I present this study to further expand our imaginations as we work to make the academic domain more accessible to *all* students (not just those historically privileged).

In particular, this study investigates the rich classroom community co-created by students and teacher—and the learning that occurred within the debate at the conclusion of the unit. The classroom investigation of stem cells (a subject both the mainstream and scientific community struggle with delineating its ethical boundaries) provided an exceptional, authentic opportunity to examine how students learn scientific content and develop personal positions about scientific ethics.

Research Questions

Context matters; therefore, my first research questions, explore the culture of Classroom 507, a biology class in a large, urban, Midwest high school.

- *What are norms, routines, practices, relationships, ways of being, and talk specific to this classroom? How do these norms, routines, and practices construct the culture of this classroom?*

To address these questions, I share contextual data from Alomar High School, Classroom 507, and the unit of study on stem cells—this data shared in *Chapter Four Teaching Science at Alomar: A Descriptive Portrait*. Considering these points not only focuses attention on the actual context of the study but also situates the classroom in and among other urban science education classrooms. I hope that deeper understanding of this context expands on our educational imaginations as we imagine ourselves in Classroom 507 at Alomar—as we think about how this classroom is so truly unique, but in many ways, structurally similar to other urban science classrooms. My description of the context begins with the school, then the classroom, the unit, and a description of the four focal students (Mismin, Kevin, Molly, and Michael) and their teacher (Theresa).

The teacher of any classroom plays a difficult role—trying to teach a large group while attending to the individual learning needs of each individual student. Skilled teachers can find a balance of leading, facilitating, and guiding individual students to academic success—but this balancing act of skills is highly difficult. In *Chapter Five Public Pedagogy: Design and Resources*, I share analysis of how the teacher encouraged talk and peer-peer discussion and how students took up this invitation. In addition to examining the teacher's approaches to the unit, it was equally important to see how her instruction was taken up and co-constructed by the

students as a group, but then also how individuals within the class were able to use it for his or her own academic needs.

- *What are the pedagogical moves the teacher makes to make classroom learning accessible for all students? How are these pedagogical moves of the teacher taken up by students?*
- *What resources are drawn upon in this unit? What resources "count" in this classroom?*

The curricular unit required students to understand the basics of stem cells (e.g. the difference between embryonic and adult stem cells; the role stem cells play in the body; and how stem cells differentiate and undergo determination). Using this scientific content, students debated the ethical considerations of two case studies. The primary goal of this unit, according to the teacher (Interview, May 8), was to give students the tools and content they needed to become versed in the basics of the stem cell debate and to author their own opinion in the matter.

Chapter Six The Debate: An Affinity Space is an investigation how the debate emerged as an affinity space. An "affinity space" is a space where students could contribute and withdraw tools and ideas for authoring their own understandings of the ethics of stem cell research, emerged.

- *How does an affinity space shape the way students participate in learning?*
- *How do students use the affinity space in varied ways?*

Emergent from the data was that unlike in traditional classrooms where the teacher is the only keeper/disseminator of knowledge, when teaching and learning is transparent and communal, there is a clear shift in how knowledge is created and who is valued for being a knowledge creator. At the end of the unit, students participated in a debate and I make the argument that this shifted the learning to mirror an affinity space allowing for rich and varied learning of students and their teacher.

Educational Significance

Data from this study show when the classroom space was opened for talk and argumentation, students were able to exhibit their knowledge, author their own opinions, and ground their arguments and opinions in scientific knowledge; an examination of science classrooms like this is imperative to thinking about potential changes to science education in the United States. Demonstrating how classroom environments that encourage talk, such as the one in this study, can promote student ownership of scientific ideas.

To make all of these pedagogical moves we know are effective in urban schools (calling on student knowledge, teaching the language of science, shifting power, and creating and maintaining classroom environment), there is a lot to be gained—but this is a daunting and difficult task. As teachers give up their own authority and allow for the unexpected (Heyman 2001a, 2001b, 2007), students are required to take their own knowledge and also the knowledge of their classmates and community members more seriously (Merrett, 2000). This approach, in turn, encourages students to embrace adaptability and flexibility as key attitudes when working with multiple publics (Campbell 1974; Giroux 1988; Hay 2001; Heyman 2000, 2001b; Howitt 2001; Maxey 1999; Merrett 2000; Thomas 1996). (Sletto, 2010, p. 405)

Teachers are required to wear many hats, orchestrate productive lesson plans, communicate effectively with parents, guardians, students, other teachers—teaching is often described as a juggling act. Because of the difficulty of proactive preparations (lab set-up, equipment garnering, writing of lessons) compounded by the impromptu, in time decision making, teachers are forced to be organized. Giving up control can seem counterproductive to the juggling act and thus is incredibly uncomfortable and scary for teachers. This study investigates how one teacher, while maintaining a fluid, focused set of lessons, gave up authority

in a way that pushed students listen to one another—taking their own and others' knowledge more seriously. As students interacted with many different publics (as I discuss later), they developed multiple vantage points and are more able to create situated meanings.

One can argue that teachers will ultimately hold positions of power in a classroom: students attendance is compulsory, teachers discipline and grade, determine content and activities, etc. However, it is important to think about how teachers use this power, to what degree to they call upon this power, and in what ways they invite students to share power.

Overview of Chapters

In the next chapter, *Chapter 2 Framing the Study*, I present the theoretical and conceptual frames situating the study. In *Chapter 3 Methods*, I describe context of the study, methods, data generation, analysis, and reflection. *Chapter 4 Teaching Science at Alomar: A Descriptive Portrait* familiarizes the reader with the school, classroom as a community of practice, the stem cell unit, and the focal students (Mismin, Kevin, Molly, and Michael) and their teacher, Theresa. *Chapter 5 Public Pedagogy: Design and Resources* and *Chapter 6 The Debate: An Affinity Space* uses a public pedagogy lens to see how, while not actually "public", this classroom space became similar to a public space for learning—including the benefits of learning and engagement through public pedagogy of which Hayes and Gee (2010, 2012) discuss. When put together, these chapters tell a story of how a classroom's community of practice was established, how a unit was enacted as a public pedagogy—and how one lesson within this unit emerged as an affinity space opening for each individual student.

CHAPTER 2 FRAMING THE STUDY

There are many ways to understanding learning. In the sciences specifically, determining scientific learning and competency exists in varied forms standardized tests like the TIMMS, ACT, Advanced Placement (AP); or student involvement in scientific fields noting student acceptance into and completion of science-based degree programs, career trajectories; to gauges of scientific literacy such as being able to pick up a mainstream newspaper or magazine (e.g. The Chicago Tribune or Newsweek); or making decisions for themselves involving scientific ideas, learning/using scientific Discourse.

The content in the first chapter of this dissertation presents stark, definite, clear comparisons between students: students of color and White; male and female; living in low and high poverty; in urban and non-urban residences. Although these statistics help to highlight systemic inequity, the world is vastly more complex and muddled than these statistics might suggest; qualitative, sociocultural research attends to this sort of messiness and helps look within large systems to humanize these structures. This study draws on sociocultural theory to illuminate the messiness within these systems. It is my hope that the stories and data presented in this study simultaneously complicate and make sense of the our understandings of urban science education.

Introduction to Sociocultural Theory

Sociocultural theories take into consideration the vast and varied knowledge base, enculturation, and skills required in the sciences learned through socialization. As the term implies, sociocultural theories examine the multi-layered factors between social relationships and culture: the social nature of culture and the cultural influences on society (Lave and Wenger,

1991; Nasir & Hand, 2006; Rogoff, 2003; Wenger, 1998). Calabrese-Barton and Brickhouse (2006) summarize,

> Learning science involves not only learning content but also learning how to participate in scientific or science-related communities. …Engagement suggests an embodied activity where the process and outcomes are reflected in one's changing participation in socio/cognitive activity (p. 224).

Thus, interaction is a key lens for understanding learning. Sociocultural theories de-center thinking, learning, and development from solely on the individual through the examination of how people together engage to learn through situated social interactions (Rogoff, 2003). In focusing on the collaborative, social nature of learning from the individual (for example one's cognitive abilities), sociocultural theories complicate notions of learning. Sociocultural theories foreground the collective, negotiated nature of learning and being within the community. Individuals learn when enmeshed in the dynamic, constant changing nature of culture. Broadening the dialogue on learning as cultural, Lave and Wenger (1991) explain,

> A theory of social *practice* emphasizes the relational interdependency of agent and world, activity, meaning, cognition, learning, and knowing. This view also claims that learning, thinking, and knowing are relations among people in activity in, with, and arising from the socially and culturally structured world (p. 50-51).

At the various intersections of culture and learning, it is important to understand how people in a specific community learn, know, make meaning through the tools, norms, routines, define and operate as "culture" is practice. These in situ relationships and ways of being, as they relate to learning, are the practices sociocultural theories investigate.

An example of how sociocultural theories illuminate learning in the science classroom, Kurth, Anderson, & Palincsar (2001) considered the social constraints to engaging in science for students of color in a diverse classroom. Carla, a Black sixth-grader, who at the beginning of the unit, eagerly participated, excitedly explaining her ideas, worked with the liquids, and tried to explain the phenomena, however, when grouped with peers: one White male, one White female, and one Latino male, Carla struggled to "hold the floor" (p. 291) in her small learning group as peers disregarded her comments and pushed her out of the conversation. The transcripts show that she was often interrupted, her ideas not taken up, and her two White peers led the discussion—privileging her ideas last. According to Carla,

> Well, I feel kind of weird because I'm the only colored person in the group. Uh, and sometimes, um, you know, like noncolored people like, um, they might know like, a lot more than me because, you know, it's like that way that black people they didn't hardly know anything because they couldn't have schools and stuff. (p. 306)

Later, when Carla was matched with two other Black females—she was engaged and excited to learn the explanations of the science. To have written Carla off as "disengaged" behaviorally or cognitively would dismiss the contributions she could have made or the connections she was making with the science.[2] How many of our students of color feel pushed aside because of race?

Looking at classrooms through a sociocultural lens, the scope of learning broadens from the individual to contextualize learning through the social mediation of all individuals. In essence, this theory sees learning and culture as fundamentally and inextricably related: learning as culture and culture as learning. "Participation in social communities shape [sic] our experience

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[2] While I think this can be read through as a complicated intersection of both race and gender—Carla didn't see it that way: she described how it felt like the only "colored" person in the group (even though Carlos was Latino).

and it also shapes those communities" (Wenger, 1998, p. 56-57). It would be impossible to tease learning and culture apart, akin to a chicken or egg debate, instead, sociocultural theories acknowledge and document this dynamic nature—ever broadening our understanding of learning.

Communities of Practice

> We all belong to communities of practice. At home, at work, at school, in our hobbies—we belong to several communities of practice at any given time. … In fact, communities of practice are everywhere. They are so informal and so pervasive that they rarely come into explicit focus, but for the same reasons, they are also quite familiar. …It has both the eye-opening character of novelty and the forgotten familiarity of obviousness—but perhaps, that is the mark of our most useful insights. (Wenger, 1998, p. 6-7)

In Etienne Wenger's seminal text *Communities of Practice* (1998), the construct of communities of practice (CoP) emerge to explain the phenomena he saw during his observations of a medical claims processing department of a large US insurance company from 1989-1990. His study described a typical day for novice claims processor, Ariel. In the study, Wenger describes how a person becomes a claims processor over time through his or her enculturation into a CoP. Learning, such as seemingly obscure "C, F and J" calculation lines on a form, may be initiated in training sessions, but more richly, this specific knowledge is developed through practice. But learning in this CoP does not stop with job competency —it also includes social norms for the team, knowing what rules to follow and ignore, how to speak, when to engage, and how to navigate office politics. From this year-long study, Wenger proposed how individuals learn through enculturation, social interaction, engagement with tools and artifacts, and familiarity with the "language" of the culture.

What is and isn't a CoP? Colloquially, it may seem as if any group of people living, working, or playing in close proximity naturally constitute a community of practice. However, Wenger describes the hazy boundary between people being *near* each other and people participating in a community of practice and to that end, I share an example. Imagine parents bringing their children to a park, one that draws many families from around the city to its playground. There will be some children playing by themselves and some together, there will be parents sitting or standing by themselves or engaged in casual exchanges. Parents might break up children's disagreements, encourage weary slide "go-ers", eat snacks, and meet new people.

This scenario, however, is not yet a CoP. "Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, *and* who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger, McDermott & Snyder, 2002, p. 4). Within this park setting, there may be some CoP: parents and guardians who meet with some regularity and over time talk about pre-school, foods their children like/dislike, or sharing good books they read. They coach and mentor each other as they raise their children. Over time, this group of adults and children construct and co-opt the park for their own uses (birthday parties, pumpkin carving, neighborhood meetings, etc.). Communities of practice exist when individuals ponder ideas, share information, develop common ways of speaking (about the content or context specific cues), and act as each other's sounding boards. They may or may not create common documents or artifacts. However, for a group to be a CoP there must be meaningful relationships between the individuals in which they share, establish a common way of communication, and collaborate. What might this look like in classrooms?

Classrooms as Communities of Practice

On one hand, it might seem that classrooms naturally form CoP: students see each other every day, they are in classes learning common material, they are required to follow school and classroom rules (creating some semblance of routine), and have some common communication protocols. This notion dilutes the power of the community of practice to assume that every class in every classroom is a CoP. Enyedy and Goldman (2004) smartly make the argument that overuse of CoP makes the term an amorphous catch-all that loses its meaning. Additionally, the assumption that schools are innately functional communities of practice is wholly naïve, especially when considering the contemporary manifestations of the Lancastrian, "toe the line", drill and kill traditions deeply rooted in American schools, the compulsory nature of K-12 schools, not to mention the marginalization, violence, and discrimination many students encounter in schools, it is difficult to form the "community" aspect in a CoP. I draw on the construct of CoP *because* Wenger makes a clear distinction that the "community" aspect of a community of practice, especially in a classroom, is not assumed, simple, nor unproblematic. Thus, it is imperative that a researcher using a CoP framework first establish that the classroom being analyzed is a in fact, operating as a CoP.

I purposely include Wenger's community of practice into the conceptual framing of this dissertation because of the imperative of an environment created for and used for learning. Enyedy and Goldberg (2004) argue for the usefulness of examining the social construction of learning through a CoP framework,

> … It is when the notion of community is combined with theories of practice that the analytic construct of COP becomes a meaningful and valuable framework for analysis, and provides a set of categories and relationships that one can use to understand how a

> social group coheres together and is structured by shared norms, routines, and roles to accomplish a set of shared goals and joint activities. (p. 907).

The examination of community and theories of practice are crucial for understanding the daily functionality of a classroom. The evolution and maintenance of functional, supportive learning spaces is so important as we think about how to encourage all students to study and explore careers in STEM related fields. In part of this dissertation, in the descriptive findings, I explore the community of practice in Classroom 507 in order to shed light on the community-- its norms, practices, routines, and ways of being. To think about the actual *theories of practices* engaged within a community of practice, I turned to Hayes and Gee's (2010) construct of "public pedagogy".

Public Pedagogy

Public pedagogy is used to describe the learning spaces typically occurring in the informal public domain: art, websites, games, museums, advertising, movies, Facebook, graffiti, music, blogs, television, popular culture—places in which individuals learn through spaces/objects that are public (Hayes and Gee, 2012; Sandlin, Schultz, & Burdick, 2010). It is here, in these public forums and interactions, where individuals learn about identity, literacy, content, ways of interacting, social norms, beliefs, among many other issues.

> It has been common for some time to see the formal learning in school compared unfavorably to informal learning out of school (Cross, 2006). Humans seem to learn more deeply—and more equitably, without gaps between rich and poor—when they learn outside of school in areas they choose and for which they are motivated (Gee 2003, 2004). … Informal learning has become more and more complex, demanding, and

> sophisticated at a time when much learning in school has become skill-and-drill test preparation (Hayes & Gee, 2012, p. 1).

Yet, what would it look like if formalized learning, such as the learning that happens in schools, was deep, complex, demanding, and sophisticated? What can public learning, or the learning that happens in public spaces, teach science teachers?

To better explain public pedagogy (and how I interpret public pedagogy), I describe through example the learning that occurs on the social media platform, *Facebook*. I take you through a few uses of Facebook and then pull back to examine how Facebook operates as public pedagogy. Specifically, I address the ways public pedagogy can be *implicit*—subconsciously teaching us how to be American, a student, a gender, a race, or public pedagogy can be *explicitly* educational and purposeful—such as going to a museum or interacting with a structured blog[3].

Facebook as Public Pedagogy

Facebook teaches through enculturation and about the world our "friends" create for us. Facebook is used for networking—people will post job openings, inquire about jobs, make connections with people of similar career interests; and for others, Facebook is social—posting pictures of family or wild nights at the bar or club or use the Events function to invite others to parties or fundraisers. Others still use it for entertainment with games such as *Bejeweled* or *Words with Friends*. One's Facebook page is not necessarily open to the public—one can set security settings such that only a "friend" can be allowed to look at the pages, thus, people can "friend" or "de-friend". Individual motivations for using Facebook vary: for some, videos, pictures, websites, and "lists" are shared throughout Facebook, posted on one another's "wall"—

[3] To my knowledge, most people who write about public pedagogy do not use these terms—but for purposes for explanation, I use it here.

and these can be “liked” or commented on. Fights or social drama in schools and classrooms are started (or have added fuel to a fire) on Facebook.

But this dissertation is not about Facebook. My point with all of these random uses of Facebook is to point out the different kinds of implicit and explicit pedagogy that public spaces like Facebook make possible.

Implicit Public Pedagogy

If you effortlessly read the above description of Facebook and recognized or understood terms such as “posting”, “friending”, “lists”, “wall” and “liking”—you have learned, through interaction, the ways of interacting and functioning within Facebook. This is one way in which public pedagogy operates: teaching others how to function, the norms of interaction, the etiquette and rules for being, through its use. Sure, you could read a book on “how to operate Facebook,” but most people learn by doing. On the other hand, if these terms are completely foreign to you, you have not interacted with Facebook (at all or enough) to understand the terms, norms, ways of being, or common practices associated with this social media.

Learning in our society is shaped by public pedagogy in ways we unconsciously recognize: person’s consumption, interpretation, and viewing of popular culture are shaped the way he or she interacts in the world. However, learning in public spheres is not only implicit—it also serves to teach content and shape opinions.

Explicit Public Pedagogy

In contrast to the more subtle, implicit public pedagogy, there is a more direct, structured learning found in the public. Returning to the Facebook example, public pedagogy also operates in more obvious, explicit ways. In addition to knowing how to operate and interact on Facebook, from Facebook, people also learn about issues, comedy, song, the arts, political stances, family

developments, etc. through their exploration of friends' "walls" and postings. When a person logs into Facebook—they can scan through friends' walls—and once there, engage the ideas on which that friend posted. Perhaps someone shares a viral video on how to do a dance (like the "Dougie") and a video of Michelle Obama "doing the Dougie"— from these links, you can learn how to "Dougie." On a wall, one can rant or rave about any subject and create "evidence" via positions and web links for others to see.

These sites of learning, while informal, are still structured and have an explicit function. In informal learning spaces and public pedagogy, such as a website or blog, participants willingly engage the community and over time, through legitimate peripheral participation (Lave and Wenger, 1991), become full members of the community.

Again moving away from the Facebook example and into another form of public pedagogy, Gee and Hayes (2010) examined the learning of members in a SIMS on-line community to find out what SIMS players learn from the site. SIMS is an on-line space in which members create an avatar and interact with other members (world-wide) in this second life. In their research, Gee and Hayes analyzed the depth and breadth of knowledge required to fully participate and how "newbies" were enculturated into the community (implicitly learned). They document how this online space has become, over time, a CoP. Participants in a SIMS second life are tasked with learning complex vocabulary, rules, negotiating "fairness", language, discursive patterns, meaning-makings. Over time, this community becomes a CoP whose members share common purpose, negotiate etiquette and terms, and communicate via a specific, learned language. The creation of this space and enactment, such as the creation of the software and programming of SIMS and the innovative uses of this software is another example of public pedagogy.

Public pedagogy, therefore, is the learning that occurs in… public. Museums, art exhibits, street art, rallies, demonstrations, spoken word concerts—all of these are forms of public pedagogy. These venues not only shape the ways we come to know how to interact and "be" in these places as we engage them over and over—but they also shape our thinking on the world around us.

Structure of Public Pedagogy: Design, Resources, and Affinity Space

According to Hayes and Gee (2012),

> The complexity of today's popular culture has made educators ever more interested in what makes informal learning so powerful. However, there is a long standing myth that has existed around informal learning. People tend to contrast informal learning with school learning in terms of teachers and teaching, claiming that informal learning does not involve teaching or, at least, that teaching is not a predominant feature of informal learning (p. 2).

Public pedagogy is thoughtfully planned and deliberate. Over time, the space will naturally change and shift as participants interact with the space, making new meanings, and co-opting knowledge for new and varied purposes. However informal the participation, public pedagogy is neither unplanned nor without direction.

Structuring public pedagogy are three components 1) design, 2) resources, and 3) affinity space. In this section I describe the design, or the plans, for the public pedagogy. The design is the "blueprint" for the foundation of the public space. The resources are the materials drawn upon to color the space with knowledge. The affinity space is a unique physical and social place created wherein participants contribute knowledge, build knowledge, and take knowledge for their own purposes.

Design

The *design* is the outline or plan for participants to engage and interact. In computer, video, or games, the design is the intricate outline and structured images, rules, terms coding, and the platform in which participants interact. Each public pedagogy has its own situated meanings (e.g. images, names, rules) and "lucidly-functional language" in which the meanings images, words, terms, and ideas are made clear for participants. In a classroom, design is akin to the unit and lesson design as well as learning the language of science, code-switching, giving clear directions, or making implementing routines and procedures that make learning the goal instead of discipline. The design, according to Gee, makes the public pedagogy useable for participants—noting that with "good design" (2009), learning is made easier.

Resources

Resources are the various contributors to the community's knowledge and skill base. Resources can be informational: websites, magazines, journals, books, blogs, teacher-based websites, video, textbooks, non-fiction texts, lessons and activities, etc. Resources can also be people (peers and leaders are all resources); the role of an individual as a specialist or expert shifts from day to day and experience to experience. Resources are plentiful in public pedagogy because they are not constrained by curricula, standards, testing, textbooks, or blocked websites. This study elucidates how public pedagogy is possible in formal science learning settings and considers how this enriches the student learning.

Understanding the design and resources in this classroom is important to think about how the teacher structured the outline of the learning environment and how students took this up and enacted it. Keeping the design and resources in mind, a unique way of learning, an affinity space, emerged within this public pedagogy.

Affinity Space

"Affinity spaces are places—real world or virtual world…—where people interact around a common passion. [It is] a place where people go to get and give resources… are the spaces in which public pedagogy takes place" (2010, p. 6-7). Further, Gee argues this method is effective: Affinity spaces are an important form of social affiliation today, places where effective learning occurs (Gee, 2003). Drawing from stories people's use of public pedagogy sites (on-line environments (SIMS), complex card games (Pokemon, *Yu-Gi-Oh*), and a real-time computer strategy game (Age of Mythology)[4], Hayes and Gee present the idea of *affinity spaces* (2010).

Hayes and Gee (2010) list thirteen different characteristics of affinity spaces. While the list of characteristics is lengthy (see Appendix I for full chart of characteristics)—the authors use this list to "define" affinity spaces. For ease of reading, I rearrange and group the characteristics into three categories: participants, knowledge, and use of space.

Participants:

- Newbies, masters, and everyone else share common space;
- There are lots of different routes to status;
- Leadership is porous and leaders are resources;
- Roles are reciprocal;

Knowledge:

- Content is transformed by interaction;
- Both specialist and broad, general knowledge are encouraged, and specialist knowledge is pooled;

[4] I admit, I know very little about these games myself.

- Both individual and distributed knowledge are encouraged;;
- Tacit knowledge is used and honored;
- And explicit knowledge is encouraged;

Use of space:

- Everyone can, if they wish, produce and not just consume;
- There are many different forms and routes to participation;
- People get encouragement from an audience and feedback from peers, though everyone plays both roles at different times;
- A view of learning is that individually proactive, but does not exclude help, is encouraged (pgs. 107-113).

This list of characteristics stands in stark contrast to the dominant "traditional" view of science teaching. In this traditional view, the *participants*, or students, are obligated by compulsory attendance, there are vast and complicated power differentials, and the approaches to status are value-laden. *Knowledge* is held by the teacher, textbook, and curriculum and this knowledge is to be learned and memorized—transferred into the student. The space reflects the philosophy of traditional schools, designed like a factory model herding students towards graduation with teachers ensuring compliance.

In contrast, learning in an affinity space is co-constructed, power negotiated, and individuals learn from and teach each other. There are no *formal* lesson plans but rather members evolving the space and themselves through their participation. There are many teachers; novices and experts alike participate. When individuals set-up, write, read, moderate, flag, comment, and look up information on blogs—they are engaging in public pedagogy. There are not graded through tests or essays. However, because the individuals that participate are

learning (opinions, topical content, interaction styles, rhetorical conventions, various vantage points, etiquette, experiencing other's experiences, etc.), we can see use these spaces to re-view learning in K-12 classrooms, specifically science classrooms.

Public Pedagogy in the Formal Learning Institution

One can most certainly make the argument that formal institutions such as schools and traditional classrooms are not the stuff of "public" pedagogy—and this is fair on many levels. Gee[5] and Hayes (2009) and Sandlin et al (2010) make explicit that affinity spaces are rarely found in formal learning environments like schools—in fact, Gee and Hayes purposely contrast the characteristics of affinity spaces with those in schools (see Appendix I, *Affinity Spaces in Public Pedagogy vs. Schools)*. Further, affinity spaces are typically spaces used to pursue similar "passions". Mandatory attendance through compulsory K-12 education complicate this: students do not "choose" to be in classes or school, nor are they necessarily passionate about all subjects learned in class.

However problematic it is that this classroom operate or not operate as "public pedagogy" specifically, the public pedagogy framework/lens is useful for examining data because it focuses the analysis on learning through informal socialization functions. An emphasis on talk and discussion promotes movement of learning from the individual to the

[5] Gee (2009) further argues that Wenger's construct of communities of practice are highly problematic because they emphasize the community (and therefore marginalization of those who are not part of the community). He argues that use of "affinity space" refocuses on the practices embedded within the learning space. However, I see how the two constructs inform one another.

public classroom space. In a classroom, Rystrand and Christoph (1981) might relate this to Bakhtin's dialogically-organized instruction, writing,

> …Dialogically-organized instruction provides public space for student responses, accommodating and promoting the re-fraction of voices representing differing values, beliefs, and perspectives, and ideally including the voices of different classes, races, ages, and genders (1981, p. 252).

When teachers share power, open up time and space for students to contribute, and encourage peer-peer discussion, they make the learning experiences more "public." This study re-thinks formal education by paralleling the teaching and learning that happened in this classroom and the teaching and learning found in the practices of public pedagogy. Viewing classrooms through public pedagogy affords a new way of thinking about what formal learning spaces, such as science classrooms, can look like.

Public pedagogy opens up for the freedom for participants to use their knowledge to author their own views and examine/develop their own values, beliefs, perspectives and ways of being within a classroom. To better understand the community of learners in this urban high school biology class, I analyze and parallel the dimensions of learning to *public pedagogy*. Finally, to imagine how individual students learned within the CoP and engaged the unit vis-à-vis public pedagogy, I look at how the classroom became a unique space for sharing and bouncing around ideas around, or what Hayes and Gee (2010) call an *affinity space*.

Philosophical Merge of Community of Practice and Public Pedagogy

Aside from contributing to the research base, this dissertation also contributes to the literature in examining theoretical methodology. Specifically, I demonstrate how the hybrid of CoP and Public Pedagogy frameworks can be used to more powerfully analyze social/science

learning. The two frameworks, CoP and Public Pedagogy, both have their individual strengths, but together, they deepen the analysis of data from science classrooms.

CoP has a great number of advantages as a method of analyzing community using the analytic frames of joint enterprise, mutual engagement, and shared enterprise to elucidate the norms, practices, routines of a community. Additionally, it is grounded in the field; frames descriptions of communities, allows for delineation between a functional CoP and groups of people who do not function as a CoP; and helps to better understand the daily inner workings of the people in a group. In this study, when I coded for aspects for CoP, I was better able to see the norms and routines of the day-to-day interactions of Classroom 507. This frame helped me think about the generalities of the classroom—but I needed something to better unpack the actual *practices* of the teacher and *participation* and *experiences* of the students.

Public pedagogy does just that: it illuminates teacher practice and student learning. Recall that public pedagogy has three components: design, resources, and affinity space. A focus on design considers what the teacher did and how she framed lessons, the teacher lesson plans were shaped as "common experiences". These common experiences provided different access points to the content. A focus on resources opens up what "counts" (and who "counts") as a resource in the classroom. This highlights and encourages students and teachers to bring in outside resources—and sanction students becoming "experts" in their classes. A focus on affinity space illuminates the power of students teaching and interacting with students on authentic problems. Public pedagogy, with its roots in critical theory, challenges teachers to shift power in classrooms and challenges researchers to think what this shift looks like. In short, public pedagogy helps to understand how the community operates and how teachers might structure their lessons and units in order to develop successful CoPs.

To this end, I argue that the combination of CoP and public pedagogy beautifully complement one another. CoP provides insights into the day-today norms and public pedagogy provides insights on teaching practices. As teachers prepare students for 21st Century Skills, Next Generation Science Standards, the Common Core, and to be scientifically literate, it is no longer enough (and perhaps was never enough) to have a functional CoP that learns science content. Instead, students must interact with the scientific content, bounce their ideas and questions off one another, make decisions about ethics, and consider where they fit in the world in relation to science. Public pedagogy pushes the envelope on what teaching can (and does) look like—and the very nature of knowledge and knowledge construction. However, without a functional CoP, students don't have the built in norms and structures to open up and experience academic discomfort. Thus, the philosophical and practical merge of CoP and public pedagogy illuminates the day-to-day functioning of a CoP *and* expands teaching practices to make science accessible and public.

CHAPTER 3 METHODS

"People develop as participants in cultural communities. Their development can be understood only in light of the cultural practices and circumstances of their communities—which also change" (Rogoff, 2003, p. 3-4). Ethnographic research primarily seeks to understand that which Rogoff describes: how people develop and relate to one another in cultural spaces (and how their relationships create culture and how that cultural space shapes their relationships). Its use extended to classroom studies, ethnographic study frames the study of teachers and students as they develop, create, draw from, and navigate a socially-mediated learning environment (or in this study, a CoP).

In this chapter, I describe the methods employed to conduct this ethnographic study. I briefly describe the context to orient the reader to the research site: the school setting, the unit of study, and the participants (Theresa, the teacher, and the four focal students presented in this study: Mismin, Michael, Kevin, and Molly (all pseudonyms self-selected by the students). Then, I describe the logistical concerns of the methods: the methodology, design, data generation, and analysis. Finally, I reflect on the study itself: its validity, its strengths and limitations, ethical considerations and my role as a researcher creating and running a study with participant care in mind. In this chapter, I demonstrate how the study design is "logical" and conceptually, theoretically, and methodologically matches the investigation.

Methodology

Geertz (1973a) cautions researchers to write to evoke instead of writing to represent. The purpose of this dissertation is not to essentialize or simplify the stories of students or teacher, but to document and complicate—considering the contradictions and multiple meanings in the

context. Ethnography (Lincoln and Guba, 1986), thick description (Geertz, 1973a, 1973b), and making "strange" the common place (Erickson, 1973), reconstructs cultural events for the reader and was best suited for this study. Prashad (2005) nicely pulls these ideas together writing,

> …Local interpretations themselves can only be followed by grasping the wider cultural sense making that is at work. Our day-to-day interpretations are embedded in broad cultural and subcultural codes that mediate even our most mundane experiences. Ethnography, … is intent on understanding cultural practices … that pervade everyday social action and interaction (p. 80).

Thus, drawing on Lincoln & Guba (1986), Geertz (1973a, 1973b), Prashad (2005), and Erickson (1973), ethnographic study is the emergence of the themes and patterns of cultural practices as conveyed to a reader in a way to both describe and complicate our thinking about a given culture. Ethnography in a classroom allows for the making strange (Erickson, 1973)—the subtleties and nuances of a classroom environment more clear.

While I cannot recreate events, feelings or fully express the dynamics of the relationships I have formed over time with the school or participants, I hope to share enough to spark some discussion in the academy (or "here" (Geertz, 1988)) and provide a sense of how I understand Classroom 507. Ethnographic study can make the Classroom 507 CoP explicitly come into focus and in delineating the boundaries of a CoP, we see how it is shaped and operates. Further, the use of public pedagogy, in particular affinity spaces, helps us unpack the dynamics of practices, teaching, participation, and learning within this science classroom.

Ethnographic research is intimidating to me as a researcher: how do I tell a story *about* other people in ways that are true to the voices of the participants, can be validated, and that acts as a coherent argument that grips you, the reader, and causes you to think about something in a

new way? It is the job of the ethnographic researcher to put forth a narrative that contextualizes the study to understand the practices of the classroom as contextualized within the school community. It should provoke new ways of thinking about teaching and learning. More important than generalizing the teacher, classroom or school-- the stories from this research act to inspire and complicate teaching and learning.

Selection of Site, Teacher, and Focus Students

Because of the nature of ethnographic research, I attempt, through writing, something akin to a hybrid of story-telling and thick description (though I don't claim to be nearly as skilled as Geertz, 1988) to help you, the reader, be "there" with me. Though still writing for an academic genre, I try to write in a way that is accessible, casual, and inviting: I want you to feel and think about the school and participants in a familiar way, in a way that brings you closer to the site and each person. In this section, I try to bring you "there" through a brief description of the school, the stem cell unit, the four focal students, and the teacher; each to be described in greater throughout the dissertation.

Site Selection: School

The site of this study was an urban high school, Alomar High School (pseudonym), located in a large Midwestern city. There were 28 students in Theresa's first period honors biology class: twelve male and sixteen female—mostly Latino (Mexican or Puerto Rican) and Black. Alomar High School educates 1858 students from the surrounding ethnically and racially segregated neighborhoods in the city with attendance noticeably dropping every year. 85.1% of the students participate in the free/reduced lunch program (indicating low-income status). 20.4% of students have disabilities and 8.2% of students are ESL/ELL. Racially, the school is comprised of 63.9% Latino and 33.5% Black students.

The class was beginning a new unit on stem cells at the beginning of my observations. The primary objectives of the unit were to understand the basic structure and function of stem cells; to explain the process of stem cell determination and differentiation; and to question the ethics of the use of adult stem cells. The unit spanned three weeks, or twelve class periods. On Mondays, Tuesdays, Wednesdays, and Fridays classes were 45-minutes long and on Thursdays they were only 35-minutes long. The unit provided common experiences through a variety of media and plans: 1) a video on stem cell research, 2) a webquest, 3) a simulation of cell differentiation, and 4) and a reading packet on stem cells. As the unit progressed, students developed arguments for or against the use of stem cell research. Students were assessed throughout the unit with class-constructed summaries of content, creation of a stem cell "scrapbook," participation in a debate on the ethics of stem cell research, and a summative test on stem cell research. Students also participated in multiple small and large group discussions on ethics and the ethics of stem cell research.

Site Selection: Students

Four students (Mismin, Michael, Kevin, and Molly—all pseudonyms selected by students themselves) and the teacher were focal participants in this study; I describe each briefly here. I purposely privilege the participants before details of the methodology and study design, to first introduce you to the individuals—my literary underscoring of the importance of context and people in the study. In *Chapter 4 Teaching Science at Alomar: A Descriptive Portrait*, I write in greater depth for each participant.

Mismin (age 16, self-identified Mexican) was selected as a focal student because of preliminary observations: her difficulty to learn and articulate content as well as her struggles in constructing her own understanding of the ethics of stem cell research as it related to her ideas of

God and religion. It was the nature of these struggles that caught my attention: she appeared truly unflappable in her efforts. Despite her rapt attention in class (she was present and punctual, sat in the front by the teacher during large group, asked questions, worked on task in small group), she often articulated her (mis)understandings of the content and ideas as she grappled with her religious views as seen in stem cell research.

Michael (age 16, self-identified Puerto Rican and Irish) was selected as a focal student because of the various roles he played in class: a leader, peer support, researcher, and introducer of popular culture. When he walked, peers seemed to follow (in fact, when Theresa was assigning teams for the debate, he silently held up baseball signs to indicate to peers what to say in order to get on his team). Michael's ease of leadership style, self-awareness, and confidence led him to be a powerful focal student—often taking me by surprise with his actions.

Kevin (age 17, self-reported Filipino) first caught my attention because he is of Asian descent (Alomar is a predominately Puerto Rican and Black school); he was, in his words, "85% Catholic, 15% Agnostic." Kevin became part of the study on the recommendation of the teacher, Theresa; because he was almost always late to class and rarely spoke—I barely noticed him during the first few classroom observations. Praised by peers and Theresa as the smartest student in class (and he humbly agreed), Kevin already completed high school and gained acceptance to a Philippine university prior to leaving his home country and was now repeating high school for the second time. Kevin was highly analytic, thoughtful and self-aware, which made me want to learn more about him as a student in this classroom.

Molly (age 15, self-identified Puerto Rican and Mexican) was dynamic, stated she wanted to be a stem cell researcher, had good command of the content, and spoke to me frequently in class. She was deeply involved in school– re-creating and leading the school's

student council and participating in city-wide political rallies to improve the school district. Because of Molly's passion for science, interest in the content, and insights of the classroom, she was selected as a focal student.

Site Selection: Teacher

Finally, Theresa (self-identified Caucasian: Polish and Swiss), the teacher, was also a focus of this study. She has taught over eleven years, all of which at Alomar, as a biology/environmental science/physics teacher; during the 2009-2010 school year, she has four biology classes (two of which are "co-taught" special education classes with inclusion teachers) and one environmental science class. She graduated college with a major in biology and an emphasis on environmental studies (and received her teaching certificate through this program as well). When asked why she was an urban teacher, she got a funny look on her face and replied, "I grew up in the city—why would I teach anywhere else?" (Interview, March 9).

Theresa is often the first teacher to arrive and the last to leave the school, involved both in the class and out. She constantly seeks out support for her classroom and opportunities for professional development and collaboration. The creation of the stem cell unit, the focus unit of this dissertation, was the collaborative effort of two teachers and Theresa sponsored through a workshop held at the Field Museum in partnership with University of Chicago. Further, this unit drew upon several different resources including books and articles on the science behind stem cells, the National Institute of Health's *Exploring Bioethics* supplementary curriculum, studies, websites, *The Immortal Life of Henrietta Lacks*, and the University of Utah's *Learn.Genetics* website.

Data Generation

Multiple data sets allowed me the ability to select the richest data and offer both validation and seemingly contradictory data. The data sets included classroom observations (audio and video-recorded) of the lessons over three weeks; participant interviews (audio-recorded); field notes; and classroom artifacts (e.g. student work, classroom handouts and materials, and images of the classroom). Acting as a participant observer, I took field notes and field "jottings" (Emerson et al, 1995), video-recorded with two cameras, and interacted with students. For each participant, two to three interviews were conducted (over student lunch periods and each roughly 42 minutes long). Two types of interviews were conducted with participants: 1) a semi-structured interview and 2) participant interpretation of critical event viewing. Interviews were designed with feminist methodologies (Cazden, 2001; Nielson, 2009; Pugh, 2002, 2004; Pugh, K., Linnenbrink-Garcia, L., Koskey, K. K., Stewart, V.C., Manzey, C., 2009) intended to support student learning through discussion and reflection of their ideas on the unit and the science content. I designed interviews to be educative to students and informational for me—I did not want to be the only one gaining from the interviews (and feedback from students and the teacher was that students appreciated the time in interviews to reflect and talk about their ideas).

Interviews and Focal Students

For each participant, I conducted two to three interviews on-site over the students' lunch period (see Table 1: Interview Collection). In the interviews, we would check in on the day's events, we would discuss the interview questions, and our lunch provided a balance of distraction that seemed to put the students at ease. I conducted two types of interviews with participants: a semi-structured interview and second, participant thoughts on viewing critical events. Prior to

the second set of interviews, I had transcribed classroom observations and created a preliminary story-line of the class events. I then selected specific videos to show students in which he or she interacted with peers—I then asked them for their interpretation of the events.

The first semi-structured interview (see Appendix C for protocol) helped me "get to know," from the student's perspective, how each participant saw himself or herself as a student, science student, their relationships with the teacher and peers in the class, and their ideas about the stem cell unit. This first interview gave me a chance to explain the project in more depth, learn more about them than I had in the classroom observations, and seemed to create a foundation for our comfort-level with each other. Depending on the discussion, the semi-structured interviews took one to two interview sessions.

The second set of interviews (see Appendix C for Interview Protocol) were designed as "metacognitive" sessions (Pugh, 2004) in which participants were asked to look at critical event video data (see coding of critical events) to understand their impression of what transpired. This interview technique allowed us to revisit the moment together and provided me with additional insights into how students understood the content, how they thought they understood their roles at the time, and what they saw or remembered about their peers' reactions to their roles. With the video-viewing I was not looking for "accuracy" nor objectivity, but rather acknowledging the multiple view points of single events—as well as multiple interpretations of events after they happened (e.g. a person may experience and re-experience the same event differently). In the interviews, I wanted to see how students and teacher processed the events I presented and how they recalled them. My second goal for interviews was to make them educative for participants as we discussed the science content and their ideas.

Data Analysis

For this study, use of grounded theory (Glaser, 1978; Glaser and Strauss, 1967; Strauss, 1987; Strauss and Corbin, 1990), allowed for the emergence of themes, patterns, and analysis from the data. Not entering this study with predetermined, or an *a priori* framework, open, modified, and axial codes emerged directly from the data—and bringing the research closer to the context. In reading (and re-reading) the data set, codes were generated through constant comparative methods.

Coding Scheme

Several layers of coding were used to both examine the CoP and how this community provided various learning opportunities for students. Open coding in grounded theory is grouping, labeling and/or categorizing data into common themes (Glaser and Strauss, 1967; Strauss and Corbin, 1990). Three sets of opening coding were developed: 1) determining the nature of talk during observations, 2) the creation of "talk webs" to organize who spoke, when, what kind of lesson it was, and how that talk was taken up, and 3) determining the nature of the classroom as a community of practice when generated data showed evidence of joint enterprise, shared purpose, and mutual engagement. Modified open-coding is the process of re-grouping, labeling, and/or categorizing data—in this case, I re-coded data using data from critical events to see when members of the community shaped each other's learning. What were the routines, discussions, and norms of talk that allowed knowledge to become public and taken up by others? Axial coding involves looking for relationships, patterns, and connections between data sets. In this study, I was looking evidence of a CoP and public pedagogy. Axial coding helped to categorize and group events, talk, and participation into components of public pedagogy (design, resources, and affinity space) and CoP. Finally, selective coding was used to look for

connections within public pedagogy (design, resources, and affinity space) and the dynamics of talk, use of space, and knowledge creation within all lessons (for whole class and each individual student). In addition, I used the video to show students and ask their opinion of the event. I was looking for relationships in which the CoP influenced public pedagogy and creation of an affinity space; and how public pedagogy and creation of an affinity space influenced the CoP.

Open Coding	Types of Talk: • Procedural • Science • Ethics • Comedic • Religious • Sound Bytes • Personal Connections/stories • Popular Culture • Media Talk Webs • Who was talking/ • participating • Nature of conversations • Comments taken-up Evidence of community • Shared Repertoire • Joint Enterprise • Mutual engagement

Modified Open Coding	Critical Events
	• (if applicable) Teacher proposed objective
	• How taken up by students
	  o Participation
	  o Positioning
	  o Interactions
	  o Types of talk
	  o Knowledge
	  ▪ Use of knowledge
	  ▪ Creation of knowledge
	  ▪ What counts as knowledge

Table 1. Coding Scheme (Open, Modified Open, Axial, and Selective Coding)

Table 1 (cont'd)

Axial Coding	Talk as public in Classroom 507 • Design • Resources • Affinity Spaces		
Selective Coding	Design: • Use • Resources • Knowledge Creation • **For whole class	Resources: • Use • Resources • Knowledge creation • **For whole class	Affinity Spaces: Use • Resources • Knowledge creation • **Per each student

In this study, I considered *how* individuals in this classroom learn and teach one another (including students teaching the teacher) and what this learning looked like for each participant. These perspectives helped me operationalize and code for how this class became and worked as a community of practice as evidenced by the data that emerged from the study.

> To generate an applied theory relevant to practitioners and scholars alike, all theory-building researchers must take two steps: (a) move down the ladder of abstraction and into the realm of observation (functionalist paradigm) or interpretation (interpretive paradigm) *and* (b) logically relate the observations or interpretations to each other. (Storberg & Walker, 2008, p. 557).

In this study, I take three theories (communities of practice, public pedagogy, and an emphasis on affinity space), and try to see how it applies in observation.

For example of how coding operated, as I was analyzing data and coding, I kept hitting on an idea that I colloquially called "the floor." I continued to code those times when ideas, comments, gestures, jokes, questions, responses were contributed; when students or teachers would recall an idea or a "sound bite" (a phrase or description that was used frequently by multiple participants) as they were originally coded. Students and teacher seemed to contribute to this space in varied ways, they recognized this space from many different vantage points, and

they accordingly seemed to use (or "withdraw") from "the floor" in unique ways. Some students' roles are more obvious than others—there are students who raise hands and have the "answer", there are students who raise hands and don't have "the answer", there are students who joke, there are students who are so quiet no one seems to notice them. Regardless to what degree we "think" a student *should* contribute—they contribute. They participate in building the classroom space socially. The role of expert shifted constantly-- students and teacher shared this role from minute to minute. The "floor" had space and time. Students, in their ideas/actions/gestures/social actions contributed to "the floor."

And this is where Hayes and Gee (2010)'s affinity space became invaluable. In particular, this component of public pedagogy, an affinity space, is useful in thinking about what learning looks like when students are using this space to co-construct knowledge and build their own knowledge. These places of learning—public, informal "spaces, sites and languages of education and learning …exist outside the walls of schools" (2010)—these are public pedagogies. These perspectives acted as a guide, helped me think through difficulties with analyzing my data, and helped me think about how to approach the analysis.

Ethical Considerations

All care has been taken to comply ethically and legally with the Michigan State University Human Research Board. Through the Institutional Review Board, I was granted an extension on my practicum and pilot of this study completed in the Fall of 2008 and approval to conduct this dissertation study. Teaching and learning can be very deeply personal practices and I did not want to insult or embarrass any participants in the study.

Feminist approaches to ethics: (1) privilege participants' well-being over the work, (2) give voice to historically silenced participants, (3) emphasize the "plurality of voices" (Usher,

2000, p. 31), (4) maintain a dialogical relationship with the participants, and (5) recognize and confront researcher biases (and acknowledge that research is not value-free nor objective). Invoking a feminist care ethic (Fine & Weiss, 2000; Lather & Smithies, 1997; Usher, 2000), I took several measures to ensure the safety of all participants (the teacher and students).

First and foremost, recognizing the power differentials that "(en)force" consent upon participants (Fine & Weiss, 2000), I worked to ensure that they understood the risks associated with this project and had the option to withdraw at any point. Assent and consent forms (see Appendix for forms) were designed to inform all participants of risks associated with the study (clear, user-friendly, and readable for students, teachers, and parents/guardians). Forms were written in English and translated into Spanish as well—though only a few students requested the translated forms. If a participant was made uncomfortable by an interview question, s/he could "pass"; likewise, if s/he decided it was not a good day to be interviewed and wanted to, we rescheduled. Second, I listened and made every effort to use participant voice and whenever possible, quoted them verbatim in the dissertation. Third, I used as many voices as I could and selected vary diverse focal students to hear many viewpoints. Fourth, the process was designed to be educative. For Theresa, this meant I shared notes, we debriefed right after class, and we met to discuss preliminary claims and data. For students, this meant that I might switch to my teacher hat—correcting inaccurate science following the interviews. In interviews, I would often ask follow up questions or cite student and teacher comments from class and ask for clarification. However, after the interview, as we were wrapping up, I would remind them what conversations had taken place, reminding them of the content they misunderstood, and suggesting things for them to look up. Finally, aside from invoking feminist methodologies, I also took care to call upon race-based approaches- acknowledging the ways in which I may "other" the students with

whom I work (Carter, 2003; Scheurich & Young, 1997). The students, who were all students of color, and I differ in our race (I am White). Most, if not all, live at or below the poverty line—I came from a middle class family and attended a highly competitive high school. Participants and I varied in religion, education background, approaches and thoughts to science—all of which needed to be taken into consideration as I conducted this study. To attend to this, I was up front with students about the study, why I was there, why I wanted to learn from them, and how I was going to represent them in the study. In interviews and in "off" times during the classroom observations, I would talk to them about the importance of their voices in this study and how I was truly learning from them. From what I understood from Theresa and the students themselves, students trusted me and were glad to talk to me about their learning.

Ethics metaphorically sat on my shoulders throughout the data collection period into the writing process (and I am sure the defense as well) causing continual reflection; "how do I tell the story of a teacher and her students in a way that is complicated, honest, and critical, yet kind and sensitive?" From beginning to end, I conducted this study fully considerate of ethical concerns.

Role of Researcher and Researcher Subjectivities

According to Erickson (1973) "…ethnography should be considered an inquiry process guided *by* a point of view, rather than as a reporting process guided *by* a standard technique or set of techniques" (p. 10). Similarly, Strauss and Corbin (1998) argue that researchers cannot enter studies without any bias, or *theoretical subjectivities*, but rather must become cognizant of her subjectivities and be open about them with readers.

Crapanzano (1986) additionally recommends making the role of the researcher apparent. This study was conducted at Alomar High School, the school where I taught science for several

years and the teacher was a former colleague of mine. I have a vested interest in urban schools and thinking about what successful teachers and students do to learn science. I am biased: I believe that despite the often negative reports from our city schools, the positive radiating from urban public schools are often disregarded. Throughout the dissertation, I try to make my role and many subjectivities apparent.

Validity

Drawing on Hammersley and Atkinson (1983), Creswell and Miller write, "Validity refers not to the data but to the inferences drawn from them" (2000, p. 125). Therefore, it is not the point to "get it right", but rather to create the depiction in a way that does the context justice. Creswell and Miller define validity as "…how accurately the account represents participants' realities of the social phenomena and is credible to them" (p.124-5).

In an attempt to make this study more compelling and "valid", I employed member checking, triangulation, and thick description. For member checking, I interviewed students to get an idea of their perspectives of critical events and tired to use participant words and quotations as often as possible. To triangulate data, I not only observed classroom interactions, but I asked students and teachers about these interactions, and mapped how some events were taken up at different points in the lesson. These multiple vantage points provided confirming and contradictory stories—making the ultimate story more complex. Validity in this study was attended to through "thick description"—in my role as researcher, my ability to tell a story of a group of people in ways that most bring the reader "there", the data coming alive for the reader—the details painting a complex picture. Finally, I attempt to write in a way that is descriptive (hopefully not ad nauseum) and helps the reader experience the study as best as I can through words.

Limitations of Study

With respect to the data collection, there are three primary limitations: 1) length of time in the field; 2) need for more member-checking with students; and 3) questioning if this dissertation speaks for the needs of all students. Regarding the analysis, there were two primary limitations: 1) assigning through writing/reading of causality and 2) the broadened use of public pedagogy and affinity spaces. I more rigorously describe each below.

One of the strengths of ethnography is that the intensity of the field work allows the researcher to immerse herself in the culture and the data. While I was fortunate to have taught for the school prior and had a good idea of the school culture, I only conducted detailed observations of the class for three weeks, the duration of the unit. Three weeks is relatively short for an ethnographic work and cultural immersion, but I felt I had a strong data set with which to work.

Additionally, I would have liked to have had the opportunity for additional member-checking interviews. Data collection was completed in April—and I would have liked to interview students after the codes emerged more clearly. The codes only emerged as I began reading/re-reading the data and the students had already left for the summer and were on to the next school year. While some of the open codes emerged early and I was able to talk with students about those—I would have liked to have the more re-fined codes for them to discuss and to hear their perspectives.

One of my lingering questions always comes back to, "Did this classroom environment serve *all* students?" This notion is of great concern to me as I think about how to make classrooms powerful learning environments for all students. I have been back in the classroom as a high school teacher now for two and a half years and I am constantly reminded that the

"squeaky wheel" students get the attention. With the exception of Kevin, the other three focal students were students who caught my attention. Yet I know from interviews that one of the most powerful experiences and catalysts for change in my own thinking was quiet Kevin. What was missed because my focus was naturally drawn to those who participated "louder"? What were the experiences of the silent and quiet students?

Causality is also a concern for me as I present my findings in writing. In this study, I share how this pedagogy with these students, in this particular urban science classroom, engage the ethics of stem cells. As Nasir and Hand write,

> On one hand, we must understand the local environment where learning takes place and know how culture plays out in these settings. On the other hand, we cannot lose sight of how such settings make up and are intertwined by broader societal forces. (2006, p. 452)

It is worth mentioning, I believe, that while ethnography is tremendously powerful in its site-specificity, it is also dangerous in how it is presented, how it is read, and how causality is assigned. Therefore, I must be very specific in that I only looked at one frame of urban science education—and there are so many other societal forces intertwined in the context.

CHAPTER 4 TEACHING SCIENCE AT ALOMAR: A DESCRIPTIVE PORTRAIT

In order to create familiarity with the context of the study, I use this chapter to paint a vivid picture of Alomar High School, Classroom 507, the classroom environment, and the four focal students. These descriptions are much greater in detail than the demographics used in the methods chapter to situate the study. The school is a traditional, formal, urban high school—likely similar to other schools in the city and perhaps urban schools nationally. However, in so many studies of classrooms in urban schools, the studies are located in magnet, charter, or selective enrollment schools or are advantaged by a university grant or partnership. Part of my rationale behind selecting Alomar is because it is not a privileged city school, it is a neighborhood school with no extra funding to the school or classroom from this study. While within Alomar there is a math and science academy, the students in this classroom are not part of that small school. I do this purposely as this study pushes on our imagination: what science teaching and learning can and does happen in under-funded, neighborhood schools? What is happening in urban science classrooms that, with no additional funding, can engage students in deeply thoughtful science? Following the description of the school and classroom, I introduce each of the four focal students to help you, the reader, get to know them as their stories come up in the varied and rich vignettes.

Alomar High School

Alomar High School begs attention—a formidable building visible from miles because of its height and location at the intersection of two large streets. From this intersection facing east, the school sprawls across the street by way of a bridge connecting the academic building to the gyms, athletic fields, and pool. Facing west, there is a historic street — marked by two 59 feet

tall steel flags that span from the north to the south side of the street. Standing on this corner and looking all around, the signs of increasing gentrification bear down on Alomar.

Inside, students traverse the floors via escalators (up to the seventh out of eight floors), three staircases, and two unreliable elevators. Like many urban schools, metal detectors greet students, teachers, and visitors in the vacuous two-story lobby. Student bathrooms are deplorable: stall doors missing, mirrors scratched so reflection is near impossible, absent are soap and paper towels, and toilets often clogged. Walls dividing classrooms are thin— voices and noises of classroom discussions floating between the rooms. The roof and windows were renovated during my study—necessary repairs as the roof leaks and the windows are ineffective (letting the elements in and the air conditioning/heat out) and a safety concern (many windows being bolted shut from previous years when students threw furniture out the windows). Deans, security guards, cafeteria staff, (and several students dodging class) move through the halls during class time.

Alomar High School, through both folklore and reputation, is simultaneously a source of pride and concern for alums, teachers, and community members. Luiz Pedreira (a pseudonym) wrote about his memories of the school and his beginnings as gang member in *Two Different Families* (also a pseudonym)—a Bible of sorts in the school. The Latin Kings (a local and now national street gang) and Alomar High School, though seemingly odd bedfellows, share a rich history: the Kings stood up against police violence and fought for youth education aiding the formation of Alomar in the 1940's and now, in their current relationship of Alomar serving as a gang recruitment site (and as a site for drug sales).

With the implementation of Opening Doors (a pseudonym) 2010 in 2004, a city-wide initiative to close underperforming schools and reopen schools as magnet and charter schools in

the city (spearheaded by the then mayor and then CEO of the city schools), the city has seen many school closings. Under Opening Doors 2010, schools not making "annual yearly progress" (AYP) over several years are closed to be "reconstituted"; between 2004 and the spring of 2010, this amounted to 61 schools—including nearby high school, Alex Haley High School, roughly five miles west of Alomar and in rival gang territory. In 2007, when Haley closed, Alomar High School violently "welcomed" 150 Haley students (out of 7,000 displaced Haley High School students). With little warning of the new enrollments, Alomar was unable to find classrooms for the students—housing the students in the auditorium for over two weeks until placements could be made. Violence took center stage as the school stumbled through the transition with incidents including over twenty fire alarm pulls, stabbings, and near daily fights. Rumors (heard from teachers and security guards) flew that the school was ranked as the most violent school in the state during this transition year—though I could not find any sources to back up that tale.

Yet, it was often with a great source of pride that parents and family members would re-enter the halls of their alma mater reminiscing about the days they attended the school. It is important to note that I have purposely drawn a dark and grim picture of the school and described the negative press it often receives because I can: I can depict the school mirroring the stereotypic image of an urban school—akin to that in movies such as *Freedom Writers* or *Dangerous Minds*. Alomar High School can be violent, crippled by gang violence, underfunded, broken, but real. These are not untruths. But, more importantly, these descriptors do not tell the entire story of Alomar and I would be remiss by describing the school with doom and gloom as my only paint and brush. To do so would reinforce the very deficit perspective I hope to temper with this dissertation. For inside, amidst the stereotypes, are people. The students and teacher of

whom I speak are complicated, diverse, thoughtful, intelligent, dynamic, though the media often depicts them otherwise.

Alomar High School is, at its heart, a community school. On the weekends, local churches rent out the auditorium and lobby for services. Weeknights before tax time, tax preparers offer their time to help Alomar community members with taxes. Night school for many of the neighboring high schools is held at Alomar. The school co-operates the swimming pool with the City Parks and Recreation-- members of the community, students and teachers use the facilities. With the success of the varsity baseball team (winning City Champs for more years than I can recall) and the prominence of the baseball diamond on the campus, it is common to see passersby stop to watch a varsity baseball game. Skateboarders with video cameras flock to the benches and ramps located on the east exterior of the building. Students and teachers have planted gardens around the school and the lobby was recently made more welcoming with the installment of tiled murals lining the pillars and several walls—designed, made, and installed by students led by an art teacher. Athletic teams run the stairs and sprint the hallways after school lets out because practice space is shared and overcrowded. The recycling club deposits recycling bins and collects its contents. A local prestigious hotel partners with young chefs in training—sending graduates to nationally ranked Kendall College, Culinary Institute of America, and other professional culinary programs (the school participates in many culinary competitions around the city and puts on a fully operational restaurant once a month for teachers). The Army Junior Reserve Officer Training Corp (JROTC) program has won competitions, has opened for professional teams in the city, and taken students on annual camping trips out of the city. It is here where these stories are set: re-framing the negative and reexamining the education and power of the students within its walls, foregrounding the positive within the school. It is here, in

this classroom with these students and teacher, where I began to see how in *this* classroom, a community of practice was created.

Classroom 507

Figure 1. Images from Classroom 507
For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

Classroom 507 is a bright classroom—the outer wall lined with tall windows (see figure 2 below). The benefit of being on the fifth floor of a tall building is the southernmost view of the

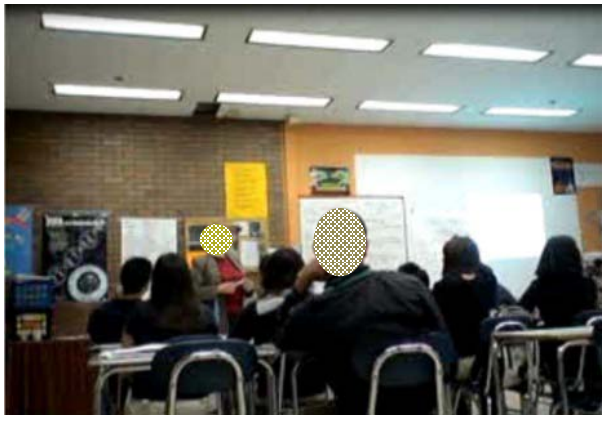

Figure 2. Students in Classroom 507

City's beautiful skyline. Most mornings, the classroom lights are off—with the natural light streaming in. Classroom desks are rarely organized the same way each day—some days desks are lined up in rows, other times in pairs, or groups of four, spread around the room for a large group discussion, or any number of iterations based on the lesson for the day. Student work, posters, plants, a full-sized skeleton, and other bright pictures decorate the classroom. In the back corner, there is a large cabinet with books and along the back wall—a shelf with supplies,

extra textbooks, and paper for students should they have forgotten theirs at home. Any "extra space" is filled with materials for clubs, projects are pushed into shelves, under tables, and in other crevices—a lot of stuff for constant movement, activities and extra-curriculars. The vibrancy of the classroom was the result of contributions of energy and manual labor by Theresa and students.

The classroom itself is physically run down. The window shades are old and yellowed—covered with posters and student work; some parts of the room updated with a paint job courtesy of Theresa and students the previous summer (orange for the front wall with a large white rectangle to project against) (see figure 2). The overhead projector precariously balanced on a tall table near one of the two computers in the classroom. The room is not designed for science: there is only one sink in the room, no lab tables, microscopes, or prep areas for labs. Yet, Theresa and her students make it work for their needs.

The classroom door is opened long before first period begins. Student morning routines vary before the bell signaling the beginning of class: some students come in and drop their backpacks off and leave to see friends or teachers; others come in and sit quietly; and others come to talk with Theresa and peers. Prior to 8:00 in the morning, the feeling is laid back—everyone trying to wake up for the day. However, this relaxed feel shifts at the bell: class starts with the bell and runs from bell to bell—packed with action. Most days, Theresa has student "brain food" worksheets (a multi-purposed bell-ringer) sitting on individuals' desks—and a question to get students started. To her chagrin, Theresa battles tardiness much like every other teacher at the school; she has tried many tactics (reminding, extra credit, loss of points, and practically begging) to get students to class on time. Some days, a full class was not present until

ten minutes after class had begun (tardiness to first period is a problem for many schools—as it was at Alomar). However, Theresa and the students who were on time started promptly.

This was the first time Theresa had undertaken teaching and learning about stem cells with students and it was the first time she concluded any unit with a debate. The unit was not part of the curriculum of the school—Theresa was the only teacher at Alomar trying it with her students. To prepare both herself and the students for the unit, she co-wrote the unit with other city teachers through a district and university partnership (although she received no funding for the partnership). In addition, she read articles, found library books, located case studies, and looked through websites for student use (Interview, March 9).

Theresa's classroom is unlike most of the science classrooms at Alomar. Theresa was constantly changing her curriculum to change with the needs of students and the ever-changing body of scientific knowledge. Theresa was the acting chair of the biology department for several years until a recent political move by several science teachers relieved her of this position. More specifically, many of the teachers in the department did not agree with hands-on or inquiry-based science pedagogy and wanted to move the department to a textbook driven, standardized test approach to teaching science (field notes). Theresa was both thankful to be done with department chair duties (at Alomar, it is an additional duty with no additional pay), but also frustrated with the shift in philosophy and unorganized meetings in which teachers haphazardly write assessments and curriculum. She has, thus far, been attempting to resist the current political climate while working within it: she designs her units and lessons as inquiry for her classroom, but also spends hours writing thoughtful multiple choice questions to submit to the department. It is in this classroom, with this group of students and this teacher, this unit comes to life.

Classroom Environment

Students often echoed one another's feeling of the community within the classroom, saying things like, "Everyone in class agrees with each other—everyone just gets along but there are some days that they just don't want to be bothered by others" (Mismin), or "Not to be to cheesy-- but since we have known each other now for two years, we have become like a family and that even though we might get on each other's nerves-- it is still okay and we get along" (Eric), or talking about the classroom's "aura of calm" or that the "classroom is a family" (Bob). The vignette below demonstrates how their idea of "being like a family" with an "aura of calm" manifests itself in this classroom.

It was Monday morning, around 7:30 and I brought the class breakfast. Already in the room were five students (including one focal student, Michael) and teacher: Myra, Bob, Eric, Corazon, Michael, and Theresa. Students and teacher were informally talking with one another, waiting for breakfast to start and the school day to begin[6]. I present this short pre-breakfast discussion to introduce the fluidity of banter among students and teacher and to encapsulate the types of relationships found within this classroom.

1	Theresa	Okay guys, here you go- (she has finished setting up the table of food, organizing and shaking the orange juice as I have left to move my car)
2	Jacob	(pointing to the orange juice) Which one did you…?
3	Theresa	I shook that one. (Jacob grabs that container of orange juice)
4	Bob	I want some orange juice.
5	Michael	You should let the ladies get it first.

[6] In full disclosure, I was not here for this event, having left to move my car, I found this event after it happened when I transcribed the class session.

(Corazon and Theresa are standing near the table).

6 Jacob I'm opening it for her.

7 Theresa (Michael reaches across Corazon)

Maybe you should walk around it (gestures around Corazon) instead of reaching in front of her. (Michael starts moving around Corazon).

8 Theresa Ahhhhh! (as he does this)

9 Eric (Eric re-enters the classroom and looks down)

Only Ms. Theresa would have fruit at breakfast. (students laugh)

10 Theresa Actually, Ms. Slaton. But you're right, I would have fruit. It's called *real* food!

11 Michael (Jacob starts to get food. Michael puts his hand on Jacob's chest).

We need to wait for everybody.

12 Eric So we can pray (inaudible).

13 Michael Let's all hold hands (puts his hands out)

14 Eric We need a separation of hand and body.

15 Michael Hold hands.

16 Michael Bow our heads and pray (moves over to William in a posture of prayer).

17 Eric No, you gotta get the food first! I'm dead serious.

18 Michael Come on! We gotta pray. (William takes Michael's hand.)

19 Eric Come on man! We gotta hurry up.

20 ? (students grab each other's hands. Theresa has her hand on Bob's back nudging him towards the other students holding hands)

Hold hands.

(Theresa walks away—she is not part of the prayer session. Bob takes a step

back away from the students and puts his backpack on).

21 Eric (orating enthusiastically)

Blessings on high—beautiful. This food is not only delicious but nutritious for our bodies. Amen.

22 Stm That's a prayer!

(Michael takes a step back and does the sign of the cross and kisses his hand. They drop hands and start getting plates, napkins, silverware, and food)

(students talk about the food and more students file in. When I enter—several thank me.)

In lines #1- 8, students and teacher are negotiating rules and manners associated with breaking bread at breakfast. As Jacob pours himself a cup of orange juice, Michael encourages

Figure 3. Students Praying Over Breakfast

him to let "ladies [go] first" (Line 5) and Jacob follows his suggestion (even playing off that it was his idea in saying, "I'm opening it for her" (Line 6)). Theresa instructs them not to reach across each other as they get food and drink later reinforcing this when it is done (lines 7 and 8).

And even when Corazon ends up pouring juice for others-- but with reminders, the boys were forced to contemplate their habits. Lines #9 and 10 demonstrate that Theresa has spoken with students about healthy eating such that Eric says sarcastically, "Only Ms. Theresa would have fruit at breakfast" (line #9) and students laugh, indicating he is right and they agree with his joke. This give and take also demonstrates a playfulness: that teachers and students can joke, poke fun, and that this does not seem out of the norm. At line #11, Michael stops Jacob from eating-- asking to pray over the breakfast food. There is some compromise in this plan: Eric suggesting they get plates of food first, Bob stepping out (with nudge on the back from Theresa), and further deciding to hold hands. In the end, most students spontaneously prayed before eating.

Not being one to pray over my own food at every meal-- I was not expecting it to happen in the first place, but it was not purely the surprise factor/students doing something unexpected that made this significant. I wondered if this caught my attention because I often don't see young men holding hands and praying (outside of championship athletic games). I contemplated if I thought it was significant because it was religious (Alomar is a public high school)-- but having taught in the school before, I knew several students were very religious and this did not seem unusual.

I realized later that this vignette demonstrates the comfortable nature of the classroom—a space where students were encouraged to come as they are. It is ultimately significant because it illustrates the effortless, natural way the students and teacher interact. This scene opens with the students slowly approaching and surveying their breakfast options. They begin to serve themselves and engage typical high school talk—greeting one another, joking, discussing the food; at first glance, this breakfast is fairly ordinary. What makes it remarkable is their natural,

common ways of being with each other provide insights into the interpersonal dynamics of this classroom.

Embedded within this playful banter are negotiation of rules and manners, discursive practices, familiarity with one another, and the fluctuating participation in-group events. They appear to work like a healthy, functional family—with playful banter, disagreements, but a strong sense of respect towards one another. While the prayer appeared to be neither ritual nor routine, it seemed to be seamlessly taken up by other students and their self-described non-religious teacher. This was evidence that this group of individuals had established relationships in which it was okay for students to joke with their teacher, correct each other's manners, and for young men to voice a request (even an intimate one holding hands), enact the request, and participate in something not often found in public schools (young men holding hands).

I asked Michael about this impromptu prayer session and he told me, "Telling everyone to hold hands and pray: it helps us make a bond. Here we are a bunch of guys holding hands—something that everyone thinks is wrong—but with this group—it forms a bond. Holding hands and praying—it's a bond" (May 7). Michael later told me that he is not so religious he goes to church every Sunday (though he prays before every baseball game) -- but that "it was like, you know what, let's just say a prayer. Let's do something new and it was fun."

Keep in mind, a classroom community of practice does not have to operate as a pseudo-utopia or a social anomaly in which everyone thinks alike and agrees. This is true in a family as well—functioning families disagree and argue—but how they do it is important. According to Wenger,

> Because the term 'community' is usually a very positive one, I cannot emphasize enough that these interrelations arise out of engagement in practice and not out of an idealized

> view of what a community should be like. In particular, connotations of peaceful coexistence, mutual support, or interpersonal allegiance are not assumed, though of course they may exist in specific cases. …there are plenty of disagreements, tensions, and conflicts [members]" (1998, p. 76-77).

This is true in this vignette and classroom as well: not that everyone in the class just goes along with what another student suggests. In an interview, Michael himself admitted he wasn't sure if everyone would participate. He said he might have tried—but didn't think everyone would do it. He said this wasn't "some serious thing of having to pray—but to make it fun" (May 7). In this family, students joke, play, correct each other, remind each other of manners, listen, and can be themselves; but like any family, they disagree and negotiate. On a cursory level we know that students (and teachers, of course) gossip, create sub-groups (cliques or crews), (dis)like each other to varying degrees, express (dis)interest at hearing each other—but how does this impact the learning environment?

It is moments like these, where a teacher encourages the suggestions of students when we see how such actions creates an environment supportive of student-student interaction. While Theresa is not a religious person—she encourages the students to pray over the food—allowing them the space to be themselves in the classroom space. The "allowance" of these moments (what Olitsky might call "interactional rituals" or "synchrony) encourages talk—talk that ultimately, as I think ahead to future chapters in this dissertation, develops into science talk. As students in the beginning of this section mention, they feel like a family in this classroom with an "aura" of calm—and moments like this breakfast illustrate this calm.

Focal Students of Classroom 507

I now shift attention (and will return later) from the large group class environment to introduce some of the students, the focal students, in Classroom 507: Mismin, Michael, Molly, and Kevin.

Mismin

Mismin was 16 years old at the time of the study. She self- identified Hispanic, Mexican, and Catholic (saying she "knows her stuff" and "feels very religious" but has been attending church less frequently than she would like). Mismin described herself as quiet and clumsy—blaming the later on her April 1st birthday. I would describe her as eager to please, warm, awkward, punctual and diligent. I first met Mismin at a field trip to a city museum before the study started. At this field trip, she and I realized I taught her older sister when I taught at Alomar years back—this exchange providing me entry and a little bit of "street cred." She was glued to my side the whole trip—even indulging me by accompanying me to my favorite exhibit, the Hall of Gems.

Of the students who agreed to be interviewed, I was initially worried that Mismin was reticent to participate (somewhat nervous at the beginning of interviews), yet by the end of our interviews, she would ask when we were scheduling the next interview, seemingly excited for the next. She and I disagreed on her participation style: she called herself quiet while I observed a great deal of participation in class. Perhaps this discrepancy from what I observed stems from what appeared to me to be her awkwardness and discomfort talking in class. According to my field notes, there were only two days she did not speak in class and those were the days the other team was debating. I found myself taking note of actions that demonstrated what I think of as "being present": answering teacher rhetorical questions (e.g. is everyone ready?) or raising her

hand to show she had heard of something. Often her talk was procedural—asking Theresa about the "brain food" (bell-ringer), how to spell something, or to clarify a direction. She did this in a way that demonstrated to me that she was a conscientious student—trying to ensure that she had written down the required information.

Yet, often her conversation was often much more personal, and she allowed her teacher and peers to see her thinking on issues. While a couple students also talked about religion in the class—it was Mismin who spoke of it the most, and she was the first student to bring it up in relation to the stem cell unit. With regard to religion, ethics and stem cell research, she often vocalized her own struggles to the whole class in determining what was right or wrong, something I coded as "Devil's advocate" (something of which I spend time writing about in greater detail later).

In later chapters, I talk a great deal about Mismin and the nature of her talk and social interactions, how she helps us understand the influence of peers on one another's thinking and on her own thinking.

Michael

Michael was selected as a focal student because of the various roles he played in class (as a leader, peer support, researcher, and introducer of popular culture). Because of his large stature, he was simply difficult to ignore (he looked more like a college student than a high school student). When he walked, peers seemed to follow.

Michael and I talked sports each day: NHL hockey was closing out their season and MLB baseball was just beginning the 2010 season. We'd talk and recap random Sports Center highlights and talk about his shoulder injury that was preventing him from pitching and playing first base. One day, the class was talking about the ethics of athletes using steroids, and he was

genuinely concerned that he was using steroids in receiving steroid shots in his shoulder (he and I talked about the differences and he seemed relieved to know he was not on steroids—though maybe in a macho sort of way—disappointed to not have doctor sanctioned illegal drugs).

At the time of the study, Michael was 16. He self-reported as Hispanic (Puerto Rican and Irish) and Catholic. He described himself as confident and his confidence showed in classroom observations and interviews. In class, he appeared comfortable talking and although he doesn't like it when he is wrong—he noted that sometimes you "…just have to throw ideas out there to get your participation points. You learn from your mistakes." (Interview, April 6). He says he gets his work done—but he knows the line of when he can make it fun and joke around and when it is time to work.

Being a baseball player at Alomar was historically a big source of pride for students. The school has one of the only baseball fields in the district and they have a long tradition of winning city championship games (in which they play at a pro ball field near the city). This year, however, there was an unusual dynamic involving the baseball players: there was something akin to a gang war between several gang/crew members and the baseball team. I had heard about it from teachers and a couple of security guards (several big fights broke out between gang members and baseball players while I was there) and Michael also mentioned the fighting in interviews. Because many of his teammates have learned that he doesn't get into trouble, they have stopped asking him to hang out with them—thus challenged his social place on the team. However, in class, Michael's ease of leadership style, self-awareness, and confidence led him to be a powerful focal student—often taking me by surprise with his actions.

Kevin

Praised by peers and Theresa as the smartest student in class (and he humbly agreed), Kevin already completed high school and gained acceptance to a Philippine university prior to leaving his home country and was now repeating high school for the second time. When he moved to the United States (California), someone from that school district told him it was unsafe for a student his age to not be in high school and required him to go to high school again. When his family moved to Chicago, he matriculated at Alomar. We spoke about going to college instead of his senior year and he said he would be interested, but decided to stay in high school and build his resume.

In this section, I share a few stories about Kevin that struck me. The first is his explanation of his tardiness and the second relates to his thinking about religion (substantiating his "85% Catholic and 15% Agnostic" comment). Both stories I found I could not cut because they were so explanatory to who Kevin is—as a student and person.

In our first interview, we talked about his tardiness. He attributed it to self-diagnosed OCD. On the first day of school, because of nerves, he woke up unusually early and did things he said he would not typically do to pass the time until school started. The following day, he repeated this routine. And then the next day. In a *Groundhog Day*-esque compulsion (my words), he found himself bound to these seemingly arbitrary routines (practicing piano, eating, going for a walk, going to the bathroom twice, among other things) following his schedule from the first day of school. Eventually, this schedule became his established routine for the rest of the year. His tardiness to class, then, is due to the fact that he cannot wake up as early as he did the first day, but feels compelled to follow this routine he is often late to class. His tardiness has no impact on his grade and he enters the classroom quietly and without interrupting the class.

Kevin did not simply answer questions directly in an interview—he thought about them, reflected on them, and talked through his ideas. For example, when focal students were to identify their religious beliefs in the first interview, most replied quickly "Catholic" or "Christian". Kevin, on the other hand, took me through an internal struggle with his growing doubt of the Catholic Church. Describing himself as 85% Catholic and 15% Agnostic; his secular education in the Philippines conflicted with the discrepancies he began to see between the Bible and religious practices he saw around him. He shared a story of attending a revival in which people spoke in tongues and priests healed the ill. At the revival, Kevin could not understand what those speaking in tongues were saying; he argued, if they were truly speaking in tongues as per the Biblical description of the Pentecostal miracle, he should have heard the Word in languages he knew (English, French, or Tagalog), not an unintelligible language. This discrepancy cast doubt: were people "pretending" to speak in tongues and if so why? Similarly, his suspicions grew when was pushed on stage to be "healed". He saw the pastor push people backwards and they fell; he wanted to test this—so when the pastor pushed him—he pushed back, refusing to fall back. The pastor gave him a look and Kevin decided to fall back; this idea haunted him: why did he have to pretend to fall back? I share these two stories because I think they present an interesting facet of his life as a student and thinker.

Molly

Molly was dynamic, claimed she "wanted to be a stem cell researcher," had good command of the content, spoke to me frequently in class and established a relationship with me early on in the study. She always greeted me with a smile and asked how I was. Of all the students, I spent the most time with Molly. I interviewed her several times, observed her, chatted with her after class and after school, and we (Molly, Theresa, Stephanie, and myself) even went

to a peaceful rally to protest the district's proposal to eliminate teacher jobs, increase class size and board member raises.

Molly, a 15 year-old Hispanic (Puerto Rican and Mexican) and self-proclaimed atheist (acknowledged her parents are "kind-of" atheist), was incredibly involved in school – re-creating and leading the school's student council. Under her charge, an assistant principal gave the students an unused, dirty, and run-down classroom to hold meetings. The students cleaned, painted and organized the room--with further plans for renovation following my observations.

Molly and many other members of the student council spoke at a March 17th PTSA (Parent-Teacher-Student Association) meeting and requested that the student council become a permanent fixture on the agenda-- requesting changes and making suggestions for the school and an opportunity to follow up with them on the implementation. For example, upset by the conditions of the bathrooms-- the students researched and presented to the PTSA. Aside from documenting the facilities with pictures, they also went to a local Wendy's and McDonalds--taking pictures of those bathrooms. They then compared the number of times the school bathrooms were used in comparison to the fast food restaurants-- noting that the restaurants' bathrooms were in better condition and used more frequently. At this meeting, the student council thanks the PTSA for putting in the paper towel dispensers (they were installed the day before) and then asked for more improvements. Molly cautiously and politically said they were not trying to place blame but to instead bring awareness and solutions to some of the school's problems. Molly and her student council peers got their regularly slated time on the PTSA' s meeting agenda.

Molly was as tenacious about change and school improvements as she was about school and learning science. In fact, Theresa went to the city library to get Molly extra books on stem

cell research prior to the unit at Molly's request. It was not uncommon for Molly to ask Theresa when the debate was being held-- anxious for both the action of debating and talking about stem cells. Following a video in class, Molly mentioned several times that she wanted to become a stem cell researcher. Molly was one of the top students in the class and has a genuine passion for science. One of her biggest pet peeves was when students reported inaccurate science but sounded like they knew they were correct-- out of respect for the science, she claimed, she would correct them.

Molly was in class with her best friend, Stephanie-- whom both decided many classmates liked, but also expressed that peers thought they were "smarty pants" who "didn't give others a chance". Stephanie additionally noted that while they were best friends and both straight, many people thought they were lesbians because they often were seen in hallways holding hands. They were inseparable--I even found it odd to see one without the other. They interviewed together and were together often; on one occasion, they forgot about an interview having not slept the night before baking mass amounts of cookies to raise money for a fundraising walk the following day (they still did the interview when I reminded them—despite their exhaustion).

Focal Teacher of Classroom 507: Theresa

I now turn attention to the teacher in Classroom 507: Theresa. In an interview, she once said, "It's my job… to teach [students] how to look at something and to *really* look at it." (Theresa, Field Notes)—and I think this nicely encapsulates her teaching philosophy. Through observation, I saw what appeared to be admiration and appreciation for Theresa as a teacher; students seemed to like her. Moving beyond my observations—I asked students in interviews what they thought of her as a teacher and these are a few of the things they said:

- She is awesome and knows **how to explain** the material. She'll (like) act it out while explaining it. She's **open-minded** because not everyone agrees on the same things. (*Mismin*)
- She's a great teacher. She gives **great opportunities**, she just, she needs to open up more. I know she's **goofy enough**, and she has fun, but she tends to get in a mood where she'll trip for no reason. It's like, there's been a couple times where I've asked her for help and she's been like, **"oh, you should know that"—attitude**. But then she also does help, so you know, most of the time, she's real cool -- **she's a good teacher**. She teaches you the material-- I like her as a teacher. She's got flaws, but everybody got their flaws (sic). (*Michael*)
- …Great. She is enthusiastic. She is not like my previous science teachers—who were not enthusiastic but expects a lot. [Clarifies] **she expects a lot**- but **will explain** if you don't get something. That she does the work as well. (*Kevin*)
- What she does is very **memorable**. It's not reading out of a book, being drones—it's engaging yourself in what you're doing. [Ms. Theresa] seemed really excited in learning about it. She is very open-minded and that she **doesn't ever push her ideas** on another. She's very **passionate** about science. (*Molly*)

The students, whom I interviewed, experience her teaching as positive, calling her open-minded, passionate, knowing how to teach material, maintaining high expectations, and memorable. Michael was the only students who expressed some concern saying that Theresa might "trip[7] for no reason", but also acknowledged that if pressed, she would always help. These short quotes

[7] The term "trip" means to get pissed off or become irritated.

demonstrate that her neutral teaching position was embraced and favorably responded to by students.

I argue that one of the primary reasons students liked her is because of her refusal to share personal opinions of science with students—allowing them to make up their own minds about the topics of which they studied. I talk about how Theresa saw her role as a teacher to help students explore ideas for themselves. Specifically, in this section, I unpack how Theresa's silenced opinions regarding stem cell research (and other scientific topics) in discussion encouraged independent, scientific thinking, and provided the space for students to explore, develop, and take ownership of their own ideas. Because she kept her opinions private, students can and did share ideas freely—feeling safe to engage the ideas and play with them in their heads. As the quote above alludes, Theresa felt her role in the classroom was to teach students to learn-- but to go deeper in their own thinking.

To introduce this section, I included student opinions of Theresa as a teacher. Foundational to her pedagogy is the imperative of safe community—one in which comments are welcomed and honored—and their comments of her as a teacher reflect how they feel in the classroom. In the following section, I unpack Theresa's teaching from her perspective and then move into observational data using a short classroom discussion to examine how her teaching is taken up and plays out in the classroom.

Theresa's Teaching: In her Own Words

Regardless of how she personally viewed stem cell research, she *attempted*[8] a public stance of neutrality; by public stance of neutrality, I mean being silent on her personal opinions

[8] In another interview, she talked about how even presenting issues shows bias and there is not a way to be completely unbiased—however, it is a goal of hers in her teaching.

in order to encourage students to develop their own opinions. During one of our conversations, I asked her what happens when students disagree with her and she replied,

1 I try as much as I can, to be respectful of how they think, but I also challenge them in their thinking.

2 That would be the same as someone who agrees with me—that I would challenge: [I would ask] "Why do you think that?"

3 I try really hard not to show a face… I try really hard to keep asking both sides the same way.

4 I think either way—if you're too one way or the other—you limit conversation.

5 I try [to be non-biased].

6 I think that sometimes I can't be—not can't—but I don't do a good job.

7 But maybe there are ways [to improve] because bias is a huge deal.

8 Or maybe I should work with them once—the way I present it can bias they way they think and then I can present it the opposite way and then show how bias can make them think again.

9 Because we talk about bias in science—but it's hard to talk about when it's abstract. It's a really hard concept to work with. (Interview, May 8)

In her response to how she thinks about neutral public stance, she talks aloud about both how she values neutrality, but also how difficult it is in practice. In lines #1-2, she talks about her tools or techniques for consistently challenging students—regardless of if she agrees or disagrees. In class, she will say things like, "say more" or "can you explain that" to urge students to talk more and emphasize their thinking and ideas—resulting in students seeing her as a teacher who challenges thinking but also then emphasizes the thinking process. In line #3, she talks about

how she tries to “not show a face” or to keep a poker face and in line #4, she substantiates her logic: being overly aggressive in pushing her perspectives could limit conversation. As she reflects on how she can improve on being bias-free (lines #5-8), she then dialogically moves into a new stream of thought: how there is bias in science and we often do not discuss it with students—perhaps because it is so difficult to conceptualize. This experience with stem cell research presents the opportunity for the students to question something as seemingly abstract as bias or ethics in science and for these ideas to become real and tangible. As students have authentic scientific discussions—evaluating the ethics of stem cell research—they are themselves engaging with the idea of bias, a concept Theresa notes is hard for students to understand.

Theresa’s pedagogy opened up floor space, which provided opportunities for student discussion and working through their ideas as a class. As a teacher, a person with power and authority, Theresa’s opinion can often influence her students—more than the opinions of peers might or her voiced opinion could also disrupt student discovery of their own ideas—being a “good student” can also mean listening to the teacher. It is this self-discovery and student thinking Theresa strove for in her teaching.

Theresa constructed open-ended assessments that highlight student thinking. For example, students completed a “brain food” (her term for a bell ringer) each morning and on one morning in particular, she encouraged students to think deeper about their work and the process of thinking versus trying to get the right answers. Saying, “Some of you… you are still in the mode where ‘I’m reading the biology book’. So I’m not getting to know what you really know, or how you think. That was the whole purpose of this activity” (March 8). Similarly, when she graded, she gave more credit for the explanations than for the correct answers on a test—requiring explanations of each answer (August 3, interview) (for example, if the question was

worth 5 points, the answer itself might only be worth 1 or 2 points, whereas the correct explanation was worth more). In this classroom, Theresa wanted students to demonstrate content mastery, but she did this in a way that further pushed their thinking and explanations.

Additionally, she wanted to showcase student knowledge publically and her belief in her students as thinkers sparked the idea for the debate. Theresa wanted to see how students took ownership of the content and showcased their ideas originally, or as she said, "If it's very structured, then you won't get the creativity; whereas I know I can get that out of them." (Interview, March 9). In this case, her role as a classroom facilitator required her to remind students of process: provide opportunities for original student thought and encourage the process of learning. This played out in the classroom with students speaking aloud ideas and her encouraging peer-peer discussion.

Thus far, I have described the school, the classroom, the focal students, and Theresa's philosophy (what I called a stance of neutrality). I once again transition—the last data set I present in this chapter—from Theresa's descriptions and philosophy of education into a glimpse of how one part of her philosophy (neutrality) plays out in the classroom.

Philosophy in Action

On the first day of the unit, students were sharing out ideas on the question, "What is a stem cell?" One of the focal students, Mismin, brings up the idea of religion and stem cells. In this brief vignette, Mismin straddles the fence in describing the religious perspective of stem cell research. As you read, you see Theresa ask questions, challenge, and try to have students talk with one another in this discussion.

1 Mismin Well. (then hesitantly puts her hand up and continues to talk as she puts her hand up, further calling attention to herself). Um, well, I think

		it's good, 'cause it's like a new way of thinking about stem cells—but also, what if it comes out wrong? Or like something goes out wrong? But then in religious ways, it is wrong since you are playing God.
2	Cookie	I don't know about that. (she turns and looks at Mismin)
3	Theresa	Okay (points to Cookie), say that again.
4	Cookie	I said, I don't know about that.
5	Theresa	Why?
6	Cookie	I don't know. What'd you say again? (Cookie looks at Mismin).
7	Mismin	(Mismin laughs.) Like, the reason a lot of people are against it, it's because people, religious people, believe that they, scientists are trying to play God, which they're not—they are trying to create something useful. But… It's not easy.
8	Stephanie	We get you. (several other students jump in to support her on this).
9	Mismin	(Mismin turns and looks at her). But in the other way, we can learn about how different things work.
10	Theresa	So it's a dilemma. It's a dilemma.

In line #1, we see Mismin stumble over her ideas about stem cell research as it relates to God and religion. She begins by saying that it could be good as it is pushing forward new advances in science, but then offers a different take on this idea same idea, citing that it could be dangerous or might be counter to some religious doctrines as it is "playing God". In line #2, Cookie interrupts, a norm in this classroom; instead of reprimanding Cookie, Theresa encourages the peer-peer talk pointing out Cookie and asking her to repeat herself. Cookie (line #4) repeats

herself verbatim and Theresa then asks her to say more (line #5). Cookie seems unprepared to expand on her ideas—asking Mismin to repeat herself. Mismin, still unsure of her own point, stumbles again in articulating: "…A lot of people are against it, it's because people, religious people, believe that they, scientists are trying to play God, which they're not—they are trying to create something useful". In the video, Mismin appears somewhat uncomfortable with her statement—and there could be many reasons for this (the topic is somewhat controversial, could be trying to get her head around her own ideas of religion and stem cell research, it is the first day of the unit and she does not really understand the content)—and her voice is a little unsure. Stephanie jumps in to support (line #8), "We get you." Mismin again says that it could be good—still trying to wrap up her thoughts and Theresa summarizes (line #10), "It's a dilemma." Theresa guides the conversation and encourages the formation of a peer-peer discussion as shared repertoire: one in which students can talk, question, and think aloud ideas.

Classroom communities benefit from many opportunities for students to talk aloud and articulate their thinking, similar to the vignette above, and Theresa provided this. In the large group setting, she often asked open-ended questions and her teaching style was dialogic: she posed questions or shared a piece of information, students talked to her and among themselves, she rephrased student ideas, and fielded student questions. One of the provisions of creating a space in which students felt comfortable contributing was that as a facilitator, Theresa accepted all student contributions (as shown above in the vignette), valuing the contribution, but also valuing the creation of scientific knowledge: if student ideas were in dissonance with scientific principles, she would challenge student thinking through a variety of methods (methods such as questioning, direct correction, invitations for peers to explain).

Theresa's facilitation and "stance of neutrality" allowed for the formation of routines such as asking questions, thinking aloud, encouraging peer-peer discussion, and inviting student comments. Due to this facilitation style, student talk included appropriate interruptions and deviation from waiting to be called on to talk in class. In essence, Theresa modeled the ways of doing things in the classroom—and in a way students found educative.

It was a classroom norm to interrupt a teacher or peer and ask for clarification or to push further. It was a norm to ask somewhat tangential questions or to contribute something that seems related. In this classroom learning environment, the norm was to be open-minded—with the teacher modeling and students following suit.

Discussion of Chapter 4 Teaching at Alomar: Descriptive Portrait

In the next two chapters, I analyze the curricular unit and its enactment through a public pedagogy lens to consider how this classroom was able to deeply engage authentic science. It is important to keep in mind the "feel" of the school, classroom, students, and teacher as described in this chapter when thinking about the curricular unit. Evidence is strong that Classroom 507 was a community of practice—with relationships among peers that fostered a positive learning environment. Without the trust and familial relationships formed among students, this unit requiring students to explore a controversial subject and develop personal opinions on the subject matter might not have happened.

While so often we are looking for a "silver bullet" in education, I purposely discuss the relationships and classroom environment before the unit and curricular plans to underscore that this "silver bullet" simply does not exist. The complex relationships I describe in this chapter necessarily had to be formed before the unit was enacted: the power of this unit is because of the strong relationships built in prior to this unit. While it is *possible* to take lesson plans from one

class and move them to another or share ideas for curriculum (like the common adage to "beg, borrow, and steal" in education)—it is important to keep in mind how this unit was designed specifically for and within this classroom. Keeping in mind these impressions of the school, the classroom, and focal participants, I now share how this unit was designed for students in Classroom 507 and what resources were drawn upon to encourage multiple perspectives.

In the following two chapters, I discuss the unit through the frame or lens of public pedagogy—in *Chapter Five Design and Resources*, I map design and resources onto the curricular unit and in *Chapter Six The Debate as an Affinity Space*, I examine how the debate encouraged student-student talking and learning from one another. The examination of the unit as public pedagogy provides a lens for thinking about what made this unit different when compared to other units in which the students participated.

CHAPTER 5 PUBLIC PEDAGOGY: DESIGN AND RESOURCES

I begin this chapter with quotes from the four focal students because they collectively acknowledge that neither the stem cell unit nor debate was typical for Classroom 507 and set the stage for what made the unit seem distinctive to them. When asked how this unit was for the four focal students, they individually responded,

- **…Hard and more interesting than others**. I think it's good to talk about [religion] in class, that way people from other religions could see different perspectives from a religious point of view. You get to see other ideas—it's the same as electing a president—there is two sides and a decision. There is a right and a (left/wrong) but there is **no real right answer**. *(Mismin)*

- This unit was okay—but it was **definitely different** than the other units. It was **vague** and there was **not a specific right answer**. When asked how he felt this worked—he liked that it was vague—it gave students a chance to figure out what they thought on their own. *(Kevin)*

- Stuff in class is challenging? Yeah. At first, I thought it was challenging because I wasn't really putting myself into it.... and I didn't find it interesting, but **when I started reading and learning more, I wanted to learn more**. *(Michael)*

- It was very interesting-- but every subject we cover, [Theresa] picks something and covers everything. And we study that for that-- we go into detail, which doesn't happen a lot. Most classes just go over the basics. **This was a challenging topic**-- there were a lot of things to cover. *(Molly)*

Mismin and Kevin both acknowledge there was an element of ambiguity unique to this unit as well as the opportunity to develop personal opinions and hear the personal opinions of other students. Michael's comments indicate a shift in dedication towards his own independent learning and how learning had a somewhat contagious effect: the more he learned, the more he wanted to learn. Molly did not find the rigor to be much different than those of other units—but thought this unit was challenging because of the breadth of content. This chapter unpacks what made this unit "different" from others and why students found it challenging and vague.

Public Pedagogy: A Re-Engagement with the Frame

As an analytic frame, *public pedagogy* is typically used to describe learning shaped from public or online spaces; however, using public pedagogy as an analytic tool in a living, breathing classroom, we can expand on ways students and teachers learn, perhaps in ways that model more natural, in situ learning.

Given that Theresa neither set out to construct this unit as "public pedagogy" nor would she call it this now, I use public pedagogy as an analytic tool to unpack the powerful learning that unfolded during this unit.

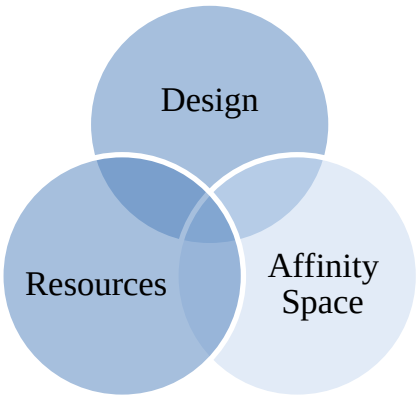

Figure 4. Schema of Public Pedagogy

Recall from *Chapter 2 Framing the Study*, there are three components of public pedagogy: 1) design, 2) resources, and 3) affinity space. For purposes of this study, I draw on the terminology of public pedagogy, but co-opt it in ways that make sense for a classroom. For example, I talk about the *design* as the teacher created unit and lesson plans: her design for the learning about stem cells and how students engage these plans. These design moves created the learning opportunities and experiences I observed in the classroom. Likewise, I refer to *resources* as any and all sources of knowledge that "counted" in the classroom: library books, internet articles, videos, webquests, one another, among several others I will describe later in the chapter. Theresa encouraged bringing in multiple, diverse resources to support learning about stem cells. The last component of public pedagogy, *affinity space*, I refer to a specific time and place in which students co-opt knowledge from the classroom for their own uses and to author their own opinions about the science content; this will be discussed in the following chapter (*Chapter Six The Affinity Space*).

What makes this unit compelling is not just that it parallels public pedagogy, but *how* it parallels public pedagogy-- through its structure (design) and the sources of knowledge drawn upon (resources). This classroom, its norms, routines, goals, ways of speaking, interactions, and relationships, allowed for the possibility of the implementation of public pedagogy, by opening up the classroom space and making student thinking visible, students had access not only to teacher thought, but also one-another. This chapter examines the role of two of the three components of public pedagogy (design and resources) in order to better understand the third component: affinity space.

The first half of this chapter is an in-depth description of the curricular unit to help the reader imagine the curriculum and become familiar with the daily activities. Each week was

broken up thematically (*Week One: Introduction and Piquing Interest*, *Week Two: Common Language and Stem Cell Knowledge*, and *Week Three: The Debate*). I examine the curricular unit (and philosophical underpinnings of the unit) as the *design* of the public pedagogy. Following the design—I then unpack the *resources* used in the unit through vignettes. I explore other observational data in order to see the interplay between design and resources—wherein because of the design, students were able to become critical resources and were able to call upon one another as such. These illustrative descriptions capture the ways Theresa allowed for and legitimized student experiences and how the public sharing of these experiences and resources positioned students as experts and co-constructors of the unit.

The Stem Cell Unit

There is an important yet subtle difference between experience and education, and this unit underscores this difference: an experience does not directly create an education. There are two pieces embedded in this idea: 1) teachers cannot present a lesson plan and have students "learn" exactly what the teacher intended and 2) there is not one education that can results from an experience. Students will make of the experience what they make of it. Dewey writes,

> The belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative. Experience and education cannot be directly equated to each other (Dewey, 1938, p. 25).

Ultimately, teachers cannot control what students learn and internalize, but they can be thoughtful about the creation of powerful learning opportunities, or experiences. In Classroom 507, Theresa cannot control *what* students learn (nor can any other teacher) but what she can control are students' *opportunities* to learn. It is implausible to think that each student walked out with the same understandings of stem cells and the ethics of their use—however, they were

exposed to multiple, common, and varied experiences with which to relate so that each individual was able to engage material as needed. Thus, the following section takes you through the design of this unit. This unit operated as a series of activities— or common experiences— proposed by the teacher, and students engaged them and used the experiences for learning.

Thus, when reading, imagine each activity as an invitation to engage. I begin where the unit started: the beginning. The first week was designed to piqué interest in stem cells; the second week was designed to provide common definition and language of stem cells and stem cell determination; the third and final week was for debate preparation. Below, I summarize each of the three weeks in a table (Table 1, below) to provide a snapshot of the unit.

Week One	
Day/Date	**Content Covered**
Monday 3.1.10	*No school*
Tuesday 3.2.10	Filling out Scantron for National Testing Brainstorming definitions of stem cell research PowerPoint of images (e.g. 6 fingered hands, mice with ears on their backs, etc.)
Wednesday 3.3.10	*School-wide testing: No class*
Thursday 3.4.10	(shortened day) Discussion: What is ethics? Watching video: *EuroStem* Cell Discussion of video/group-think of stem cell ideas
Friday 3.5.10	In computer lab (students working on *Learn.Genetics* Webquest)

Week Two	
Day/Date	**Content Covered**
Monday 3.8.10	Breakfast/Prayer Session Collection of Student work Cell Differentiation Activity (in hallway and classroom)

Table 2. Overview of Stem Cell Unit

Table 2 (cont'd)

Tuesday 3.9.10	Summarize Cell Differentiation Activity from yesterday Students Move to Paper Body- tying ideas from yesterday's activity together Going over scrapbook assignment directions
Wednesday 3.10.10	In computer lab to work on Stem Cell Scrapbooks
Thursday 3.11.10	(shortened day) Brain Food: Prescription Meds- What would you do? Introduction of NIH Ethics vs. Science/Research Lesson
Friday 3.12.10	*Quarterly science department assessment*

Week Three	
Day/Date	**Content Covered**
Monday 3.15.10	Legal vs. Scientific vs. Ethical Discussion Reviewing NIH lesson plan for debate
Tuesday 3.16.10	Organizing students in small groups for debate Working in small groups to prepare for debate
Wednesday 3.17.10	Explanation of debate Debate Day One: Heart
Thursday 3.18.10	*(shortened day)* Debate Day Two: Kidney
Friday 3.19.10	Debate Day Three Kidney Stem Cell Test

Week One of Stem Cell Unit: Introduction and Piquing Interest

The unit began with a share out of ideas from students: What was a stem cell? (this conversation is discussed in more detail later in this chapter). Following this introduction, students engaged a short PowerPoint of genetic modifications (such as an additional finger, an

ear growing out the back of a mouse, glowing mice, and a cat with four ears) and discussed what they saw (see figure 5).

Figure 5. Images from PowerPoint

The next day, students watched a video on stem cell research produced by *EuroStem* and then compiled a class list/share out of contemporary ideas/issues relating to stem cell research (social, political, religious). Using the *Learn.Genetics* webquest (Figure 6, next page) from the University of Utah, students learned how undifferentiated cells became differentiated (or specialized). Part of the site included a stem cell entering a phone booth, entering a cell phone number, and exiting as a differentiated cell (e.g. in a stem cell out a blood cell) (the webquest has since been updated and the phone booth analogy is no longer part of the tutorial).

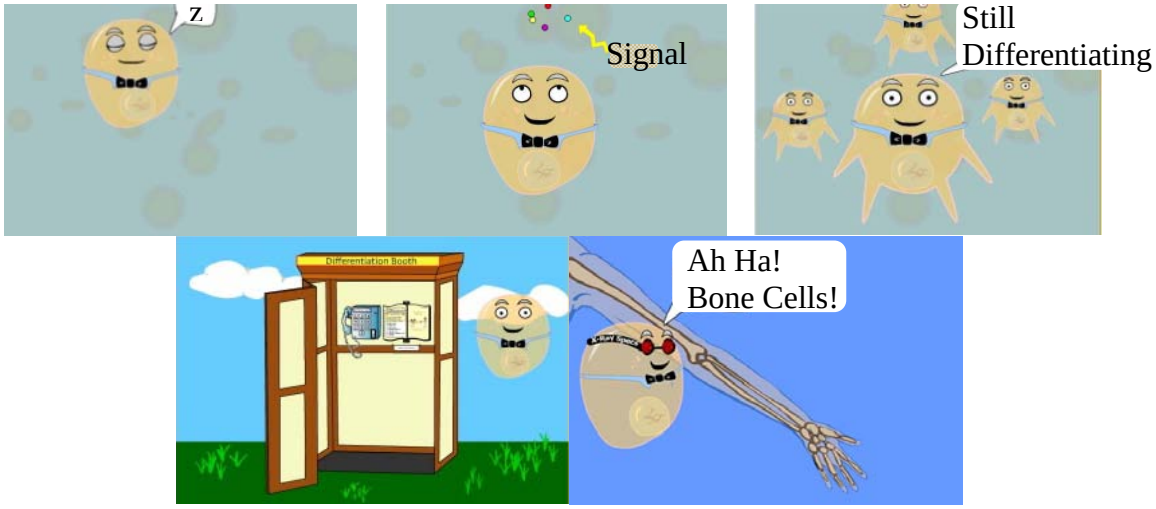

Figure 6. Screenshots from *Learn.Genetics* Website

Week Two of Stem Cell Unit: Common Language and Stem Cell Knowledge

The second week of the unit week began with a kinesthetic simulation of embryonic stem cell differentiation. First, a quick science lesson for readers unfamiliar with the transformation of embryonic stem cell into specialized body cells in order for the classroom simulation to make sense[9].

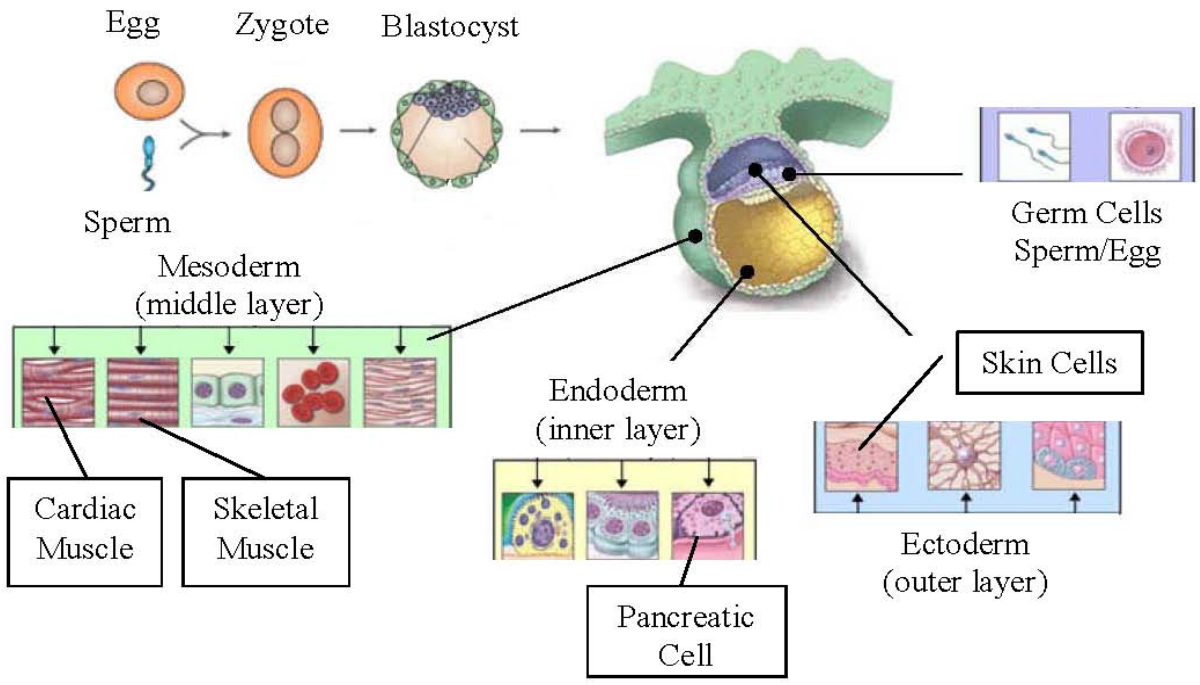

Figure 7. Stem Cell Differentiation

After an egg is fertilized (see Figure 7, a merge of multiple images from Nature Reviews, 2012 and National Institute of Health, 2012), the cell makes exact replicas of itself hundreds of thousands of times—creating a ball of cells with multiple layers called a "blastocyst" (see Figure 7). The location/layer within the blastocyst determines the kind of general body system the cell will become—this transformation triggered when the cells receive chemical signals that turn on

[9] Additionally, the explanation provided by the Learn.Genetics site is succinct, accessible, and helpful to understanding stem cells. http://learn.genetics.utah.edu/content/tech/stemcells/scintro/

and off genes within the cells. For example, a cell located on the middle layer of the blastocyst in the mesoderm (see figure 7, "Mesoderm") could become cardiac muscle (see figure 7) or skeletal muscle; a cell from the external layer (ectoderm) could become a skin cell and a cell from the internal layer (endoderm) might become a pancreatic cell (see Figure 7); the location of the cells determine the chemical signals the cells receive each body cell becomes fully differentiated and ultimately "determined" (into say, cardiac or skeletal muscle). Once differentiated, specialized cells *cannot* make entirely different types of cells[10]. For example, skins cells make other skin cells (through a process called mitosis) but not bone cells or muscle cells, even though all of these cells have the same DNA. This is where the power of stem cells comes into play. Stem cells *can* form new, different kinds of cells. Stem cells can multiply and become skin cells, or bone cells, or muscle cells, depending on how far differentiated they are.

[10] Until recently, this was not possible. The winners of the 2012 Noble Prize fully reprogrammed already differentiated cells.

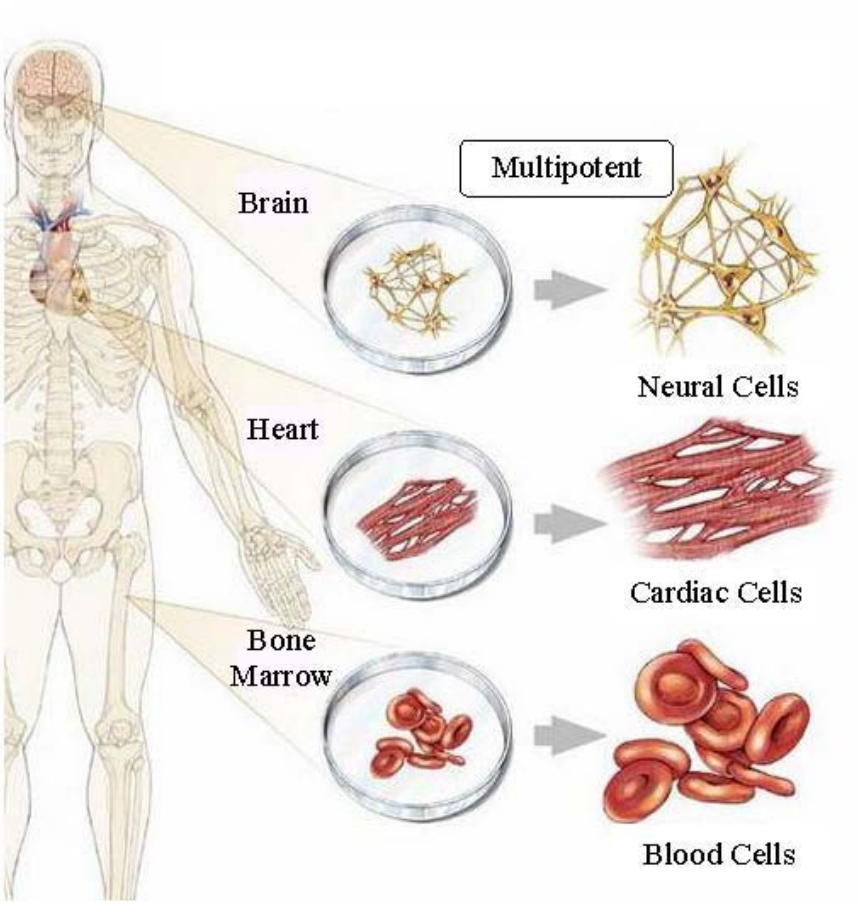

Figure 8. Adult Stem Cell Differentiation

In the paragraph above, I described the differentiation of *embryonic* stem cells. This process is very similar to what occurs in *adult* (or body) stem cells—adult stem cells are just a little more differentiated than embryonic stem cells. For example, bone marrow cells (adult stem cells) can be reprogrammed to become blood cells, neural cells and muscle cells, repairing damaged organs and tissues (see Figure 8, Adult Stem Cell Differentiation, from Stem Cells Therapy, 2012), however, bone marrow cells cannot naturally form skin cells. (One line of stem cell research investigates reprogramming differentiated cells into undifferentiated cells). Concluding this brief science lesson, embryonic stem cells can ultimately multiple to create *any*

kind of cell, whereas adult stem cells can only multiple to become a discrete number of new cells.

Returning to the student simulation: to understand the complex idea of stem cell differentiation, the students acted out the process described above. At the beginning of the simulation, each student received a colored card on a lanyard that had both a color (indicating the layer in the blastocyst) and a number (indicating what specific kind of cell within that blastocyst layer they would become). For example, a student might have a green "#1" card, green indicating the student would "become" part of the mesoderm and then #1 indicating the student would further differentiate into cardiac muscle (using the example and Figure 7).

Figure 9. Students Forming Blastocyst

Figure 10. Students Reading About Blastocyst Layer

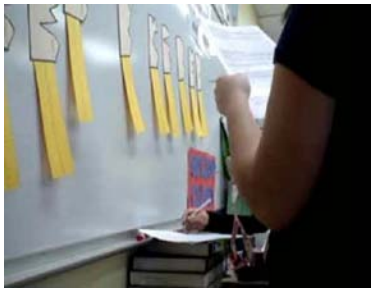

Figure 11. Students Finding Genetic Code for Differentiation

Theresa gave out written instructions (the task) and told them to move out of the classroom to a tape circle in the hallway outside of the classroom (see Figure 9) and determine where, based on their card coloring, they should stand (as part of the endoderm, mesoderm, ectoderm, or germ layer). With the whole class huddled tightly on this circle of tape, each received a chemical signal (a tap from Theresa and then peers spreading the signal), and then broke into different groups based on their layers/placement (using color on card) within the blastocyst to become various human systems (nervous, muscular, skeletal, digestive…). Each "layer" of students moved to different areas in the hallway and found specific readings taped to the lockers and "signal molecules" specific to what kind of cell they would become (see Figure

10) (using the number on card). The readings explained how they would become further differentiated into the specific cells of each system (e.g. brain cell in the nervous system). After reading about stem cell differentiation, small blastocyst "layer" groups then returned to the classroom to matching "signal molecules")—demonstrating what genes were turned on making chemicals that specializing their cell (see Figure 11). By the end of the simulation, they had "become" a specific cell in the human body.

Figure 12. Paper Human Activity

The following day, they continued this activity. Students stood on a life-size "paper human" (see Figure 12)—to see how their placement in the blastocyst (the large group of embryonic cells) and specific chemical signals ultimately defined the type of cell and placement in the body. To return to the previous example (and Figure 7), "Green #1": a cell that ultimately became a cardiac muscle cell was originally in the mesoderm, would be differentiated into a cardiac cell, and the student would stand on the paper human heart.

In addition to participating in activities such as the webquest and stem cell simulation, each student created a "stem cell scrapbook" in which they wrote about and downloaded pictures of their transformation, chronicling how, for example, s/he had become differentiated from a totipotent embryonic cell (a "totipotent" cell can become anything—it is the most undifferentiated/malleable of stem cells) to a nerve cell. Theresa had created one herself as a

model for students (she "was" a brain cell). Students spent the next day in the computer lab working on their scrapbook—with Theresa and I walking around to help students with the content and the project itself. These tasks, designed by Theresa, were taken up by students as they formed their content knowledge of stem cells.

Figure 13. Debate Day One

Week Three of Stem Cell Unit: The Debate

The focal point of this three- week unit was a debate on the ethics of stem cell research; thus, the third week involved learning about debate, organizing into debate groups, preparing for the debate, and then conducting the debate. The debate served as a formative and summative assessment, and more importantly for their learning, as another opportunity to engage with the ethics of stem cell research critically. Students were divided in half—Team One working on a case study of a heart transplant and Team Two working on a case study of a kidney transplant. When Team One debated, Team Two of students acted as judges observing the debaters and writing feedback. The following day they reversed these roles, with Team One acting as judges and Team Two debating. On the final day all students took a final, traditional, paper test on stem cells.

In three weeks, the classroom community endeavored to learn about and debate the ethics of stem cell use. Students were given multiple tasks each day and for each activity. Students engaged each task with freedom to ask questions, form their own opinions, discuss among themselves, and try out the different common experiences to build their collective and individual knowledge of stem cells.

I transition now from an overview of the unit into specific vignettes to examine how students enacted the tasks or lesson plans from the unit. These experiences, initially proposed by the teacher, are interpreted and defined by students, the processes/products negotiated, and ultimately enacted.

Examination of Experiences in Stem Cell Unit

There are many stories to share about how participants (students and teacher) negotiate their experiences with daily lesson plans. In this vein, I return to Dewey's quote: "Experience and education cannot be directly equated to each other" (Dewey, 1938, p. 25), to think about how experience leads to varied and unexpected educating in this classroom. To illustrate this point, I introduce the following vignette in which Theresa encouraged students to construct their own knowledge through collaborative talk to define stem cells.

Defining a stem cell: Co-constructing a Working Definition

This discussion took place on the first day of the unit and students had not spoken about stem cells in class before. Theresa introduced the topic by saying,

> The unit that we're starting is about two weeks long and is on stem cells. You've learned a little bit about genetics. You've learned about how your genes are on your DNA, a portion of your DNA. And then how the DNA has to tell the RNA what they're all about, and the RNA has to go and tell… the message, now make proteins. So there is this whole

process. Well, this also has to happen with stem cells. Does anybody know what a stem cell is? (March 2, 2010).

Theresa connected prior knowledge, recapped a very simplified version of protein synthesis (protein synthesis is helpful in understanding cell function and therefore stem cells), and then opened the discussion to defining stem cells.

At this point, students had not done anything with stem cells in the classroom and the prompt morphs into a conversation garnering student ideas. One student mentioned that it has to do with babies and aborted fetuses or that it might be used to help diseases like Parkinson's. Theresa writes the word "research" on the board along with "fetus (material)" and this begins a list (see Table 2) of student ideas. Other students add in and the list of what students know about stem cells grows: "for it", "against it", "Obama started it up again". Theresa encourages this meandering route, a discussion of terms and diseases students don't know begins and the class flows with the tangents, with Theresa explaining or asking other students to explain the terms. At this point in the class, there is still not a definition, but a list talking around the subject. By pooling their ideas, they are enacting the task of defining a stem cell.

Research	People against it
Fetus (material)	for it
Parkinson's Disease	
Bush (no) stem cell research	
Obama (yes)	

Table 3. Notes Written on Board: Brainstorm of Stem Cells

Theresa then offers a piece of information saying, "There are some adult stem cells. Which is a weird term, because little kids have stem cells… Have you ever heard of bone marrow transplant?" (March 2). Many students reply yes. One student offers that they use it for "bone cancer stuff". Theresa describes bone marrow for the class (connecting it to how bone marrow transplants are conducted to eating soup and sucking the marrow) . She says, "Bone

marrow are stem cells- in your bones all the time. And I forget what the rate is, but it's really, really high, but your bone marrow is making new blood. You need blood all of the time. (March 2, 2010)". Theresa then brings the conversation back to defining stem cell:

1	Theresa	So guys, stem cells, back to stem cells, what does the word sound like?
2	Stm	Like a plant.
3	Stf	Sounds like stem.
4	Stm2	Stem of a cell.
5	Theresa	Sounds like a plant. Good. Good. Um, what do we know about the stem of a plant?
6	Mismin	It supports the whole thing. (is talking with her hands too) (students are all talking at once).
7	Theresa	So the stem supplies the nutrients, you can cut a plant and get it to start growing from the stem, we can get roots to grow from the stem (Theresa has grabbed a plant from the sink and pulled it up so the roots are dangling)
	Theresa	Um… so a stem gives us the idea that there is a lot of growth? What about a cell, what's that?
8	StM	Micro building parts (?).
9	Theresa	If we were a building and cells were bricks, we would be made of bricks. Okay, so that's what we're made up of. So a stem cell… is a cell that makes more of itself or it can make more of a different kind of cell.
10	Andrea	It like, doesn't have a purpose.

11 Theresa Awesome, no, awesome! (gesturing with her hands, leaning in the direction of Andrea) It has not been given its direction! (acts out something)

The conversation ends (with the bell) and ultimately, at the end of this discussion, there is no agreed upon definition in the traditional, formalized sense: for example, students do not write down a definition such as "a stem cell is a cell that has not been given direction" or "a stem cell relates to growth like a stem or root in a plant" nor do they look up the scientific term.

Interpretation of Task

In this classroom, a prompt, such as the one presented here "Does anybody know what a stem cell is?" was interpreted as an invitation to share out, contributing what they knew. Implicitly, students know this as a norm: they are encouraged to talk and share in this space. In this classroom, *both* students and teacher contribute to the building of knowledge through student free-reign in asking questions, exploring, and discussing ideas. Knowledge, even something as small as a definition, is co-constructed in this classroom. Students are encouraged to activity contribute because they have knowledge to contribute. In Classroom 507, students' knowledge is legitimized and in this class, they are asked to share out and deepen their knowledge.

While defining a term could easily involve looking to the textbook glossary, an internet search, or making flash cards to "learn" material—in this classroom, definitions come alive with student contributions and discussion. In this way, Theresa guides students to find situated meanings. The actual definition of the term is insignificant compared to understanding *how* this class interpreted and enacted a task: for this was how other activities in the unit were enacted.

One could interpret the discussion at this point as fruitless or insignificant as it does not produce explicit knowledge: a definition. However, it does get students involved and in

honoring their ideas, their web of thoughts grows bigger. Rightly, the argument could be made that because the definition of a stem cell was not formalized (through finally looking up the term or writing down a final group definition), students could have walked away not knowing what a stem cell was—and this is a valid critique. However, the power of this approach is not in "finding the answer" but rather that it relies so heavily on student contributions.

Roles and Knowledge Construction

Further examination of this vignette helps us think about roles the teacher and students play as well as who contributes knowledge and how knowledge contribution is legitimized. Looking first at Theresa, she makes a few pedagogical moves that should not go unnoticed. Instead of pulling from a traditionally sanctioned resource, such as a book or website, she drew from student ideas. Students were not playing the role of sponges or note-taker, but rather they "spit-balled", throwing out ideas into the open classroom space. With these ideas put out into the classroom space, Theresa acted as a task-master or conversation herder in that she encouraged students' wandering thoughts towards politics, disease, and body tissues. Herding the conversation back to defining stem cells, she does not recommend someone look up the definition—but instead suggests a small piece of knowledge about bone marrow and asked students to probe further ("There are some adult stems cells, which is a weird term because little kids have stem cells."). The conversation meanders again—but this think aloud is an opportunity to collect student ideas, reactions to the term, and get a pulse for the classroom knowledge set: producing a vast network of images, mass-media sound bites, and misconceptions. In this discussion, the role of teacher is not only to suggest information, but to vocalize the diverse and seemingly unconnected ideas and to connect student thought, legitimizing their ideas on stem cells.

Each activity in the unit, from exploring personal opinions down to defining common terms, are engaged in the public space and co-constructed by students. Exploring ideas through common experience and legitimizing student thought in the learning space fundamentally shifts who "counts" as an authority on the topic and what "counts" as scientific knowledge. From the overview to the vignettes, this classroom can be viewed as public pedagogy in many ways. Education does not automatically result from experience—but in a diverse, complex experience, there is much education to be had.

Stem Cell Unit through Public Pedagogy Framework

Working from the definition of public pedagogy as the organic learning that emerges from public spaces (e.g. museums, graffiti walls, libraries), and public forums (e.g. websites, blogs, Facebook, etc.), this section investigates the ways the stem cell unit can be analyzed with a public pedagogy lens.

Public Pedagogy: Design

The "design" in public pedagogy is the planning including the overarching unit plan, daily lesson plans, intricate activities, and assignments Theresa prepared for class. At the heart of the unit design is common experience; each of the activities was designed in a way to provide shared learning events for all students. All but one of the activities students recalled in interviews and students described them as helpful (the exception was the creation of the stem cell scrapbook—an individual task). Each of these activities or common experiences provided opportunities for student talk and interpretation.

These common experiences, described in detail previously included: 1) looking at images of stem cell research, 2), watching a video on stem cell research, 3) defining stem cell, 4) simulating becoming a stem cell, 5) interacting with the *Learn.Genetics* website to simulate cell

differentiation and determination, 6) reading case studies, 7) debating the ethics of stem cell research, and 8) creating a stem cell scrapbook. In the chart below, I summarize the key design moves of the unit and highlight both the participation structure and the purpose of each activity as it relates to public pedagogy.

Key Design Moves	**Grouping/Structure**	**Purpose**
Defining stem cell	Large group—share out after	Exploring student prior knowledge and co-constructing stem cell definitions Ask questions
PowerPoint of images of stem cell research	Large group- individual students get talk aloud reactions during PPT	Piqué interest and some of the various (and extreme) potential uses for stem cells
Stem cell video	Large group—share out after	Watching the video first, some content was explained—while students were also encouraged to share prior knowledge. If students were unaware of stem cells—the video provided something for students to share.
Stem cell differentiation simulation/Paper human	Large group—but each student has different role. Share out experience after.	Kinesthetic, visual, and auditory learning—all students participated but each differentiated into a singular type of cell. Experience was shared out in a large group and students from layers of blastocyst are in appropriate places on paper human.
Learn.Genetics website- cell differentiation and determination	Individual, but talk with those around them—same webquest and worksheet	Independently paced activity—students can move as fast or slow as needed and were talking with each other throughout. Students were seen going to related websites throughout activity.
Reading common case studies	Small groups: half of class per case study. Discussed in small groups.	Processing of case study with peers (e.g. Michael, Molly, Stephanie's group reads aloud first). Discussing debate tactics and understanding of case study in small groups.
Stem cell scrapbook	Individual*	(not public—students commented this was less helpful).
The debate: the ethics of stem cell research	Whole class- but each student had to individually participate.	Put forth perspective of stem cell research based on case and knowledge learned from unit. Influence each other's thinking through talk and argumentation.

Table 4. Design moves and Summary of Stem Cell Unit Design

Returning to student comments (some of which were presented at the beginning of this chapter) suggest that this unit was different than others. All but one student interviewed said this unit was more difficult than others giving reasons such as: it was vague and without a specific answer (Kevin), it was relevant (Stephanie), it was more interesting (Mismin), it put her out of her comfort zone, which was good (Cookie), it required more work than normal (Bob), and it was more hands-on and more personal (Eric). The one exception was Molly who felt this unit was *as* challenging as others because it, like the other units, went into detail (comparing biology to other classes where she felt they just scraped the surface with content).

Repeatedly, the subject of "talk" came up in interviews. Students expressed varying comfort levels with talk: such as Mismin needing tricks to get over her public speaking phobia, or Cookie feeling discomfort in expressing personal, religious ideas to Molly who is at ease speaking in public. All students, however, said that the opportunity to talk and hear from others and decide for themselves is what made this unit unique.

In Hayes and Gee's (2010) analysis of the *Yu-Gi-Oh* card game, the design is in the embodied meanings of the cards and the implicit understanding of what each card means and what actions to take if using that card.

> Lucidly functional language goes even beyond situated meanings (which just require images, actions, experiences, feelings, and/or goals) in that people are crystal clear on how the images, actions, experiences, or dialogue they associate with a word in a specific situation ties to a clear function, goal, accomplishment, "move in a game" (p. 5).

The design, therefore, is in the definitions of the characters, terms, moves, and images—and these determine the actions of play. Therefore the more lucid and clear the images, the more specifically and complexly players can interact. I include this quote from Hayes and Gee to help

think about how complicated and necessary a common language is for participation in any learning space. Without common experiences or the lucidly functional language of stem cell research, students would be limited in their ability to coherently communicate their positions on stem cell research. Though the example they present is a card game—Hayes and Gee demonstrate the imperative of language and the need for something more substantial than just a means of communication. Because scientific Discourse is a second language – there need to be design moves in a classroom that supports language acquisition for students and newcomers to the field. The design of both Yu-Gi-Oh and the classroom lesson plans are both needed to ensure basic communication—and from that basic foundation to move into more in-depth conversations. Once students learn the situated meanings and lucidly functional language of a scientific content area—and their expertise legitimated in the public sphere—they can become one of the resources for peers.

Public Pedagogy: Resources

Resources are the varied sources of knowledge and skills participants draw upon to "get smarter" about the space in which they interact. Resources in this classroom are driven by Theresa's imagination and student interest in the subject. Resources are plentiful in this unit and consist of the various media contributing to the community's knowledge and skill base: websites, magazines, journals, books, blogs, teacher-based websites, video, etc. Eventually, in this unit, students themselves become resources.

When teachers are gate-keepers and holders of knowledge, the possibility of students as resources is limited. However, when the opportunity arises for students to share and discuss ideas and then to challenge others' ideas, peers become legitimized as resources to each other (I describe in the next two chapters). Additionally, to prepare for the public debate opening speech

and to intelligently challenge each other, students had to seek outside resources such as internet sites, books, and articles to give them an "edge" in the debate—to make themselves more knowledgeable.

In the stem cell unit, the students drew from many resources including, etc. Here I list the *EuroStem* video, PowerPoint, *Learn.Genetics* webquest, daily "brainfood" discussions, outside texts texts/media from outside of class, people, common documents (e.g. tables), and connecting prior knowledge. Already, we see how the design and resources overlap and interact: the design in many ways is an examination of how varied resources are used in the classroom in a formalized, sanctioned way. The products of experiences and learning can become resources—as can students as their knowledge becomes legitimate in the classroom.

Below, I summarize some of the resources students drew upon to learn more about stem cells and connect them to the key design moves to show the relationship between design and resources. It is important to note that this list is not exhaustive as I could not have seen all the resources students tapped into in formulating their debate statements.

Key Design Moves	**Resources (Used for Activity or Produced as a Result of Activity)**

Defining a stem cell and PowerPoint Discussion	Use of out of classroom texts and media
	• PowerPoint developed by Theresa and colleagues
	Discussion of student experienced out of classroom texts and media
	• Media
	  o Michael J. Fox
	  o Parkinson's
	  o Presidents Obama and Bush
	• Religion
	• Personal Experience
	  o Family members
	  o Personal health

Table 5. Summary of Selected Resources

Table 5 (cont'd)

	People • Teacher • Students • Recognition of images, "I've seen that before" • Social/joking (e.g. Cat with four ears: Molly says, "That's a *wild* animal!" or The mouse with ear growing on back: a male student says, "Can you Hear me Now?" • Connection to Prior Knowledge • What do these pictures have in common? Genetics Common Documents What do we know about stem cells?
EuroStem Video	Out of Classroom texts and media • *EuroSte*m video Common documents • Student created video summary chart (*opinion, medical, social/political,* and *religious)*
Stem Cell Differentiation/Paper Human	Out of Classroom Text/Media • Stem Cell Differentiation Activity Connection to Prior Knowledge: • Previous Unit—connection to prior knowledge (DNA matching to mRNA and making proteins to determine cell type)
Learn.Genetics	Out of classroom texts/media • Learn.Genetics Website • Students (Molly, Stephanie, Bob—perhaps others) searching other on-topic websites People • Student-student discussions • Teacher answering questions
Debate Case Studies	Out of classroom texts/media: • Case Studies Discussion of out of class text/media • Michael brings up John Q People • Molly read a book on SCR • Michael looked up information for the debate
Scrapbook	(students were supposed to use the resources developed over the course of the unit)
The Debate	People • Sharing of opinions • Correcting misconceptions • Several students were typically thought of as smart and experts (e.g. Kevin, Molly) • Students not typically seen as smart emerged as experts (e.g. Taylor, Corazon)

The resources that were contributed and used in this unit, listed above, came from varying sources and individuals. In looking at the chart—many of these are resources from outside of the classroom that Theresa deliberately brought in—but many are the experiences, opinions, and references students brought in. The support and encouragement of many resources encourages students to contribute and become resources—especially when their resources are legitimized by peers and teacher. Because of the fluidity of who counts as a "resource" and how one can contribute, there are many pathways to expert. This is similar when examining Hayes and Gee's work in the *Yu-Gi-Oh* card game.

In Hayes and Gee's affinity space work, they note how resources are varied in both media and in who the "teachers" or content authorities are. For example, a *Yu-Gi-Oh* "newbie" can learn how to play via television, websites, tutorials, and even lectures by young players.

> *Yu-Gi-Oh* learners are not left on their own, they are given good resources to facilitate their learning. While *Yu-Gi-Oh* is a card game, the television shows, movies, and books associated with it model how to play the game through narratives that are actually acted out versions of game play. Video game versions of *Yu-Gi-Oh* contain tutorials and models of how to play and allow players to set difficulty levels to customize their learning. There are a great many websites that demonstrate how to play *Yu-Gi-Oh*—in many different ways, so people can choose their learning style—and there are even lectures by 12-year-olds on how to play on the Internet. (p. 6)

Yu-Gi-Oh participants are not left without access to ways learning how to play. While the game itself is a card game—there are many offshoots to the game including television, movies, and books. Tutorials led by participants (including young participants) aid in the learning and enculturation into the environment.

In Classroom 507, the resources are the many outside resources drawn upon (video, webquest, library books, internet searches, and ultimately, like the 12 year old lectures on *Yu-Gi-Oh*, the participants themselves become resources). Students recognized each other as resources and appreciated the opportunities for talking with one another. Unlike the scrapbook, that while was supposed to help students pull together their ideas and resources—the important of talk and student-student interaction is invaluable as a resource.

Interaction between Design and Resources

It is important to recognize that design and resources are dependent on one another. As Table 4 suggests, there is a relationship between the design moves and the resources that are legitimized and used in the classroom. The use of varied resources makes a more engaging design, and a more compelling design encourages participants to see additional resources (and become resources themselves as they learn).

I previously shared the *Defining a Stem Cell* vignette and add to this chapter another illustrative vignette, *Stem Cell Video*[11] *and Reflection*. I selected these two vignettes for similar reasons: they are both typical kinds of lessons in a science classroom. Defining terms and watching video clips are very common in science classrooms—but what makes them distinct in this unit is how talk was encouraged in these lessons. I cannot attest to whether or not talk was encouraged like this in other units in Classroom 507—I was not here for other units. However, with the exception of the Stem Cell Scrapbook, talk, like the talk described in *Defining a Stem Cell*, was a commonality in the Stem Cell Unit.

[11] http://www.eurostemcell.org/films#story

Having laid a foundation for the terms and ideas of design and resources, I use the *Stem Cell Video and Reflection* vignette to explicitly look at the interplay between design and resources as well as how resources are legitimized. While I used the *Defining a Stem Cell* vignette earlier to highlight only design—I then return to the vignette in the discussion at the end of this chapter as I unpack the relationship between design and resources.

Stem Cell Video and Reflection

The *EuroStem* Video and this discussion took place on the second day of the unit and demonstrate this close interplay between the design and resources of public pedagogy. While much of the design and resources are controlled by the teacher, if it is truly "public" pedagogy, then the public of the classroom must have a say and a stake in the ultimate design of the learning environment. With this vignette I examine not only the relationship between design and resources, but also provide another example of this community's norms and practices.

Prior to watching the video, Theresa writes four categories on the board for students to organize their thoughts: *opinion, medical, social/political,* and *religious*—reminding them to jot down notes as they watch (their completed, complied class table is presented in several pages in Table 4). Immediately following the video, the class discusses their notes and this discussion is presented below. Notice, as you read, 1) student and teacher contributions to discussion, 2) student and teacher roles in creating the chart, and 3) the categorization of the student collective comments (as opinion, medical, social/political, religious). At the conclusion of the transcript, I discuss each of these three themes, in order think about the relationship between design and resources and the significance of this transcript as it helps us think about learning in a classroom as public pedagogy. Also, as you read, notice the structure of talk, agreements/disagreements, and the role of teacher as evaluator.

1	Theresa	So, what do you think?
2	Molly	Makes me want to be a stem cell researcher. (Bob turns around to her and chuckles, says something inaudible).
3	Mismin	One of the scientists was saying that, um, they use stem cell research, like if you have a burned skin, and it rebuilds a new skin; but the problem is that it might not make new sweat… um (seems to be searching for words).
4	Theresa	Sweat glands.
5	Mismin	Yea.
6	Theresa	And hair—they said hair, right? (she agrees). Okay, where would that go? (referring to the chart on the board)
7	Class	Medical.
8	Theresa	Medical? Writes this down (see chart below). So stem cells can be used for burn patients. Right? Okay, anything else about that?
9		(someone says something about animals—inaudible).
10	Theresa	Do they want to test on animals or… what do they want to do regarding animal testing? Will it reduce or increase the amount of animal testing?
11	Stephanie	Reduce.
12	Cookie	They said if they had stem cells, they wouldn't have to do all those experiments.
13	Theresa	So where would that go, medical, social, opinion?
14	Stm1/St	Social. Opinion.
15	Theresa	Opinion? Less animal testing?
16	Bob	No.

17	Theresa	Where?
18	Stf2	Wouldn't that be social?
19	Bob	Yeah. And political. (Theresa writes it under social and political.)
20	Theresa	Anything else?
21	Michael	Stem cells can either rebuild like one tissue or one area each one has a different stage to become like skin cells
22	Molly	They chose what they are going to go. (Bob has hand up)
23	Theresa	Okay. Where would that go?
24	Michael	Um…
25	Theresa	Is that a religious idea, a medical idea, a social idea? Or is that an opinion?
26	Stf3	Medical.
27	Theresa	Medical? Okay. Um, so the word is stem cells differentiate. That means they become something specific. (Theresa points at Bob)
28	Bob	For the embryos that the woman isn't using, it's basically like abortion couldn't that go under medical and religious?
29	Theresa	Yes. So, say where do the embryos come from?
30	Bob	If the woman isn't going to use them for, like, pregnancies, then she can like have an abortion basically. Isn't it like an abortion? Cause she's like giving up the… (trails off).
31	Theresa	They don't use them from aborted fetuses (Bob: yeah, but), (Bob hand gestures to continue his thought) they use them from in vitro fertilization.
32	Bob	And what's that?
33	Theresa	Where they put egg and sperm together in a test tube, (corrects herself) on a

Petri dish, and then when its fertilized, then they put it back into the woman but then there's always leftovers… because you have to have a lot of them. So umm. So (is writing) in vitro fertilization. Yeah. That is a big issue. That's huge on the religious side. (Writes this as medical first. Jesus reminds her to put it on religious.)

34 Stm3 You forgot to put it on there. (points)

35 Theresa Oh. (writes).

This discussion goes until the bell—concluding with a cursory discussion of how stem cells can be used to fight disease and Bob and Molly saying again that they both wanted to be stem cell researchers. The final chart on the board looked like the image below:

Opinion	**Medical**	**Social/Political**	**Religious**
• Cure disease • SCR is good • It can cure more diseases than known • It's complex • It's bad • It makes me wanna be a SCR	• Stem cells used for burn patients • Stem cells differentiate • Embryonic from IVF • Cured diseases	• Less animal testing • Cure diseases • Save a life	• Embryos used from IVF • Cure diseases • Playing with God's work

Table 6. Student-generated Notes originating from Eurostem Video

I analyze the following themes in order to consider the implications of the design and resources of public pedagogy on this classroom: 1) student and teacher contributions to discussion, 2) student and teacher roles in creating the chart and 3) the categorization of the student collective comments (as opinion, medical, social/political, religious).

Student and Teacher Contributions to Discussion

The student roles in this vignette are varied: some students contribute content, some contribute opinions or are reactionary, others play off others' comments, and some ask questions. As a contribution to the knowledge base, students add the following points they learned from the video: scientists use stem cell research to rebuild new skin but without sweat glands (line 3, Mismin); changes in animal testing (line 9, unknown student), stem cells can rebuild new tissues (line 21, Michael), and "for the embryos that the woman isn't using, it's basically like abortion[12]" (line 28, Bob). A couple of the contributions re-appeared in other conversations—those comments taken-up and re-appropriated by other students. Those comments include 1) animal testing, 2) stem cells rebuilding new tissues, and 3) un-used IVF embryos equating to abortion.

Additionally, there is some (though brief) student-student interaction: Bob turning to Molly to chuckle at her comment about being a stem cell researcher (line 2, Bob), [stem cell research] reduces animal testing (line 11, Stephanie), "if they had stem cells, they wouldn't have to do all those experiments" (line 12, Cookie- adding on to Stephanie's comment), and then comments of collective agreement (lines 7, 19).

The majority of the questions were video recall or placement of idea on chart, posed by Theresa (lines 1, 6, 8, 10, 13, 15, 17, 20, 23, 25, 29). Breaking this down a little more, she does this in several ways: 1) soliciting student comments (lines 1 and 20); 2) introducing new information in the form of a question (lines 6, 8, and 29); 3) re-guiding student thought (line 10) and 4) determining the column (lines 6, 8 and 25). Bob asks the one question about whether use

[12] One can argue this is not a fact per se—but we do see Bob's thinking and misconceptions of where the embryos originate naturally v. IVF and where they are stored in the case of IVF.

of embryos in stem cell research is considered abortion (line 30) and for Theresa to explain in vitro fertilization (IVF) (lines 31 and 33).

From this focused task and the resultant student/teacher contributions, we see that 1) there is not a great deal of discussion between/among students—most of the talk is between teacher and student and 2) most prompts were given by the teacher, answered by students, and evaluated by the teacher (by way of clarifying/writing the comment on the board), there is very little disagreement. The structure of this discussion is very similar to Cazden's (2001) Initiation, Response, Evaluation (IRE) in which the teacher asks a question (e.g. "anything else?" or "what about?", "reduce or increase animal testing?"), a student responds, and with little disagreement, comments are added to the chart. At this time and in this space, teachers and students are invoking very traditional school discussant roles. In many ways, this conversation is traditional in that it mimics an Initiation, Response, and Evaluation.

Student and Teacher Roles for Task

Somewhat less traditional, but not entirely uncommon are the roles teacher and students play in the actual creation of the chart. Here I make two specific points. First, students often correct Theresa if she has misplaced or forgot a term with comments such as "wouldn't that be" (line 18), "yeah, and political" (line 19), "you forgot to put it there" (line 34), and her responding to multiple student suggestions at the same time (line 39). Additionally, Theresa checks to see if she has placed their ideas in the right place (lines 27 and 43). Theresa, in many ways is not just playing the traditional role of teacher/discussant, but she is also the scribe. She is making the collective student comments visual and legitimizing contributions. In the role of scribe, students feel comfortable correcting her and directing her on the list. The second example of roles we see in this vignette is that there is very little hand-raising/teacher "calling-on": Bob does at one

point, but for the most part, all student contributions are share-outs where students contribute in unison, with overlapping comments, one after another, or simple call and response. There are trace amounts of traditional power structure in which a teacher controls who speaks, when s/he speaks, and what they can say. Because of the shift in roles, with the teacher relinquishing power, this conversation is informal and causal.

Categorization of Student Comments

From the transcript above and the chart, we see that the majority of comments added were the six opinions, followed by four medical comments, and equal numbers of social/political and religious comments (both three each). Additionally, while all opinions put out into the classroom space were added to the list and these opinions were not challenged, it took participants several turns to discuss fully the medical/scientific concepts. For example, Mismin and Theresa together determine that new stem cells can build new skin—but without sweat glands or hair (lines #3-8). Stephanie, Cookie, and an unknown female all piece together that researchers predict decreased use of animal testing with the advancements of stem cell research (lines #9-12). Michael and Molly define stem cells and stem cell differentiation together (lines #21 & 22). Theresa and Bob tease out the difference between the use of embryos created from IVF vs. natural conception and abortion. For each of the primary medical ideas, multiple contributors were required to complete the entry on the chart.

Interplay between Design and Resources

To see how the design and resources play out as public pedagogy in Classroom 507, I presented two detailed and illustrative vignettes: *Defining stem cells* and *Stem Cell Video and Reflection*—both typical of the talk during lessons in the Stem Cell Unit. These vignettes help us look at the way the design and resources are in a necessary, reliant relationship with one another:

resources are used in a particular way—which is the design; without resources, the design would be less multi-modal and incorporate less perspectives on the topic. Additionally, from the design emerge new resources and new resources bring about new ways of (design) interacting with the learning environment. The design and resources here are inextricably linked. The use of the video (a resource) was, through its use (design) used as a common experience because of the discussion that followed the viewing. Because of the accessibility of content in video form, many students were able to quickly understand parts of the scientific ideas and together with other students piece together the more complicated ideas of stem cell research. As the students put together the chart, they *became* resources, helping one another and talking through the material with which they were just presented. Use of film or technology is not necessarily unique to the classroom; many teachers ask students to take notes and turn them in to give credit for students worksheets. What is unique in this design, however, was that because the class as a large-group had to create a common product (the chart), synthesizing the material, the learning became public. The only guidance Theresa gave in taking video notes was the chart categories, she shifted her guidance of student viewing from the typical basic recall questions (usually a fill in the blank or copying down sentences from the video) to a more open-ended categorization, students were able to more creatively interact with the video and discussion. Asking students to move beyond recall into a synthesis and application allowed for student voice to come through. Mismin, for example, was explaining the creation of skin cells in her own words. Michael and Molly's definition of stem cell differentiation was uniquely theirs. The design of this activity resulted in the shift of students as resources. Students were beginning to author their own versions of the resource with which they interacted.

In another example of the relationship between the design and the resource is the creation of the chart. The chart itself became a resource, emergent from the design. The *design* called for a synthesis of the video and a "think-share" (variation of "think-pair-share") to talk aloud the main points of the video. Theresa facilitates the creation of the chart as a scribe (as well as a teacher prompting participation)—and this parallels the learning and knowledge creation of a wiki (a website in which participants can modify a public webpage): participants can, by simply telling Theresa where they want terms, make changes to the public product. The design of the lesson, sharing out, and creation of new resources promotes student ownership of knowledge. This resulted in a co-constructed artifact; a demonstration of the production of classroom knowledge, and in its process: public learning.

This product could have become a *resource* helpful for students after the completion of class. For students who were reticent to talk, participate, struggled with the content of the material, were zoning out, not paying attention, or otherwise disengaged, the chart might have acted as a resource for students to return to and use at a later time. Theresa scaffolded this movement of text/media as resource to students as resource by writing the chart on the board for students to write down—anyone from the classroom could draw upon the class constructed resource.

Discussion: Not Yet an Affinity Space…

While the creation of the chart could be interpreted as a form of IRE (Cazden, 2001) with the chart being a form of evaluation, I think it is much more interesting to think about how it is a subtle way to get other students to participate, and call on students as experts—highlighting what they understood from the video. The chart categories themselves create "points of contention", providing opportunities for students to disagree—forcing engagement.

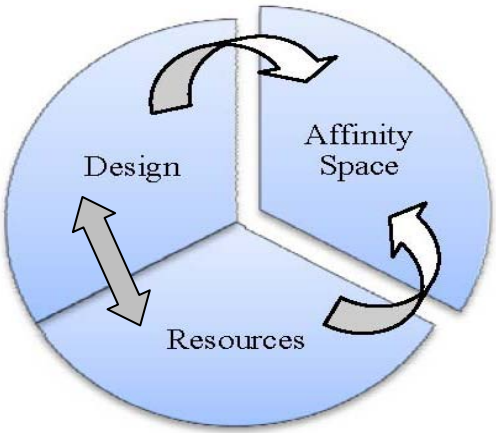

Figure 14. Relationship Between Design and Resources and an Affinity Space

While the design and resources of public pedagogy were present in this vignette, there was very little student-student discussion—and this is where the debate plays a role and more closely parallels public pedagogy. Very few of the characteristics of an affinity space—or a "floor" in which students can contribute, withdraw, and use as needed in their own individual construction of knowledge. This vignette, while public, is still enmeshed in traditional power structures; students are not freely sharing or arguing. It is demonstrative of how a video lesson can shift to become a more public learning moment through thoughtful design and creation of resources, it is still not complete as per the definition of public pedagogy: it is still lacking the free-talk unique to an affinity space. For this, I discuss the debate as evidence of an affinity space.

From Figure 14, I want to point out the importance in the design and resources in informing the affinity space and thus establishing the overall nature of learning in public pedagogy. Consider, for example, a scenario of another classroom, let's call it Classroom B, in which the lesson plan (design) was to read the textbook aloud as a class. In this classroom, however, opening up learning to the classroom public with the students interacting, talking, asking questions, and processing together, these common experiences gave students something with which to hang their proverbial "hat" and reference throughout the unit. In Classroom B, the resource, or what counts as a resource, is often the textbook or workbook. In Classroom 507,

students have not one single resource that counts more than any other. The use of varied texts and media and individuals almost exponentially increases the resources.

The design and resources were thoughtfully constructed and implemented by Theresa. In the beginning of the next chapter, I talk about her rationale for designing the unit in the way she did—and more specifically, why she decided to hold the debate at the end. With this, we are provided additional insights into the design and resources of this unit—and how this unit opens up for the creation of an affinity space.

However, as we think about the learning taking place, we have not yet examined the most powerful aspect of this classroom: the affinity space. In many ways, teachers are aware of the design and resources as they create unit and lesson plans. Less obvious to many teachers is what happens when students are encouraged to talk with each other and how to structure lessons to support students talking with each other. The next chapter, *Chapter Six The Debate*, examines what learning resulted from the debate and how Theresa was able to promote the student to student discussions.

CHAPTER 6 THE DEBATE: AN AFFINITY SPACE

"…Learning is an issue of engaging in and contributing to the practices of their communities." (Wenger, p. 7)

"…I don't want them to go into the debate thinking there's a right answer because then there's no debate." (Theresa, Interview August 3)

In the previous chapter, I examined the design and resources and how these were taken up and used by students. Design and resources are two of the three components of Hayes and Gee's public pedagogy (2012), affinity space is the third. In this chapter, I examine how the debate held at the end of the unit played out in what Hayes and Gee call affinity space (2012). To this end, in this chapter I discuss the overall structure of the debate (the structure, student groupings, and the two case studies the students used to debate), explain Theresa's rationale for holding the debate, then describe each focal student's engagement with the debate.

At the heart of this chapter and the heart of this dissertation are the stories of how each focal student engaged the debate and interacted with others during the debate. These stories, of which I refer to as "affinity stories", paint a picture of the debate from the perspective of each focal student: examining their opening statements, interview data of their interpretations of the debate, as well as my observations of critical events and student roles during the debate. *Individually*, each student's affinity story examines the student's interaction with debate and how these interactions shaped his/her learning, participation, and/or ways of being within the debate. *Collectively*, the focal student affinity stories provide insights of how this classroom lesson became an affinity space—a place in which all students could contribute, participate, pull from, and "be" in ways productive to themselves and the class. Unpacking the students affinity stories,

we see the various ways focal students used the floor and how they used the floor to position themselves in particular ways.

Analyzing a lesson as an affinity space is powerful in that it unpacks how one "activity", or design move, provided such varied opportunities for engagement. Students were able to personalize their engagement, position themselves among peers, and use the floor as they see fit. Data shows that students co-opted the debate for their own uses. For example, **Mismin,** who struggled with the basic content of the material used the space to rectify misconceptions and to wade through muddy waters of perceived science-religion disconnects. **Michael** used the space to reinforce and maintain academic, social, and leadership status and to position himself to help friends "get points". **Kevin**, who rarely participated in large group discussion, used the debate as a game and as a challenge in intellectual argumentation. **Molly** used the space to make a statement—having a sanctioned platform to preach, teach, and clarify classroom scientific misconceptions. Once students were given the freedom to co-opt the learning environment for their own needs, student engagement in the science became more of what each needed and less of what the teacher required.

As knowledge became public and accessible for participants, individuals have increasing freedom to contribute, take, make, reshape, or co-opt knowledge for their own purposes. Returning to Hayes and Gee's definition of affinity space, I close this chapter with an examination of three common threads throughout the construction of the affinity space: knowledge, participants, and use of space. By pulling together the affinity stories of these focal students, I highlight the distinct and nuanced role the debate played in the stem cell unit in the creation of knowledge, class use of space, and participant roles. Examining the collection of

student stories illuminates the debate as an affinity space—a place for personalized engagement with science content.

Before moving into each focal student's affinity story, I first provide needed background and details on the debate. I start with some of the specifics of the debate to contextualize the students affinity stories. I then discuss Theresa's rationale for holding the debate in order to examine her intent for the debate with what played out in the classroom.

The Debate: Hearing All Student Contributions

The debate shifted the talk dynamics of Classroom 507 and created an entirely new mode for scientific learning. The structure of the debate space encouraged students to *stop* talking to the teacher and *start* talking to each other—transforming who participated, how they participated, and how knowledge was created.

Structure of Debate

While the debate was one common experience (one complicated design move)—it was experienced in vastly different ways as each student co-opted the space for his or her individual learning needs. It is because of the incredible variety of student experiences and learning emergent from one design move—and how it opened up the space for students to become resources for one another—that I found myself drawn to the examining the debate.

The debate spanned three days. The class was split into two teams: *Team One* debating reparative stem cell therapy for congestive heart failure and *Team Two* debating the use of stem cells use to treat kidney failure. Team Two's debate took two days because day two was a shortened day and students continued onto a third day. Thus, on the first day, Team One debated each other while Team Two acted as judges (observing the others debate). The following two

days the team roles switched and Team One became judges and Team Two debated the use of therapeutic cloning to produce new, healthy kidneys.

In addition to assigning the case studies, Theresa chose the student sides for the debate ("pro" versus "against"). She did this purposely to focus on debating vs. sharing personal opinions—hoping this would emphasize the debate itself and not turn into a Jerry Springer-type debate (my words) with students yelling "I think it's stupid and my baby's not going to die" (her words) (Field notes, March 9). Each student was required to make a one to one and a half minute speech introducing his or her individual stance on the position as well as a back and forth rebuttal (posing and answering questions from peers) (focal/notable student's opening statements can be found in Appendix G).

Team One

The 2009 article for Day 1 presented conflicting viewpoints. One viewpoint citied the success of reparative stem cell therapy to treat congestive heart failure while the other viewpoint argued the somewhat inconclusive results. The students' job was to debate whether the use of stem cells was ethical and/or appropriate to treat congestive heart failure or to instead rely on heart transplants. Below is an excerpt of the article they read (see Appendix E for full article):

> Dr. Donald Orlic from the National Institutes of Health announced in April 2001 that stem cells from bone marrow injected into the damaged hearts of mice had morphed into cardiac cells, implanted in the damaged tissue, and laid the seeds for regenerative healing, the news was met with great enthusiasm. … But the finding supported early beliefs about the promise and challenge of using stem cells – that they might work before we fully understand why; that if you put them in the right place, they will do the rest; and that if they worked in a damaged heart, they would work in other damaged organs as well.

> …Others over the past 4 years have been unable to confirm [the] experiments. During this same period, clinicians in at least 10 different studies have harvested bone marrow and peripheral cells, cultured them to expand their numbers, and injected them or deposited them into the damaged areas of patients' hearts, then watched, waited, and measured with variable and not fully conclusive results. … The NIH says, "Scientists are interested in exploring this ability to provide replacement tissue for the damaged heart. This approach has immense advantages over heart transplant." Certainly, regenerative medicine would be less invasive and less expensive. Beyond this, it would resolve a nagging supply and demand crisis. As of September 2005, there were more than 85,000 Americans awaiting organ transplants. The year before, nearly 7,000 Americans died while awaiting an organ. (Magee, 2009)

Team One's "against" side includes the following students: *Kevin*, *Mismin*, Cookie, and one other female student (focal student names italicized). Team One's "pro" side includes Taylor, Rafe, Corazon and two other students (one male, one female). The opposing side started first with opening statements.

Team Two

Team Two (who took two days to debate because of a shortened school day) examined the case of a child named Katie Dyd whose kidneys were failing. While she was placed on the organ donor list, her parents sought another option for their child's care. Below is an excerpt of Team Two's prompt (see Appendix F for full case study).

> …Their one ray of hope came in the form of a controversial technique that would involve therapeutic human cloning to create embryonic stem cells for use in growing a replacement organ. …Researchers have told the Dyds that the success rate for organs

> grown from embryonic stem cells is higher than with any other type of cell. The transplant is even more successful if the embryonic stem cells used are an exact genetic match to the recipient. To achieve this, the doctors would use one of Katie's somatic[13] cells to produce an embryonic clone from which the stem cells would be harvested. Because this is such a controversial technique, this form of treatment must first be approved by the Hospital's Ethics Committee before the team of scientists and medical professionals can begin. (Field Notes, March 16).

Team Two's "against" side includes the following students: Eric, Bob, Gloria and two other students. Team Two's "pro" side includes *Stephanie*, *Molly*, Jacob, *Michael*, and two other male students (focal student names italicized). The "against" side started first with opening statements.

Theresa's Rationale for a Debating

"I want to figure out how to get all kids to speak so they can all say something to contribute." (Theresa)

Theresa and I discussed why she decided to hold a debate at the end of the unit and I share her ideas to underscore the debate as both an authentic learning opportunity and how engaging in debate is more true to what she thinks of as real science. In an interview, she said,

> If you are going to do a week-long thing, then you need to support and make sure that whatever subsequent lessons the teachers are doing is the same format of making kids think about it. You can't go back to 'okay, now we'll read about this and answer questions' (Theresa, March 9).

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[13] Somatic means body cell (e.g. bone marrow). The term "embryonic" here does not mean taken from Katie's embryonic tissue, but is a body cell reprogrammed to be completely undifferentiated and act like an embryonic cell.

Theresa agrees with students that this unit is different than others in that it emphasized critical thinking more so than the other units in Classroom 507. Underlying this statement is Theresa's perceived need for biology curricula that is contemporary and promotes student examination of key ideas—one that "make[s] kids think about it" and challenges students beyond the traditional "read and answer questions" engagement with content. Once students' minds are opened to critical thought and thinking for themselves—how does a teacher convince students to go back to rote learning? In her statement, she suggests the power of authentic, critical thinking in science class. Further, emphasizes the importance of being able to author personal perspectives on scientific issues in the following statement.

1 Um. (she sits back). I just think that if you are going to learn about stems, you need to think of them in your life. And stem cells, or this particular issue, are something they [the students] are going to have to live with.

2 It's like, if I was teaching about computers back in the 80's, I would, you know, hone in on that to get kids to understand the implications and all that.

3 Because it's teaching something new I just knew would take off. It's huge. And I just think ethics are a huge thing.

4 Because it's just too… if you look at what the kids are saying,

5 It's just too easy to, for someone to be taken off track… like if you listen to two sides of a story, and you're listening to Rush Limbaugh and you're listening to, I don't know who the other guy is, [inaudible-?], they're very strong on both sides, and they could convince you either way, but you really have to listen to what they're saying.

6 And then, to be able to say, well that sounds right, but what about that? Instead of, you know, listening to very inflammatory statements.

7 I think it's my job to for them to be able to, to teach them how to look at something and to really look at it.

8 I may not personally believe in stem cell research, um, that doesn't mean that's what I am going to teach them. Or I may believe in it, but that's not my job.

9 My job is for them to get them to look at things and for them to say, wait a minute—there's this and there's this.

Several key pedagogical beliefs are touched on in this excerpt: a) understand current, cutting-edge science (lines #1, 2, 3); b) that knowing science content is imperative for science teaching and learning (lines #1, 7, 9); c) students must be have the ability to "read" media and (de/re)construct scientific media for themselves (lines #5, 6, 7, 9), and d) her role as a teacher is to provide the time and space (devoid of her personal opinions) in order to shape the skills for authoring their own interpretations of the science in their lives (lines #2, 5, 7, 8, 9).

Additionally, Theresa wanted students to access multiple and varied resources: including peers, experiences, and outside of classroom materials. In the next quote she explains how this unit compared to the other units she has done this year and the importance of guiding students through education as a social process through the use of debate.

1 I really liked that they were able to debate.

2 That's definitely something I want to work more with [in future units].

3 I've had class discussions, but I like that they were able to debate.

4 Because they had to talk to each other and a lot of times with class discussions, they still want to talk to me. And this—they had to talk to each other.

5 For the most part, I think they felt they really made a good argument that couldn't be put down.

6 And I think that most of them did not expect a response, you know, like they made their point.

7 And … then when Taylor said "you're gonna die anyway"[14]—everyone dies—I love that!! Um, when those [arguments] were put out there, the kids were just, "Woah, that's good".

8 I thought that was nice that they were able to recognize when somebody had a strong point.

9 But I think when they [themselves] said something, they thought they were making a very strong point. I thought that was good. (Interview. May 8)

Theresa not only liked the idea of the debate as an assessment, but that students actually debated (lines #1-3). The debate itself encouraged students to talk to each other instead of to her. While at times, students tried to talk to her, the format of the debate encouraged them to speak with each other (line #4). Not only to speak with each other, but they also took pride in their individual arguments (line #5-6), cheered each other on (line #7), and listened to each other's strong points (line #8-9). From Theresa's point of view, students were legitimizing each others' ideas and arguments.

Personalized Use of the Affinity Space

To demonstrate how students personalized the debate and used it as an affinity space, I share stories, observations, interview data, and student work pivoting around each student: Mismin, Molly, Michael, and Kevin and the changes observed in Theresa's thinking.

[14] Will return to this statement during Mismin's affinity story.

Each participant's thinking evolved in varied ways. **Mismin's** thinking is circuitous; she often articulated accurate and inaccurate scientific ideas and she frequently referenced religion as guide to her thinking. **Kevin,** who came into the debate with relatively strong content knowledge, uses the debate as a game and experiences unexpected challenges from peers. He subtly changes in his ways of speaking about stem cell research—nuancing the difference between the use of embryonic stem cells and adult stem cells. **Molly** came into the classroom with strong content knowledge and was able to "preach" accurate science to peers. **Michael** often drew from his peers' comments, integrating them into his own discursive patterns—strengthening his academic and social standing in the class. I end this chapter with a description of **Theresa's** thinking on stem cell research. I include a glimpse into Theresa's affinity story specifically to help think about how teacher thinking evolves in authentic problems in ways that content-driven units do not. Without the debate, the individualized learning I describe might not have taken place: public knowledge and one's access and invitation to the floor made this possible.

To guide the reading of each affinity story (and to help think about the collective stories as an affinity space), I organize the primary points for each focal student before I share their stories. In the table below, I list the focal student, their contribution and/or formation of knowledge, their use of the debate, and their role and participation in the debate.

Focal Student	**Use of Debate as an Affinity Space**
Mismin	Construction of Personal Knowledge: • Better able to define a stem cell • Knows the difference between embryonic and adult stem cells • Knows the origin of adult stem cells Use of Space: • Voices both sides of the ethics of stem cell as she saw it • Uses the debate as a sounding board to talk out her perceived dissonance between religion and science

Table 7. Focal Student Affinity Stories

Table 7 (cont'd)

	Roles/Participation: • Maintains the image of a good Christian and the most religious in the class
Kevin	Knowledge contribution for class: • Contributes that test results can be different for rats and humans Construction of Personal Knowledge: • Challenged on a misstep about how adult stem cells differentiate Use of Space: • Participates as sport—seeing the debate as a game to be played and won • Manipulates the fact that peers do not challenge him to contribute erroneous information Role/Participation: • The debate compelled him to speak (does not regularly participate in large group discussions) • Maintains standing as a top student
Molly	Contribution of knowledge: • Clarifies all inaccuracies of stem cell research spoken by peers during debate Use of space: • Preaches accurate science in the sanctioned debate space • Enjoys public speaking and debating (was looking forward to debate, asking about it often) Role/participation: • Still the "smarty pants", she gets to "teach" without having to ask peers if she can or if they want her to help them
Michael	Role/participation: • Plays with the line between getting to work and joking around • Social Positioning: kindness and supports friends Acts to pull students together and engage in class (in stark contrast to Molly)

Each student had a distinctly personal and varied use of the debate—but together, these varied uses demonstrate the flexibility of the debate to work as an affinity space. In an affinity space, students can contribute or build knowledge, use the space, and participate in their preferred ways.

Mismin

I begin with Mismin, a student who was confused about stem cell basics throughout most of the unit and possibly after the unit. According to Mismin, this unit was harder and more interesting that other units they studied previously in class. In an interview, when asked about how stem cells worked, she told me that at first she did not know what a stem cell was—"First of all, I didn't know what stem cells were—I was thinking, what stem cell? Was it from the, like, the sexual organ, are they, like coming out? It says stem. …It has cells" (Interview, May 14). Mismin was the student who first introduced religion to the conversation on stem cell research (see *Chapter 3 Methods*). In talking about stem cells, she publically expresses her opinions of stem cell research by playing something akin to devil's advocate. If the large group conversation moved towards concluding that stem cell research "was bad", she would say it was "good". On the other hand, when a student made a statement that stem cell research was "good" she countered that it was "bad" (March 2, March 4)—chiming, "Everyone else said it was 'good'". As an example, she talks aloud her balancing judgments—

> I think it's good, 'cause it's like a new way of thinking about stem cells—but also, what if it comes out wrong? Or like something goes out wrong? …Religious people, believe that they, scientists are trying to play God, which they're not—they are trying to create something useful. But… It's not easy." (Field Notes, March 2).

Additionally, she would often fall back to one consistent comment, "It's dealing with human life" (March 4, March 17) to argue against stem cell research. Mismin, is a religious person—Cookie, a friend, called her "the most-religious person in the class" during an interview. One morning, Cookie (a Christian) and Mismin are having a playful argument in which Mismin exclaims at one point, "Oh screw you—you say that Catholic churches are boring!" (March

10)—as they debated who's churches were better. Religion and science were at times at odds in her head. Yet she appreciated science explaining she liked the idea that "God created the world—but science proves [how God's world operates]" (May 14). Comments, like this, show her attempts at bringing science and religion into conversation with one another.

Part of her struggles with authoring her own opinion of stem cells came from her confusion about the content, her understanding of stem cell research is limited through most of the unit. Recall that stem cells can be harvested from embryos or embryonic material (and these are the most malleable of stem cells)—however, research has shown that somatic, or body stem cells such as bone marrow, can be "reprogrammed" to function like an embryonic stem cell. Mismin consistently conflated all stem cell research with embryonic stem cell research as we see in the debate and in her opening statement citing that "stem cells come from unborn babies" (see below).

Mismin's Opening Statement

Mismin was placed in the first group by Theresa and Mismin was tasked with arguing against the use of regenerative cell therapy when experimental results are inconclusive. Later, in an interview, she noted that this perspective (being against regenerative stem cell therapy) is not entirely too far from her own opinion as she finds her personal stance is more in the middle of the two positions.

I begin with Mismin's opening statement and her comments during the interview regarding the opening statement (March 17). At the beginning of class, Theresa made a few announcements and reminders, and then she began the debate.

1 Theresa Are we good? Yes? Okay. So, we'll start with yellow… okay, ready?

2 Michael (joking) Court is now in session. (bangs on the table like a judge).

3 Theresa Stand up whoever the first person is. Stand up.

Mismin What is this, like court or something (awkwardly stands, trying to figure
4 out which direction to face and whom to address).

Theresa No this is a debate, so when you speak, you're making yourself known by
5 standing up.

6 Mismin Okay. Good morning ladies and gentlemen of the debate team, "debate team" (makes air quotes). (students laugh). I would like to introduce you a case about heart disease and stem cells. Stem cells are used, our team, we agreed of no heart, no um stem cells in the heart (this is very jumbled). People have heart damage problems, the reasons, some points, that I have wrotten [sic] is, um, that hospitals have short supplies of stem cells, and that stem cells are being tested on humans without the FDA agreement. This is very important 'cause it could also damage patients, it's a high risk, because if these places don't know what they're doing – then it'll be dangerous for us and the whole community of people of the world. Um, and then, also, stem cells, I would like to add that stem cells is un-religiously [sic] for many people 'cause stem cells came from unborn babies. It's like saying that… it's like having an abortion which is wrong for many religious reasons. 'Cause it's like killing another person. Thank you.

In this opening statement, Mismin is nervous (this even more apparent on video). She was the first student to speak in the entire class and this debate—showing her nerves by joking about the "debate team" and "court", her speech and grammar jumbling, and struggling to pronounce the

words related to stem cell research and properly use other scientific words. However, she persevered—stumbling through her orations as demonstrated by this opening statement of the debate. In this statement, we see her confusion about how one could use their own stem cells in donation, arguing that stem cell research would not work if people did not donate and adding that stem cells are in short supply. She also seems to allude to an ethical misstep, citing that stem cells are being tested on humans without the FDA agreement (in an interview, I got the impression the she thought the FDA was a stem cell research ethics board, vs. the Food and Drug Administration). From this statement, we additionally see her confusion between embryonic and adult stem cells by stating, "I would like to add that stem cells is unreligiously (sic) for many people 'cause stem cells came from unborn babies. It's like saying that… it's like having an abortion which is wrong for many religious reasons. 'Cause it's like killing another". If we look back at the timeline of the unit, her opening statement and this debate took place at the end of the unit—when, in theory, she should have mastered basic stem cell concepts and been able to compare and contrast different types of stem cells.

Rebuttal

During the rebuttal period in the debate, a student, Taylor, took the idea of religion and stem cell research to task, directly addressing Mismin's comments in her own opening statement. Recall that Mismin was arguing against the approval of stem cell therapy; Taylor argued for the approval and use of regenerative therapy.

1 Taylor (clears throat). Well, I'm going to start with this whole religious thing. She's going to die. (students start to laugh). (she pauses). It's not (inaudible). You're not immoral, like they're saying, but whatever that's (inaudible). As for side effects, what do you look at that—give me something that doesn't have side effects. You take medicine, you come out with a rash. Everything has side effects. …I know everybody here watches TV, now you see that stuff for depression if you take that stuff for depression, it could lead you to die anyway but it's like, what's the difference if you want to use stem cells instead of getting a heart transplant. So, um, as well for heart transplants. Who said you're guaranteed to live after that? You can die—you might die before you get your heart transplant. So- hold on—(inaudible, but the class laughs). I'm going to give an example. My great grandma had to have open heart surgery and she ended up having to get a transplant and she almost died. So, um, that's just an example of you can die anyways, so you might as well get a more natural way of using stem cells instead of getting someone else's heart—why do you want someone else's heart—its dirty. (students laugh). I don't know, but in my opinion, I feel you should let- (looks at Theresa)—oh and—oh, am I done? (she sits down).

2 (students clap for her—even on the other team- Liza, Mismin, Cookie, Kevin, Jesus, Jacob).

(students murmuring—That was good!).

3 Theresa Now, the yellow side, you get to ask them a question that they have to

		counter.
4	Cookie	So, I have a question.
5	Theresa	Stand up.
6	Cookie	(stands up). Ahh. (pretends to be exasperated by having to stand). (students laugh) So, stem cells is like a way of killing life, don't everybody have a chance to live their life? Don't you have, can't you like, pero[15], ahh-- Why use stem cells to… why *kill babies* for you to survive?
7		(Rafe: No-; Taylor: stem cells don't just come from babies—we just said that, Rafe: Yeah so there-)
8	Cookie	Wait! Okay, but pero-
9	Students talk over each other	Corazon: You can use bone marrow which is transplanted… Taylor: you can use your own stem cells. Rafe: you are using your own cells to fix your own body. Taylor: Thank you. Rafe: if you want to die, go ahead.
10	Cookie	You know what? Whatever. (she sits down).
11	Rafe	And they're not even babies yet.
12	Mismin	But it's still God's creature.
13	Corazon	They're your own cells from your own body.
14	Taylor	God wouldn't want you to die.

[15] Pero means "but" in Spanish.

15	Theresa	Doesn't everyone have to die, Taylor?
16	Taylor	Everybody does have to die, (Mismin: But everyone isn't) but (Rafe: Not painfully.) when it's your time.
17	Taylor	You don't have to die from a heart attack that could be prevented.
18	Mismin	What if your client's… in the hospital. Where are they going to get the stem cells?
19		(Talking over each other) Rafe: From their body. Corazon: From their selves.
20	Mismin	At some point, they're going to run out.
21	Corazon	No! You can't run out.
22	Cookie	Nevermind, nevermind.
23	Corazon	They're your stem cells.
24	Mismin	But what if like nobody donates stem cells or whatever.
25	Corazon	You're taking your own.
26	Mismin	What if you don't wanna.
27	Yellow team	(in unison):You're gonna die! (students laugh and Michael started clapping).

Taylor's opening statement (line #1) was met with clapping, cheering, and laughing, bringing enthusiasm and life to the debate. Her primary debate points included: 1) every medical treatment has side effects, 2) if stem cells are considered a medical treatment, there is no difference between using stem cells and any other treatment (she cites depression medicine from the TV), 3) her great grandmother almost died from open heart surgery in which she received a heart transplant, and 4) that everyone has to die—why not use scientific discoveries to push back

a preventable, untimely death. When it comes time for a response, it is Cookie who challenges Taylor. To do so (lines # 4 & 6), Cookie asked how it is ethical to use stem cells that "kill babies" in order to save adults. In lines #7-9, the opposite team argues there are ways to use stem cells from the adult's own body—not involving embryonic stem cells. Line #10, Cookie gets frustrated and sits down. There is a brief, subtle tangent in the argument as Rafe claims they are "not even babies yet" (line #11)—I read the "they" as embryos and I believe Mismin does as well, replying "But it's still God's creature" (line #12). Corazon brings the debate back to somatic (body) stem cells in reminding the group (pointedly Mismin and Cookie) that they are talking about cells from one's own body (line #13). Theresa had not interjected at any other time in the debate—except to ask Taylor about her comment (line #14)—"Everybody's got to die. ...You don't have to die from a heart attack that could be prevented (line #17). Mismin's misconceptions begin to come out (lines #18, 20, & 24) in asking what to do if the hospital runs out of stem cells or no one donates—to which the opposing team tells her it could be within her rights to donate for herself or not in which case, the students tell her, "you're gonna die" (line #27).

In this interaction, there are so many ideas added to the floor. To debate (like the conversation I just shared) students have to think quickly and deeply in order to answer questions, refute statements, or come up with the next challenge. Students are not only listening to one another and blindly absorbing this information. They are developing their own sense-making throughout this discussion. Here we see a mixture of opinion, knowledge growth and use of the floor.

Looking at Mismin's learning chronologically is circuitous. From her opening statement at the end of the unit on March 17th, is appears that she had not shifted her ideas about how stem

cells work or where she stood ethically at the conclusion of the unit. Two weeks after the debate, April 7th, I interviewed Mismin and she talked about several lingering concerns with animal cruelty (testing scientific procedures on animals first) and scientific mistakes ("what if they put the needle in the wrong spot"). She argued that her religious concern with stem cells was that "it was playing God—playing with His work—why live forever?" But she thought it was right to try and find a cure for diseases, stating, "I'm like… everywhere. Cuz for religious reasons, embryonic stem cells is wrong (sic)—its killing babies- its abortion. And then, um, but its right 'cause it can cure, maybe, cancer or leukemia" (Mismin, Interview April 7). She explained that scientists could remove a lobe of the liver and it would re-grow like a crab that had regenerated its own leg (to my knowledge, only the later idea is somewhat scientifically accurate). Even two weeks after the stem cell unit, she was still confused about stem cells and perhaps a little naive about standard medical protocols (e.g. animal testing).

I believe it was the rebuttal from the debate itself and/or later reviewing the rebuttal on video in an interview that helped her confront these misconceptions and address them head on. As evidenced in "the rebuttal", she still articulated these misconceptions during the rebuttal portion of the debate but then changed her ideas when I interviewed her after the debate concluded. In our interview on June 3rd, over a month after the debate, when I replayed two critical events, the opening and rebuttal from the debate, and her reasoning became more clear—she articulated a much more sophisticated understanding of stem cells and her perspective on their use. When asked what she thought about her ethical position regarding stem cells, she stated,

> Geez, I am like in the middle. There are many different ways to look at it. There is another point of view: that stem cells can save other lives and it could be good for saving

> lives. … I learned that there are different types of stem cells and each stem cell is used for different things and where it comes from and how it becomes that cell." (Interview, June 3).

Evidenced by her shift from a "stem cells are good/bad" rhetoric to a more nuanced balancing of ethical concerns: Mismin's understanding took time to develop and is still incomplete. While there is no way for me to pinpoint the exact moment her understanding shifted from completely confused to a more nuanced perspective, I can say that by the final interview, she had sorted out several ideas and was beginning to demonstrate a deeper level of understanding stem cells. Given that she was still greatly confused at the end of the "traditional" part of the unit, the debate and/or her re-viewing of the video with me provided her the opportunity to make sense of these ideas.

For Mismin, the debate became an affinity space when she was able direct her learning and participation. She was able to construct and refine her knowledge on stem cells, to voice the ethical issues of religion and science as she understood them, and was able to do this while maintaining the role of a good Christian in bringing up religious concerns.

Kevin

I transition now to examine Kevin's affinity story. In an interview, Kevin told me that he had a responsibility to pull back from classroom discussions because he had already completed high school science in the Philippines—allowing others to use the classroom discussions for learning. He explained,

> I don't talk a lot because I have this feeling that I already took the course back where I came from and it would be unfair to take all the points… like if I keep reciting or answering her questions, I wouldn't be giving the opportunities to other students. I try to

be as quiet as possible, but when I'm put on the spot, of course I have to answer. (Interview, May 3)

This awareness spread to other aspects of Kevin's participation, "… In group activities, I try to lay low and feel their presence to see who is acting like a leader and who is not. If there is a leader, I would lay low. But sometimes no one steps up, and then I do—but I don't like to step up immediately."

Even while trying to "lay low", he was able to co-opt this debate for his needs—the lure of the debate pulling him into the discussion. To Kevin, the debate was a game—and to maintain his status as a top student—it was a game he wanted to win. Keeping in mind how Mismin's content knowledge shifted because of the debate—Kevin's affinity story is vastly different. He entered the debate with a relatively firm grasp on the content (though the debate pointed out a large misconception) and therefore used the debate in vastly different ways than Mismin.

Kevin's Opening Statement

Kevin was the third person on his team to present his opening statement (Mismin was first). In an interview, he told me that he could not argue the scientific content behind the use of stem cells because he didn't that using adult stem cells was unethical. Worrying he would not win arguing the ethics of stem cell research, he instead appealed to the ethical concerns of science in general—thinking this might give his team a chance to "win" the debate.

We see this in his opening statement when Kevin makes several points—1) that mice and humans are not the same species (citing that Splenda caused tumors in mice, but not humans), 2) the ends does not justify the means in scientific treatments (it may appear to justify the means if

you are the one receiving the treatment later than others with the kinks worked out) and 3) he compares this mentality and logic to the Nazi experiments in World War II. He read,

> 'K, um. Morning. According to the case study, it is a fact that the process is premature and place a group of sick patients at risk. The only basis for the process is works is that it works on mice and it shouldn't be assumed that the process would also work on humans because a study on artificial sweeteners, showed that Splenda, um, causes tumors to grow in mice, which is, of course, not the same in humans. And also, the process is unfair to the people who will undergo the process first and die as guinea pigs for the progress of the process. Comparing the situation now where people want to be first in line, awaiting organ transplants when the process is initiated are the same people who first in line for an organ transplant wouldn't want to be first in line for the process. Right, because the ones who undergo the process first have less chance of success than those who go later. And um, to argue that a messy progress is progress none-the-less is the same argument that the Nazi's used to justify their cruel experiments. Let us keep in mind that the ends does not justify the means and not subject people to this premature process.

None of these directly address the efficacy of stem cells (nor the comparison between somatic and embryonic stem cells)—but potential ethical concerns with the way science is conducted. In an interview, he tells me this movement from the science was purposeful. "I planned to divert argument from the science to ethics since we could not have won based on the science. We don't have a chance—that's what they do—they test it on animals. I tried to argue based on the ethics of it" (Interview, June 4).

Applause Before Rebuttal

No one directly challenged or posed a rebuttal to Kevin. Instead, following his opening statement, students clapped for him; an action, that I thought kind and supportive, he found problematic. He discussed that peers regard him with higher status that others—stating, "They do pay attention to me more. That's kind of awkward, though. There are times when one person would say one thing, but …I could say it and people would pay attention to me but not necessary the person who thought of the idea" (Interview, June 4). In particular, his peers' uncritical acceptance of his ideas or contributions because they are his frustrated him.

> They shouldn't be clapping based on what I was saying (but they are biased towards me as an individual; they didn't clap for [the second student]—of course I would notice). I think they are biased towards me—in class, when Ms. Theresa is discussing stuff—but when it comes to those stuff, they are biased. In different situations, they are biased. If I am put in the spotlight, that's when they are biased. I like the spotlight, but not the bias. If they show the same enthusiasm for everyone (e.g. clapping for [second student who debated]- but they are not clapping at what I said or because it was me who said something. (Interview, June 8).

Roughly 20 minutes of this third interview focused on the discomfort he felt for un-warranted praise received from peers. Mismin applauded his jumping in to help the team; when Mismin viewed the debate with me, she called Kevin, her "savior" and like "superman" in the debate, swooping into save her. Cookie added, "I love Kevin in this case. He was amazing in this debate. I love when he talks, someone asked a question and he was like, bam! Here's the answer and you're wrong. I was like yes!".

For most of the debate, Kevin was quiet, telling me he finally jumped into the debate because he didn't want to lose. Returning to the debate transcripts, I pick up where I left off

from the interaction among Mismin, Taylor, Cookie, Corazon, and Rafe—where, based on the synchrony of the opposing team, Mismin and Kevin's team was not rebutting well in the debate. Kevin jumped in and Corazon (a student on the opposing team) made a point that seemed to surprise him—refuting his points about the lack of knowledge of how stem cells operate. This shows that Kevin, a student entering the debate with strong content knowledge, found a role that challenged him in the affinity space.

1	Yellow team	(in unison) You're gonna die! (students laugh and Michael started clapping).
2	Mismin	But what if the person decides to die and the doctor goes ahead and does it?
3	Theresa	Without giving someone else a chance to… We're trying to do back and forth and it's really hard to (inaudible), okay? Kevin, do you have a counter point?
4	Kevin	Yeah. I would like to quote a sentence in page 7, first paragraph. It says um, "during the same period clinicians in at least ten different studies have harvested bone marrow and the peripheral cells cultured them to expand their numbers and injected them or deposited them into the damaged areas of patient's hearts. Then watched, waited, and measured the variable and not fully conclusive results." This means that using bone marrow for regenerative medicine isn't still—there isn't, it's not a sure thing that this person will live. And, um, as we talked about the side effects, heart transplant would only have a side effect of death. (students chuckle at this). However, due to not fully conclusive results in the bone marrow things, there could be other side effects. What if this person grows a knee in his heart. Right? Who knows? Or he could grow another ear or whatever else in his heart. Would that be better?

		Would that person be better off with a knee or a foot in his chest. (students laugh). So what else? There's like a million possible side effects that can happen rather than a heart transplant which is actually, the side effects of that actually depends upon the immune system and whatever other stuff with the body, with the heart thing. (students clap for him)
5	Corazon	You said that you can grow an ear or whatever in your heart, but why would they use bone marrow for cancer, for blood cancer, it doesn't do that– it was in your the body, it wouldn't grow anything abnormal.
6	Kevin	Okay… (pause). But in a heart transplant, there's already facts, there's already statistics that heart transplants work—that there were heart transplants that were successes. Right? But right now, there's still no basis that this process would work. Rather than that it worked with mice. And we know that mice can live in a completely harsh environment that humans cannot. (student murmuring). And um, regarding the other stuff that a mouse encounters for example, who eats Splenda? (Eric raises his hand). Puts Splenda in their teas or whatever? Right? Splenda actually causes the mice to grow tumors in their stomachs. So how would we say that the same process of putting bone marrow in the heart would be a positive thing for humans?
7	Theresa	Rafe, want to comment?
8	Rafe	I just (inaudible) (a couple students laugh)…
9	Theresa	Okay.

In his statement (line #4) Kevin, who is trying to make the case for the uncertainty of the scientific processes and general concerns on medical trials by arguing that scientists are not sure

how the stem cells will differentiate, is floundering (the students saw a picture of an ear growing out of the back of a mouse, shown in *Chapter 4 Teaching at Alomar: Descriptive Portrait*). Corazon jumps on his misstep and argues that stem cells don't differentiate randomly and Kevin is taken aback. Corazon has beaten him on a scientific idea, but he seems determined to not lose the debate. He quickly acknowledges his mistake saying only, "Okay" and then switches gears and instead going back to his opening statement in which he argues that human trials are problematic because of the uncertainty in the difference between humans and mice. This decision builds momentum until students are left speechless and appear taken aback by his passionate retort.

Kevin acknowledged in an interview that he knew he was being inaccurate at times. He also acknowledged Corazon's role in the debate and agreed with me when I thought that Corazon was keeping up with him. In our event-centered interview, he kept playing out what could have been done or how he interpreted the debate. Aside from his debate point that stem cells might randomly differentiate (resulting in an ear growing out of a mouse back), he also told me of the ways the other team could have "beaten him". For example, when he cited his argument about rats and Splenda, he admitted to manipulating the situation because of his academic standing in the class, saying,

> Oh! If I were on the opposite team, I would have addressed that [Splenda] statement of mine. Because I didn't provide reference. Where did I get that from? Was it valid? I feel like a hypocrite. But I assumed they would just accept what I said, but I didn't think they would call me on it and would just accept what I said. (Interview, June 8)

In this quote, he recognizes that his comments were problematic. He didn't provide a reference, and it was information that he had not looked up recently—he told me it was just something he

"knew". Because he said his team was not given enough scientific information, he had to figure out another way to "win".

This interaction was vastly different for Kevin than for Mismin. Whereas Mismin needed the debate to deconstruct and reconstruct basic science concepts, Kevin used the debate as a game—a game he could win. This game provided two opportunities for him: 1) to assert himself as a top student and 2) to academically play in class. Part of this game involved positioning: he views himself as one of the top students and does not want to lose that standing. Another part of his making the debate into a game—he was participating for the grade and to as an entrée point into class discussion. Historically, when he speaks, students listen and do not question his command of the content, but when Corazon refutes one of his comments, he floundered and was taken aback when he made this misstep and she called him on it. I interpret this to mean that intellectually, the game was a more difficult task than he anticipated (with challenges from students he did not anticipate, team members who struggled, and a case study he found lacking in much science—though I think had much more science than the opposing team's). However, it still provided him a challenge. Kevin, who usually pulled back from discussion, could not hold back any longer and jumped in. As teachers think about how to challenge students, students who grasp content somewhat easily (and perhaps students with a bit of hubris regarding their knowledge in class), this debate provided that rigor for Kevin. When asked who won, he simply stated, "I know we did".

For another high achieving student in the class, Molly, the debate was something she had been looking forward to for weeks. The debate did not offer a chance to re-shape misconceptions about stem cells, nor did she need it to enhance her argumentation skills. Instead, it gave her the opportunity to use the floor to teach her peers.

Molly

Molly and Stephanie (Molly's best friend) walk a fine line: while Theresa recognizes them as engaged and committed students who both love science, Molly said that other students resent their participation in class, saying they are "smarty pants" who make people "look bad" by not giving others "a chance" (Interview, April 12). Molly, a lover and protector of science, stands up for science by citing inaccuracies expressed vocally in class or in the media.

When asked what she knew about stem cells prior to the unit, Molly said she was aware of them and had heard of them, but didn't recall knowing a lot about them. When asked if her parents knew about stem cells, her response was interesting telling me her mom is disabled and her grandmother has Alzheimer's (the connection there could be that stem cell therapy has the potential to remedy some ailments such as Alzheimer's and potentially the physical disability afflicting her mom). Much of her prior impressions of stem cells and stem cell research, came from an unusual source: a *South Park* episode (2003) called *Krazy Kripples*[16]. She found this episode to be both frustrating and misleading[17]. She explained,

> I'd heard about them. I've seen them on TV shows-- like negatively portraying stem cells like *South Park* with Christopher Reeve, but I didn't know the science behind it. It made you not care about it since it didn't take the issue seriously. In the show, it had Christopher Reeve tear a head off a fetus, drink its juices and grow stronger-- it got to the point where he was addicted to the fetuses. He was slurping them one after one and he

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[16] Season 7, Episode 2. Synopsis: When Christopher Reeve comes to South Park to promote stem cell research and "handicapable" Jimmy is insulted when no one pays attention to him.

[17] Before the Krazy Kripples episode, South Park had another episode on stem cells. Season 5, Episode 13. Cartman collects fetuses for sale and later tries to persuade Congress to overturn the ban on stem cell research.

> became Superman. I was always interested in stem cell research, but it made it seem like ridiculous-- because you don't know the facts, you are going to believe the TV (like killing fetuses)-- to an extent (Molly, Interview, April 2).

Molly's body language and talk becomes more heated and impassioned as she discusses these frustrations.

In one interview, we talked about the debate and her frustrations of peers not researching the science and then, when they speaking about science, speaking with inaccuracies. She recalled a time during the debate when Gloria, a student who did not often come to class, walked in late for the debate. I noticed Molly roll her eyes and look at Stephanie at one point during the debate when Gloria was speaking—I believe this eye roll to be because of Molly's frustrations with Gloria. Molly said Gloria was not prepared and participated in the debate with ignorant comments such as,

> You don't know the effects, these scientists don't know the effects of these stem cells and how can you really think, 'Oh! It's just an experiment. Let's just go ahead and do this experiment on Katie.' Well, what do you mean by experiment? Are you sure these stem cells are going to save her life? Or would it be more of a chance? (Gloria, March 18)

Molly resented Gloria's questioning human relatedness to rats—citing Gloria's comments were not scientifically helpful (see Appendix G for Gloria's opening statement).

The article Team Two read discussed the efficacy of stem cells in the kidney—and Molly felt that Gloria should have been more prepared and known the information required of her for the debate. Molly extolled:

> Gloria had her hand up—I got annoyed by that. Whenever she makes a remark, 1st or 8th period, it's like, here comes another thoughtless remark, and it's going to have a lot of

> attitude in it and it's not going to be worth it. I hate arguing about petty stuff. … That's what gets me mad the most. If it's not good or well-thought about it or easily debated—it gets me so mad. It's such a waste of time. They need to do their research ahead of time. I am really passionate about stem cells. And then it got even more, like, I got even more passionate when it came to the rebuttal because I was just so ready to come back since I have been reading a book about it ever since [Ms. Theresa] mentioned a debate. I really hate, more than anything, when people talk confidently about stuff they don't know anything about. It's like one of my pet peeves. If you're going to speak and speak confidently, have your background information right and so, it wasn't about being right, just me being right, it was about making sure that they *know* what they're talking about.

At one point during the interview, Stephanie interjected into Molly's comments saying, "With Molly, she will sit there and start reading everything. With Molly, it's like this with her in science all the time." For example, Molly stated that many people in the class did not understand the science behind stem cell research and therefore "the debate was debating and teaching" (Interview, May 2). Molly was not the only one who found her peer's lack of preparation frustrating. Kevin similarly reported that it was annoying—but he didn't usually jump in, instead he said that students such as Molly jumped in and corrected any misinformation. According to Kevin, "It's just an instinct to be annoyed and that person is misleading others. " Whereas Kevin found this frustrating, he did not speak out about it—he left it to Molly to do—and she did.

It is these frustrations over inaccurate science both in the classroom and on television shows that drives her use of the debate affinity space. Within the affinity space afforded by the debate—she could jump on a proverbial soap box and "correct" misconceptions.

Molly's Opening Statement

Opening statements (see Appendix G) from the second group were much more sophisticated than the first groups. To be fair to Team One, the sophistication of Team Two's arguments could have been because they were the second group to go and had the opportunity to see the other team debate first, because they had more time to prepare. Their sophisticated arguments could also be because the students were historically stronger students, among other explanations. Regardless of the reason, Molly's opening statement was thoughtful and sophisticated. Molly begins by explaining stem cell basics.

1 When it comes to stem cells, there are many kinds.

2 There are embryonic, there are clones, there is (sic) um, the stem cells that come from the umbilical cord, and there are adult stem cells.

3 When it comes to the ethical concerns it's mainly related around embryonic stem cell simply because it destroys the embryo and thus cannot develop into a human being.

4 But this has nothing to do with that.

5 Therapeutic cloning: this involves taking cells from the patient's body, whether healthy or not, cloning and culturing it, to create any cell needed for the body.

6 When it comes to reproduction, when a person reproduces, that persons illness or the disease or anything is not passed on to the clone or the or child, it only copies the genetic information.

7 So when we clone stem cells, it's not passing on the disease or sickness, it's passing on genetic information creating a perfect match for that kidney.

8 And also, Katie was a child who had a zest for life and she was very active.

9 We do not know her opinion and we should.

10 But looking up information, I think she would want to live and I think she'd risk any

chance she could take that opportunity to live longer.

11 She's a ticking time bomb.

12 She doesn't have the years to wait for a kidney.

13 And as low as supplies are, there's a chance she won't have one.

14 And as time goes by, she'll only get sicker and sicker and the chance to act will not be even possible.

15 Transplants are less invasive (corrects herself) transplants are more invasive.

16 A stem cell injection is not a transplant.

17 They do not cut her open like severely and they do not replace her organs.

18 It's a small injection (points to her side) and way less invasive.

19 And also, it is not the hospital , the hospital- (stumbling over words). There is no information claiming that the hospital is against or for the treatment, they simply have to make a decision.

20 Whether that should be up to the parents or not seems wrong, it should be up to the parents- not the community.

21 The community's are not the ones going to lose their baby.

Molly's opening statement functioned in three primary ways: 1) to correct all misinformation she had heard during the debate, 2) to address the prompt on the benefits of therapeutic cloning, and 3) to add in drama to appeal to listeners. The first third of her opening statement (lines #1-7) functions for her to address all of the ideas and misinformation that has been floating around the classroom during the debate. These misconceptions include the conflation of adult, umbilical, and embryonic stem cells; the idea that stem cells would carry on diseases; the idea that cloned cells could become another kind of cell haphazardly; and the origin of adult stem cells. Until

line #8, she did not even talk specifically about the case she was assigned—instead explaining these misconceptions, defining therapeutic cloning, and clearing up that therapeutic cloning is not designed to clone entire human beings. In the first seven lines of the transcript, we see how she lays out her knowledge of stem cell research and basic knowledge of stem cells. Once the "air is cleared" of misconceptions, Molly is able to climb atop the proverbial soap box and preach her frustrations after hearing from peers—their opening statements and their rebuttals (lines #15-18). The remainder of the lines are more social-emotional in nature, arguing that the opinions of those closest to the situation should be privileged: first Katie, then her parents. Additionally, there are several "melodramatic" pleas embedded through her talk: using the language from the case that Katie had a "zest" for live, calling her a "ticking time bomb, was getting sicker and sicker, and positioning the parents, not the community suffering the loss of a child.

Molly's Use of Affinity Space

Molly was politically active and involved in the school community. She is a student who lives by her words: in fact, she was really worried she was going to be put on a debate team on a side with which she did not agree—especially for this debate. Because she is so passionate about stem cells (her words), she said she would have debated against the use of stem cells, for the grade, but truly did not want to say things against her belief system. She was excited to debate on the side with which she agreed.

Molly was able to use the "debate for debating", she was also used it for "teaching"—allowing her to ally some of her dissatisfaction with misrepresentation of stem cells. As such, the debate in many ways served as an opportunity for her to take the pulpit and advocate for stem cell research.

> …That is a result of them not knowing: they don't kill you for your stem cells. They get the cells from donors. There needs to be more information for people. All stem cell research is good-- as long as the people are informed. They have done enough tests to prove the effect.

Even though she found frustration in peers "lack of preparation", she used the debate to create an emotional, yet scientifically cogent argument for the use of stem cells—one that allowed her sanctioned air time to correct others and without specifically confronting anyone in particular. Using the debate to "teach" for Molly is not necessarily about helping others in class, but rather securing a correct and accurate science. She comments, saying, "I don't do [teach others] because I care about everyone else learning it, I do it because I don't like them to think that that's true." (Interview, May 18).

Being silenced as a judge and having to watch the other team debate was hard for Molly, who told me, "I am really passionate about stem cells. And then it got even more, like, I got even more passionate when it came to the rebuttal because I was just so ready to come back." I called Molly "a protector of science" at the beginning of this section because she experiences such a visceral reaction to peers' misuse of scientific content. She does not teach to educate others—but to protect the "truth" within science. Thus, the debate provided an affinity space for Molly to "clear the air" of inaccurate science and her frustrations with her peers. This appeared to me to provide her with relief regarding the stem cell misinformation. Peers called her a "smarty pants" who "doesn't give others a chance"—but because all students were required to make an opening statement, the debate appeared to give her an outlet to let out her frustrations—allowing her to be the smart young lady she really was.

Michael

Michael is a popular and highly social student and used the debate and the unit to connect with friends, learn with friends, and at times, he saw himself taking care of friends. He often talked about his social side of learning: saying that he would crack jokes and try to make class funny and fun because "it helps get the work done". Even though he did not debate the first day. he was the first student to talk in the debate—when Theresa started it off saying, "Are we good? Yes? Okay. So, we'll start with [Team Two]… okay, ready?" and Michael jumps in saying, "Court is now in session (bangs on the table like a judge)." His use of the debate and the affinity space reflected this.

Aside from encouraging the prayer at breakfast, joking with friends, offering popular culture references in class, his actions in the debate further demonstrate this social nature. In one example, he gave teammates and friends baseball signs behind Theresa's back to assign them to a team, his team, (giving a sign to "stay" or "go" after reading the card Theresa selected behind her back)-- in all of his actions, he was conscious of other students. In another example, when his team sat down to prepare for the debate, Michael found chairs for others, suggested pulling them together in a circle so they could all see each other, and then recommended that someone read aloud after hearing that a couple of his debate teammates and friends had not read the material which was assigned as homework the night prior. He told me reading aloud as a group served many purposes: 1) he can make pieces more simple if peers are struggling, 2) to make sure they finish their work, and 3) that reading out loud keeps them all together. Whereas Molly and Stephanie started working as soon as they sat down (Molly commented that she didn't like being slowed down by everyone reading aloud), Michael's actions demonstrated collaboration (and the importance of bringing together his classmates and friends) in this science classroom.

Michael's Opening Statement

His opening statement is short and to the point, somewhat reminding me of the "layman's" version of therapeutic cloning. He said,

> Hi, I'm Michael and I am for kidney stem cell research. Stem cells are in our whole body. Stem cells (inaudible). Stem cells help recreate damaged areas: If your skin is burned, we can re-create your skin. Or patch it up (inaudible). If your kidney starts to fail, there can be an alternative as this. You don't want to wait, that whole time, not being sure if you are ever going to find a kidney. Lives are precious. We need to save them now, if we do this experimental and it works out, we've got people who we can save their kidneys for. You've got another kidney alternative. But as long as waiting, let's say never finding a kidney, a life is already lost. So what is the harm in taking that chance? (sits down).

Contrasting Mismin, Michael, and Molly's opening statements—we see that Michael's content knowledge is right in between Mismin and Molly. Mismin had a great deal of confusion and Molly had a litany of information regarding stem cells. He is somewhat cavalier (or naive) in his recommendation for stem cell research implying that there is little harm in "taking that chance".

Prior to the unit, Michael had not heard about stem cells and did not know anything about them. However, he came into our interviews with a good, basic content knowledge of stem cells learned from the debate, evidenced by large and small group discussions. When asked about the main points of the debate, Michael listed three primary concerns: tampering with religion, the cost of transplants, and concerns about the efficacy of therapeutic cloning. He then went on to talk these out during an interview. "It's like [they argue] God set up a specific time for you to die, but the thing they don't understand is that we do it very day by taking medicines getting

checked up, or in the back of an ambulance trying to resuscitate and work on you. We are messing with time the-- when you get the flu, you take medicine. We are already messing with religion" (Interview, May 3). While the use of embryos bothered him (because it is "messing with a child's life"), he didn't see the debate as a debate over the use of stem cells, stating, "They don't really use embryos, they don't have to use embryos" (Interview, May 6). He tells me how the scientific community doesn't know how it will benefit us or if it will work as well as a transplant will,

> …but as I said, if they have tested it on rats-- why can't we just try it and see. Heart transplants are already money-- costing. So if you are going to take something already in your body and make it into something new-- save some money-- why not? The economy's already bad. When they take an organ inside of you and then take the stem cells out of it and try to remake that same organ. The stem cells are not going to make a different kind of organ, it will make the same kind of organ.

These ideas are not particularly in-depth, but they show a level of application and branching out beyond the scope of what was taught in class. Again, in what reminds me of a nod to the working man, Michael suggests stem cell research to save money (and "…why not? The economy's already bad."). He also reiterates that stem cells do not randomly, haphazardly differentiate. Michael did not use the affinity space to preach science to others, flex his debate skills, nor learn the basic ideas of stem cells like the other students did. He did have a good handle on the content knowledge and could charismatically work the room.

Michael's Use of the Affinity Space

Michael, used the debate 1) for a grade, 2) to show that he knew the content, and 3) to help maintain his high social status through "helping" peers. Michael was a student whom most

students liked and joked around—but he was also a student who had a pretty good handle on the game of school. He learned what he needed to learn and then when he felt he "got his points", he shared with others.

The first vignette takes place on the last day of my observations (March 19, 2011). Students are completing the second day of the "Katie Dyd" kidney transplant debate. The previous day, the class period was shortened to 35 minutes instead of 45 minutes. As the bell rang yesterday, one of the students, Jacob asked if the students could complete the debate one more day and Theresa agreed. This interchange takes place between Bob, Stephanie, Michael, Jacob and Molly; they are discussing the use of animal testing in stem cell research. The transcript begins in the middle of the debate.

1	Bob	But there's still a chance of surviving with a transplant– it's a healthier choice to do it with transplants. A safer choice.
2	Stephanie	How is it is a safer and healthier choice if they're waiting so long? (Bob starts to answer). And with therapeutic cloning, if you can do it, like really quickly, and they're better off.
3	Jacob	And if you, sorry, didn't mean to interrupt you (I think he says this to Michael, Not Stephanie) Theresa smiles and laughs), if you think about it, like before, if you got a kidney transplant, or the stems cells or whatever, before any of those, I am pretty sure everyone agrees, that their life is already put in danger because their kidney fails them. Therefore, like, while, it's going to take years to try to find a kidney for this individual, why not experiment on them and find if this stem cell search can actually work out.
4	Several	Michael: And the other part is that (Three of Michael's friends are smiling)

	Students	Stf (yes): Well the other thing, Stf(no): I was going to say… Theresa: Wait, he wants to say something.
5	Michael	You know how yesterday, they said when testing on the rats, it doesn't always work. When they try it on rats, it works on us. And there is a statistic right here that I can't read because I lost my voice at the Jay-Z concert last night. Will you read that? (Michael points to it, Jacob is looking).
6	Jacob	This part? students are smiling and chuckling—I can see two male teammates for sure).
7	Molly	(sarcastically) Yes—he only underlined that whole part.
8	Jacob	(reading from Michaels paper) Some scientists have said that human kidneys have similar SSCs. Therefore the method can eventually be applied to cure renal failure in humans. In the experiment, the researchers transplanted 10,000 kidney somatic cells into the diseased kidney of the rats. (Molly and Michael both lean in and point to the next line. Jacob passes this off to Molly—"well you read it").
9	Molly	(continuing to read Michael's packet) Blood tests conducted on the rats seven days later found that their kidney functions had returned to normal, the researchers explained.
10	Michael	So that (inaudible) should its working on them and the tests came out positive. If it works on rats why can't it work on us?
11	Stephanie	That was, we did the research and that's one of the prior research why can't we take this step and try it on humans to see if it, if it's the exact same thing.

In this brief interaction, we see Michael pass off some off his research to Jacob, saying that he couldn't because he lost his voice following the concert. Recalling a comment Michael said about Molly having a "big head", I was interested to see his interpretation of this series of events: he passed the packet to Jacob who then passed it to Molly. Following the debate, I sat down with Michael and asked him about this interaction—apparently it stuck with him.

1	Adriane	The thing that you read in class, remember the thing that said that therapeutic cloning was tested on rats, and it showed a really high success rate, and then you didn't read it—you handed it off to Jacob, and then he handed it off to Stephanie, why didn't you read that?
2	Michael	Jacob really didn't get a chance to talk, because Stephanie and Molly always tend to try to take over like it's their classroom, I really don't get along with them. Because they try to overrule everybody. They try to be the boss of everybody. I felt bad, 'cause every time Jacob would try to say something, they would cut him off and try to bring up a total different subject. So I was like, here, Jacob, read this. I've been talking this whole time, my throat is killing me, go ahead and you can read it.
3	Adriane	So how'd you feel then, when he handed it off to… Stephanie or Molly?
4	Michael	He handed it off to Molly. …I wanted to tell him off, you know, because it's like, you said yourself you don't like them, why you gonna hand it off and try and make them get all the credit and you know the teacher's gonna give it to them. Because you know, you can tell who has a higher rank than him, got a higher rep. … I tell him, you know these two… kiss butt… and they're gonna get their way—why you gonna give it to them? You could have just read that

and gotten the credit. I gave you that chance.

5 Adriane Who brought that packet in?

6 Michael Me.

7 Adriane Where'd you find that?

8 Michael On-line. I'm the only one that came in with on-line stuff.

In this example, we see how Michael uses his on-line research as a commodity—a commodity he can share with a friend. This transcript could be interpreted as him being altruistic (and using his voice as a cover story so as to not embarrass Jacob with his "gift" of the research packet) or perhaps he realized he could not cash in the points and then turned them over to a friend—but his perspective that information in class was worth something—and that it can buy you status in class is important. In a previous interview, he stated, "…sometimes you just have to throw ideas out there to get your participation points (Interview, April 6)." From these ideas, I argue that Michael views school as a game of points to be cashed in with the teacher. In a later interview (May 6), he told me his team "won" the debate, stating, "We won-- argued more points; the points they brought up were the same. I didn't see anyone else come with packets". From these comments and his general awareness of points, I argue that he saw this debate as an opportunity to showcase some of his educational wealth, but to share that wealth with friends.

Michael's positioning in the debate did not stop there. In our final interview, we talked about how the stem cell conversation spilled over into other classrooms and public spaces. Three days after the unit, he, Jesus, and Mrs. P (another teacher) talked about the movie Denzel Washington movie *John Q* and how stem cells would have helped his son if the hospital had stem cell technology already. Explaining they talked about science outside of class, "This became an interesting subject."

Each of the students used the affinity spaces in different ways than each other—but so did their teacher, Theresa. As I teacher, I am struck by how powerful it is to learn from students and, as Theresa, experienced a change in her beliefs on stem cells. I briefly engage how Theresa's ideas shifted—and then examine the affinity space across all student and teacher stories—engaging the descriptors of affinity space—through the creation of knowledge, use of space, and participants.

Theresa

The following is a discussion I had with Theresa (Interview, August 8), months after the debate. I had already started to analyze data and was asking her for her impressions of the data and analysis. This conversation was part of that discussion.

Adriane My impression was that you learned a great deal about your own ideas on stem cell research from listening to the kids

Theresa Yes. Yes

Adriane Can you articulate that? Did your opinion change throughout the unit?

Theresa Um, actually with the adult stem cell—it seems like stem cells have a bad name. Because with all the research we have to look at it differently and I don't think a lot of people know about the newer research—and stem cells still have a bad name.

Adriane Do you mean they directly correlate it to embryonic stem cells?

Theresa Absolutely. But I think what really bothers me is that stem cells have a bad name—but frozen IVFs don't. That just doesn't make sense to me. So it seems more convenient to argue about life and all that—but to pretend IVFs don't exist—when it is this world-wide business. And that's what I learned from this stem cell stuff is how big the selling of these IVFs and the storage.

Theresa The fact that first, I'm not a, um, religious person, so this "God concept" doesn't come to me—yet I'm very um, nature conscious (laughs). So there is something that comes to me-- is, "should we do doing this?" Um, but then listening to the students helped me look at it a little bit bigger, because it isn't always what I think, or my way of thinking, but we do live in a society. So, you know, being able to listen to a lot of different… um… And then also, how to actually explain it, with the respect of other people. (Interview, August 3)

While part of Theresa's learning about stem cells came as a result of her own investigations: she reported two primary sources that shifted her thinking: 1) her heighted awareness of frozen IVF embryos was sparked by an NPR report—something she shared with students at the beginning of class and 2) listening to students. Students, and hearing the diversity of their comments sparked a "think globally" type mentality, or as she says, "…listening to the students helped me look at it a little bit bigger, because it isn't always what I think, or my way of thinking, but we do live in a society." A big part of her learning resulted from this class and group of students including 1) an awareness of how to wade through and teach students to talk with one another—students with differing viewpoints and 2) to think about multiple perspectives as she forms her own opinions. How do we, members of society, not only make up our own minds regarding scientific-ethical issues, but also, how to we think globally as we do so?

Discussion: Final thoughts on the Debate as an Affinity Space

In the previous two chapters (*Chapter 4 Teaching at Alomar: Descriptive Portrait* and *Chapter 5 Design and Resources*), I situated the study and introduced the stem cell unit through a public pedagogy lens. This chapter, I shared Theresa's rationale for the debate, the structure of the debate, and how focal students used the debate in varied ways. These varied uses made the

debate, one singular event, an affinity space with particular affordances for students to author individualized learning and participation within the collective space. There was a shift in the way students learned in this classroom and this shift is significant in many ways: students talked with each other and argued among themselves (not just the teacher); the students acknowledge and use each other as reliable sources; and students and teacher found value in building knowledge from the ground up. The debate is particularly powerful because of its social uses—allowing students to learn and be in ways that they feel comfortable in a rather difficult and controversial unit.

The flexibility and customized usage were made possible because of the fluidity in what it meant to be a participant and in how social knowledge creation is valued—thus one single space provides multifaceted opportunities for participation, learning, and knowledge creation. In this final section of this chapter, I synthesize some of the affinity stories from the debate to think about the commonalities throughout the affinity space. Recalling Hayes and Gee's list of affinity space descriptors, affinity spaces are unique in their participants, knowledge creation, and use of space.

In an affinity space, participation is not only for smart or vocal students. Instead, "Newbies, masters, and everyone else share common space; there are lots of different routes to status and participation; leadership is porous and leaders are resources; and roles are reciprocal" (Hayes and Gee, year, pgs. 107-113). Knowledge is not only found in traditionally sanctioned sources, but rather "content is transformed by interaction; both specialist and broad, general knowledge are encouraged, and specialist knowledge is pooled; and both individual and distributed knowledge are encouraged" (Hayes and Gee, year, pgs. 107-113). Finally, space is shared by many but co-opted by the individual: "Everyone can, if they wish, produce and not just

consume; people get encouragement from an audience and feedback from peers, though everyone plays both roles at different times; and a view of learning is that individually proactive, but does not exclude help, is encouraged" (Hayes and Gee, year, pgs. 107-113).

In the debate, participants did include the "usual" vocal students, but also students who struggled, students who excelled, and several typically quiet students. Knowledge was authentically co-constructed, created by the common experiences, vocalized in the classroom, with student ideas and opinions brought front and center. All who used the space, including non-focal students, were able to produce, consume, and use the debate for various purposes. I return to the characteristics of an affinity space to consider *how* the debate provided such vastly different opportunities for students.

Participation

This unit shifted leadership for the teacher Theresa—shifting leadership from the traditionally sanctioned leader to the students as leaders. While teachers are often heard saying "I learn from my students", this remark usually refers to the sentiment that teachers learn the craft of teaching or that students keep teachers young—abreast of the ever-changing youth popular culture. This sentiment rarely actually indicates a teachers learning content from students or a teacher's shift in understandings or personal ethics. It is more typical that students learn content from the teacher, not vice versa, and usually they do not learn directly from one another. Classrooms tend to be hierarchical where the teacher leads and is the holder of knowledge while students are judged on their ability to play school. Yet, this was not the case during the debate. Students took on roles of expert, teacher, "savior", "bad wolf, "Superman", "big head", among others.

Recalling Theresa's comment earlier in the chapter, "I really liked that they were able to debate. …Because they had to talk to each other and a lot of times, with class discussions, they still want to talk to me. And this—they had to talk to each other" (Interview, May 8). The structure of the debate forced students to talk with each other and this presented opportunities for entrée into the affinity space—for "newbies" and masters alike. As an observer during the unit and debate, I often found myself noticing students for the first time-- thinking that I hadn't noticed a particular student prior to the debate.

I found during interviews that students were impressed by the debate performance of some of their peers and how the participation in this debate different from previous lessons. For example, Mismin and Cookie talked about their pride in Taylor's participation (data showed Taylor rarely talked in class before this event)—both young women agreed this debate was really good for her (Interview, May 14). Cookie noted, "Taylor got really into it. I was really glad to hear her talk and participate." Theresa was equally impressed with Taylor's contributions, saying, "…When Taylor said 'You're gonna die anyway—everyone dies'—I love that! …When those [comments] were put out there, the kids were just, 'Whoa, that's good!'"

In another example, Cookie said "I felt like slapping Corazon (Cookie's friend) that day! She was just so… smart! She didn't let me finish and you know she would have slapped me if I didn't let her finish what she was saying." In this interview, Mismin calls Corazon, "the big bad wolf" and herself "a poor little sheep", remarking that this part of the debate it felt like "like a poor little sheep against the big bad wolf"—because when it comes to debating, Corazon "knows what she's doing!" Cookie added in that "…when it comes to classroom work, [Corazon] is really good—otherwise she is really shy." I asked if she learned from Corazon, and she replies, "Yeah—don't debate with her—she's the big bad wolf!" These two examples help us think

about how routes to status in this space (e.g. one's ability to argue, one's ability to create a cogent opening statement) and how the debate allowed for a shifting of roles (e.g. Cookie and Mismin note a "new side" of Corazon). I found this social aspect of the debate to be particularly powerful as I try to address the variety of learning needs of all my students. This debate helped me think more deeply about how students with varying degrees of abilities can interact in the same activity and be challenged.

Creation of Knowledge

Through the focal student affinity stories, I demonstrated how students drew from ideas of peers, corrected one another, and challenged one another's thoughts. However, I go back to one specific example—because it demonstrates the social nature of learning scientific content. During the debate, students synchronously explain that use of somatic stem cells involves neither embryonic tissue nor fetuses—and that without these stem cells—"you're gonna die". Because students were talking the science aloud in class, we have access to the thinking of many students at once. We can "see" the creation of knowledge unfolding before us. For example, we see that Cookie and Mismin did not understand the information they had been learning throughout this unit regarding the difference between embryonic and somatic stem cells. Taylor, Rafe, Corazon, for example, all realize that this discrepancy is what is holding Mismin back and they challenge her thinking. In the pooling of participant knowledge, in this debate setting, Mismin more clearly understood therapeutic stem cell research—Mismin did not understand this throughout the more "traditional" design/resource stem cell unit previous to the debate. Confirming this transformation is Mismin's interview—she shifted her ideas regarding the difference between embryonic and adult stem cells.

As class sizes get bigger, time teaching is limited by standardized tests, and the myriad of distractions of schools—the ability for a teacher to "view" student thought in real time becomes more and more important. This is not only helpful for the teacher—but for students. Students often learn better from one another—and this debate provided such an opportunity.

Use of Space

While the teaching and learning throughout the entire unit was vocalized, open, provided common experiences, and was made "public", the use of space throughout the majority of the stem cell unit was not that of an affinity space. While students were encouraged to work together and learn the content together, the debate offered a different approach to learning, participating, and being.

Students are rarely encouraged to co-opt classroom space for their personal learning agendas, to push on their interpretations of science, or to author their own opinions of the science. However, the debate afforded this possibility. Participants got encouragement and feedback from peers—the use of the classroom learning was for creation of knowledge and consumption, as we saw with the debate rebuttal. As an observer, this debate was fun, exciting, and enthralling. Students contributed to the construction of the affinity space, they had and acted on their different feelings for the space—and each got something unique out of this space.

Kevin, Molly, Mismin, and Michael were all able to use the debate floor in varied and personalized ways and this I was able to observe. Molly was able to preach the science she so desperately wanted to preach. Mismin was able to articulate and ultimately reconcile some of the dissonance she felt between science and religion. Michael was able to position himself in ways to "help" his peers, push himself to research beyond the class requirements, and showcase his knowledge in "cool" ways. And Kevin was challenged—in more ways than one.

CONCLUSION AND IMPLICATIONS

Dewey tells us (1938) learning is inevitable. And often to our chagrin, teachers cannot control what students learn ultimately. However, teachers *can* be diligent in creating challenging learning opportunities and classroom environments wherein teachers and students listen to each other and collaboratively shape each others' ideas and ways of participating in a science classroom. Theresa encouraged open talk (both social and scientific), encouraged students to participate, reinforced the notion that all students could contribute and their ideas worthy, created lessons that allowed students to make of the experience what they needed.

In classrooms where teachers are gate-keepers and holders of knowledge, knowledge is disseminated, not co-created. In contrast, when the opportunity to share and discuss ideas and challenge others' ideas becomes available, knowledge can be co-created through collaboration and when peers become resources to each other, as happened in this classroom. The emphasis on talk served multiple purposes: it opened up the classroom knowledge to the public space of the classroom—instead of individual students keeping knowledge to themselves and demonstrating their thinking to the teacher alone and allowed the teacher (and other students) to see immediately what/how students are thinking about the science. Because the knowledge was made public—roles become more reciprocal—with students teaching the teacher as evidenced by Theresa's shift in thinking throughout the unit.

I began this dissertation situating the study through statistics wherein I discussed the seemingly bleak comparison of US students as compared to their international counterparts—and these statistics illustrating an even more dire situation for students of color in under-funded schools. I hope with this dissertation, I have potentially troubled two aspects of the statistics.

First, I show how standardized tests (and tests in general—such as the final test Theresa administered at the end of the unit) do not necessarily reflect all that students know, think, and understand on scientific subjects. Critiques against standardized tests are not new—but I think an additional example, such as shown in this study help remind educators and policy makers that such indicants are not reflective of the capabilities of students. Which brings me to the second troubling which is that through this style of teaching and learning—we witness student learning. The learning itself is messy (which is one of the many reasons high-stakes tests cannot capture the complex nature of learning or knowledge). But with this dissertation, I demonstrate how the very students who "show poorly" tests (designed to be markers of scientific knowledge and thinking) are completely capable (and good at) scientific thinking and grappling with complicated issues in science.

I return to a comment I made in the first chapter the first pages. "While some of the harsh realities of high poverty classrooms are not to be ignored nor are they to be trivialized, they are lacking in the humanity and beauty of *people*." In chapter three, I explain why I specifically chose ethnography to examine the complexities within these statistics—to see the humanity and the beauty of people. Communities of practice with public pedagogy allowed a framework for analysis that illuminated relationships and interactions.

And it is true that inequities in education and society cannot and should not be ignored. But neither can the stories and realities of the actual students and classrooms such tests position as scientifically inferior. Chapters four through six provide such background and color these statistics. Classroom 507 students worked through complicated issues including stem cell research and the ethics of stem cell research that many adults struggle to understand. As a current high school teacher, I can share how impressed with the way students, without judging

each others' ideas, were able, as a large group, to work through such sensitive issues (this is not to say they didn't judge each other or feel non-positive feelings for each other, but they were able to come to participate in a productive community of practice.

I again return to the same paragraph in chapter one where I stated, "This dissertation is about people and the powerful learning experiences happening within a classroom written off as failing. …Keep in the back of your mind that there is more to come and that when students are called upon as resources and leaders, this situation is not so dire. ." I believe that in this brief, three week study, the students of Classroom 507 with the leadership and guidance of Theresa, show there is more to come for our future in science education and the situation is indeed, not so dire. In a short span of time, Classroom 507 shows us hope for science education.

Guiding my investigation into the people in Classroom 507 and how they learned science were five research questions:

- What are norms, routines, practices, relationships, ways of being, and talk specific to this classroom? How do these norms, routines, and practices construct the community of this classroom?
- What pedagogical moves did a teacher make to make classroom learning accessible for all students?
- How were the pedagogical moves of the teacher taken up by students?
- How does an affinity space shape the way students participate in learning?
- How do students use the affinity space in varied ways?

To unpack my observations of Classroom 507, I used Wenger's construct of community of practice to think about what makes a functional *community* for learning and interacting. I then used Hayes and Gee's public pedagogy framework to think more deeply about the *practice*

within this community of practice. This led to thinking about the possibilities of classroom events that are flexible enough for students to engage as they need and want.

When I first entered the classroom, I equated the norms, routines, and practices of this classroom community to those of a functional family. In this family, students had respect for one another; they thought that, on the whole, they got along. Students felt that they could voice dissenting opinions or challenge one another's ideas. Students raised their hands sometimes, other times, they did not. They asked questions, offered pop culture references, and shared stories of their family's health and medical concerns as they related them to the topic at hand. They pooled ideas and resources. And listened to one another—perhaps with an eye roll or funny retort, as teenagers will do—but they listened to one another. This classroom of students was encouraged to talk and this talk supported the eventual movement from everyday talk to science talk. Their development of science talk ultimately led to the opportunities for self-exploration of the ethics of stem cell research.

Capitalizing on the familial relationships of her students, Theresa created a series of common experiences for which her students to reference and draw upon. I can assume that no one student experienced or "learned" the exact same thing from each of the experiences—but they were able to use these experiences as they developed their own decisions regarding the ethics of stem cell research. Theresa's pedagogical moves were quite Deweyian—creating a series of lesson plans and then encouraged students to discuss. The discussions ranged from informal (talking to a peer at a computer near each other) or formal (a large group discussion where contributions were legitimized publically). Students already "liked" Theresa when I entered the classroom, but this unit was different: it was more difficult, amorphous, vague, and at times—uncomfortable. They bought into the common experiences of the unit, talking with each

other, questioning, and clarifying. Students, like Michael and Stephanie, even brought these conversations out of Theresa's class and into the hallways and another teacher's class.

However powerful the daily lessons were, and how helpful the opportunities to talk, the learning in most of this unit (weeks one-two) was still somewhat traditional and enmeshed in traditional power structures wherein the teacher initiates, evaluates, and responds. The debate was something different altogether. The debate, which I compare to an "affinity space," offered students a way to individualize their learning—as they constructed their own opinions of the ethics of stem cell research. Mismin relearned the basics, Kevin engaged the challenge of debate, Molly could preach science, and Michael could both engage academically and socially. The affinity space-like debate allowed for individuals to contribute, withdraw, and co-opt for individual learning.

Additionally, because of the authentic nature of the debate, the motivation in learning moved students away from "copy and paste" to write down answers (Theresa mentioned that Michael was a big "copy-paste-r" and he was unable to do this here) and promotes student talk in science—forces them to use ideas and concepts as their own, reinforces the dynamic and communicative nature of science, and as Theresa mentioned earlier, if there is no one answer, students are thinking on own—thus allowing the teacher to see student insights and engage a more "real" science.

Teaching in this way allows teachers to "bear witness" to students' evolving and complicated thoughts—as these complex thoughts may take days, weeks, or even years to develop, re-learn, re-engaged, reimaging, unlearn. Many educators express concern over content recall without critical thinking and frustration with the trends towards standardized tests as a measure of student learning. In this dissertation, I hope to consider how the creation of curricula

similar to one Theresa created affords students the space for critical thinking and affords the teacher unique and powerful assessment opportunities. The unit promoted discussion, debate, authentic questioning, and ultimately, the creation of an affinity space.

Implications (… Hopes, and Dreams)

To think about the implications of this dissertation, I ask myself, as one of my committee members asked me—for whom is this dissertation? What do I ideally want to get out of having it published through the library and (maybe) having (an)other(s) read it?

Is this for a politician to get a glimpse into the complexity of teaching? To show policy-makers that teachers don't just copy off a homogeneous set of worksheets, teach as a automaton for the day, and relish summer vacations? To show that deep conceptual thinking is required for each and every lesson? To explain to funding boards that if Theresa could do this unit with little overhead and capital that quality education does not have to be expensive? To share the richness of our urban students in order to remind cities like Chicago why the students in "failing schools" are still "worth" saving and the tear-down of their schools is not? While these would be really "cool" aspirations—they are painfully naive. Qualitative research that does not demonstrate gains on the large-scale or directly work to show improvement on the TIMMS or NAEP is not a typical read for this influential bunch (which of course, is troubling for reasons previously mentioned).

No, my eyes are not set on an systemic, institutional, nor broad-reaching prize. My hope for this dissertation is that a teacher (no matter the experience) will find something that inspires them to change up his or her teaching to engage students through talk. For whom do I write?

Ultimately, I am speaking to the teacher of science spending his or her weekends, evenings, lunch periods, and summers trying to write plans that reach each and every student in

class. This dissertation is for educators trying to find ways to make science relevant, rigorous, and contemporary. This dissertation is for teachers who want their students to see themselves as the scientists they are—reminding them that each and every one of them have something to contribute. While our students might not call themselves "scientists" or may in fact draw a White man with a lab coat and crazy hair (here I reference Wade Chambers' 1983 "draw a scientist" study), they are in fact, scientific thinkers.

I want this study to inspire others to teach in new and innovative ways and being "there" with Theresa and her students will. From the experiences of Classroom 507, we see creating innovative design, drawing upon students as resources, and opening the classroom up as an affinity space as possible. This is not to recommend blindly implementing her unit/lesson plans but rather to think about what Theresa and her students accomplished and how they got there. Teachers today are under considerable pressure to teacher skills, content, and to do it better, faster, and to increasingly larger numbers of students at once. This kind of teaching can be done -- without the sacrifice of content. But this work is incredibly difficult.

Theresa shows us how incredibly difficult this is through her return to giving a standardized test at the end of the stem cell unit and the return to more traditional teaching methods for the next unit on the cell. I absolutely do not write this to put down Theresa's teaching—in fact, I am sure that many of the same powerful techniques she employed in the stem cell unit (such as free-talk, collaboration, and class discussions) were drawn on in them. However, her return to traditional methods helped me to see two barriers for this kind of teaching.

The first is a battle I myself often have: the feeling of obligation to prepare students for standardized testing measures. At a time when ACT, AP, and content mastery still reign

supreme (though AP is moving to a skills bases approach)—teachers struggle to do what they might feel is right and what they feel obligated to do. While I personally ardently disagree with the use of such tests as the sole measurement of scientific learning, I also recognize that the ACT and testing is omnipresent in our educational environment of accountability. I often think that if I cannot yet break down the system, I must learn to work within the system. How do teachers who realize the damage of testing (and over-testing) both "do right" by their own students by trying to prepare them for tests (an inadequate measure), while simultaneously feeling that they are "doing wrong" by preparing their students for such an inadequate measure. The ACT is here to stay (as are AP, TIMMS, and NAEP)—but what does a teacher do on a daily basis as they prepare their lessons? And while teaching that encourages talk, promotes critical thinking, and develops scientific literacy will help students in their future—will it help on such tests?

The second barrier is the sheer difficulty in creating lessons and units that promote deep, critical, authentic thinking. How does a teacher engage a unit on cell organelles, a unit mostly taught as either rote memorization or as a process (e.g. the cell as producer or proteins) in a way that is authentic and pushes students to connect the cell with their everyday lives and political decision making? I was impressed with Theresa's creativity and willingness to take this risk in teaching. However, in watching her enact it, I came to realize how difficult this is. The debate in particular encouraged students to seek out additional resources—and as we (teachers/teacher educators) teach in a digital age (moving from an industrial age)—how does our teaching need to change? How can we do this through looking at public pedagogy and how it can be utilized in formal learning environments?

To this end, there exists the potential for professional development and teacher education within and around the CoP and Public Pedagogy model. The task of re-writing curriculum is

daunting and re-thinking science education is daunting—especially for teachers/educators trying to do it alone. The reality is that writing units and lessons like this take a great deal of time and thought. Additionally, this kind of teaching is risky. It is a great risk for teachers to open up the floor and invite all comments-- teaching like this has the potential to show a teacher's weakness in content, for students to get off task, or for the content to touch students emotionally and personally which can be painful. Teaching for affinity spaces is additionally risky working within the systems in place at schools. It can be risky to teach in ways unlike colleagues at the school. However, if a team of teachers are willing to create authentic questions and propose debates within the content of the science curriculum, there is possibility for encouraging the development of affinity spaces within teaching and learning in schools and possibly finding the congruence between teaching within the system while simultaneously pushing against the traditions of "how things work".

In science education today, new teacher candidates learn several frameworks to help them organize lessons/units to scaffold and support student science learning. Models such as Experiences, Patterns and Explanations (EPE), The Five E's: Engagement, Exploration, Explanation, Elaboration, Evaluation; Claim, Evidence, Reasoning; etc. are all incredibly powerful in framing the learning of science content. But what if we considered the frameworks of CoP and Public Pedagogy alongside them? What would/could science teacher education and professional development look like if we considered what needs to be considered to turn a classroom of potential strangers into a functional, working community of practice? What would/could science teacher education and professional development look like if we thought about examination of design, resource, and affinity space and vocalizing science teaching and learning through public pedagogy? There is much more work to be done to investigating what

CoP and affinity spaces look like in other classrooms and to think about how a practicing teacher can do this.

What can be learned from public pedagogy and affinity spaces? To *begin* thinking about this question, I briefly talk aloud how this experience has changed me. As a high school biology and chemistry teacher, I now find myself thinking about the connection of design, resource, and affinity space. From this study, I realize my best "shot" at engaging all learners is helping them engage themselves. Mismin, for example, didn't understand the content until after the unit—but she scored well on the final unit test the day after the debate (when she was still very confused). How many times have students left my classroom not getting it, but excelled at one of my tests? It was her peers, not the first two traditional weeks of the unit, that changed her thinking. Or Kevin, who thought he knew the content significantly well (and well enough to joke about the anthropomorphic simplicity of a stem cell going into a phone booth to "become" a differentiated cell)—his peers afforded him the opportunity to see how others argue, how to argue better himself, and to look at various sides of an argument. He was made to feel uncomfortable by the subject matter—but talked this discomfort out with another teacher and later Theresa. Molly—the protector of science—is given a platform and a soapbox to correct all the misconceptions she struggled to hear—without having to be "a smarty pants" who "doesn't give others a chance". Students like Michael will look out for other students such as Jacob—making sure they get in their points and participate. They will joke and make things funny. They will make the connection to movies like *John Q* and popular culture. Who are my Johns, Mismins, Mollys and Michaels in my own class—but more importantly, who are the students who enter my classroom each day? This study reminded me of the importance of knowing who my students are, each year, and how I can use my relationships and knowledge of them as individuals in my unit

design. How do I write whole lessons that bring out the scientists in each student? In ways they personalize and make their own?

Unlike differentiated instruction wherein the teacher is responsible for creating multiple avenues for participation, access to content, varied materials—in the case of public pedagogy and an affinity space—students carve out this space for themselves. Students who struggle with material will use the space to rectify misconceptions. Students who want to use the space socially and to help peers "get points" can do so. Students who are looking for an intellectual challenge and debate can also do so. And those who are looking for a space to make a statement and create a platform can do so as well. Each of these types of spaces are available once students are given the freedom to co-opt the learning environment for their own needs.

None of these happen if a teacher alone holds knowledge. Knowledge creation becomes real and embodied when students breathe life into it with their stories and connections. By opening a class to the public (via design and resources) and encouraging authentic science talk among peers— science moves from the textbooks and into the social sphere—where it naturally inhabits.

Concluding Remarks

I have often colloquially referred to studies that pushed my thinking as "no duh research". I call them this because when I read it, I think—"of course" or "that makes sense" because it helps to explain a phenomenon with which I am familiar but don't have the words or framework to describe what was happening on a deeper level. Calling research "no duh" is not intended as an insult, but rather a nod to the ability of a researcher to bring me "there" all the while, making my ordinary extraordinary. "No duh research" makes the everyday, common place ideas "look different" and in ways that push my thinking. It is my hope that this

dissertation touches on this type of emotion for you, the reader (though you probably do not refer to anything as "no duh"). My hope is to re-think common teaching activities like creation of community, lesson planning, drawing on resources, and encouraging student talk. It is also my hope, that this serves as an inspiration to other K-12 educators, like myself, as they imagine curricular units. The point of this dissertation is not to distribute Theresa's unit plan (though it is powerful and I hope to try it in my classes in some capacity), but to think about how Theresa's approach to teaching might guide future planning of units and lesson plans.

Since the data collection for this study, I have returned to teach high school biology and chemistry-- I am amazed by how the lessons learned from the students in Classroom 507 and Theresa have shaped my craft as a teacher. Often, I have found myself teaching and a visual or audio snippet of Classroom 507 flashes in my brain and I think about how I could better encourage talk and questioning in my own classroom. I am still trying to foster an environment in which the posing of authentic questions and relevant science is at the heart of my curriculum. I constantly feel pressured by the mile long and inch deep curriculum, but am trying to temper this pressure by the learning I witnessed in this classroom. The more "public" I make my classroom, the more I open up the classroom to possibilities I had no way of imagining. I am looking forward to endeavoring to make my classroom more scientifically social.

In particular, to each student—I am grateful. From each student—aside from the lessons written about in the dissertation, I learned tiny, weird lessons. From Mismin, I am reminded of the lasting impression of a teacher—her sister's experience with me as a teacher taught her she could trust me… and as a teacher who is always hard on herself—it is encouraging to hear about this kind of legacy. She trusted me and she was a true delight with whom to work. It was a struggle for Mismin, Adriana, and Kevin to reconcile religion and science—and I must think

about how I can become more sensitive to student needs—having not done something this controversial in my classroom (and often teaching science as "science" vs. science as "social"). I am impressed that Theresa was able to have conversations with them about their discomfort—even if they were unable to work through it. From Molly, my passion for teaching is reignited—I hope she is my doctor or a researcher one day (or maybe my alderperson or senator…). It is encouraging to meet students who have a pure of love science. Both Molly and Kevin remind me to work the full spectrum of talents in a classroom (I often fall under the motto of "leave no soldier behind" and support the students who struggle the most)—I need to be aware of how to challenge my students who do not struggle with the fundamentals of content—but still work through how they author their own opinion of science in more advanced ways. They are learning and challenging themselves—but I can do more to help them meet those challenges. From Michael—I have think about when, as he put it, I might "trip for no reason"—and to have fun with my students. He mentioned in an interview that he and his peers are good at knowing where the line of work and fun is in the science classroom… I like this idea. I also so truly love meeting students (and other people) who are good humans who look out for the well-being of others.

Finally, I cannot begin to share my gratitude for Theresa and the learning sparked by her teaching. I try to emulate the encouragement Theresa gave in sharing out and talking through ideas. Holding a debate is exhausting—I have tried to come up with authentic questions to pose to students and to carve out the time for something like a debate—fully convinced by my experience in this study that debate and talk in the science classroom is a 21st century imperative. Her unit design and the classroom environment is no small feat and I am constantly grateful for her time and modeling a new way to engage science.

Science as a field is also constantly changing and is frequently debated as a social, political, and cultural among scholars (Harding, 1994; Lemke, 1994; Rogoff, 2003), yet it is rarely taught this way in our high schools. I hope my future students and I have many memorable moments of learning made more rich and complex because of lessons learned from Classroom 507.

APPENDICES

Appendix A: Student Consent Forms

Principal Investigators: Adriane M. Slaton, Graduate Assistant and Angela Calabrese Barton, Professor, Department of Teacher Education, Michigan State University
Study title: Model of Excellence: Urban Science Teachers

Dear Parent/Guardian,

Your child's teacher has agreed to participate in a research study to help improve the way science is taught for equity and access. The purpose of this study is to better understand how students engage in science and how your child's science teacher promotes student engagement in the science classroom.

As part of this project, we would like to:

- Collect samples of your child's work in science class
- Video-tape the class
- Conduct select student interviews

Participation in this project will not take students away from any instructional time. Participation will not affect your child's grade, either positively or negatively. Whether you choose to participate or not will have no affect on your child's grade or evaluation.

The data collected during this research project will be kept strictly confidential. The student work, video-tapes, and interviews will be used only by the researchers of this project and will be kept in a secure location. Student, teacher, school, and district names will not be used in any presentation or publications resulting from the study.

Your child's participation in this study is completely voluntary. You are also free to withdraw your permission for his/her participation at any time for any reason without penalty. There are no known risks to participants. You are free to request that anything your child says in class and is on video-tape is not used in the research study.

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researchers: Adriane Slaton, 116D Erickson Hall, Michigan State University, East Lansing, MI 48824-1034, XXX.XXX.XXXX, slatonad@msu.edu or Angela Calabrese-Barton, 118B Erickson Hall, East Lansing, MI, 48824-1034, XXX-XXX-XXXX, acb@msu.edu.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 202 Olds Hall, MSU, East Lansing, MI 48824.

Thank you for your time and consideration,

Adriane M. Slaton
Science Education
College of Education
Michigan State University

STUDENT ASSENT. Your signature below means that you voluntarily agree to participate in this research study.

_____ _____

Student Printed Name Date

_____ _____

Student Signature Date

PARENT/GUARDIAN CONSENT. Your signature below means that you voluntarily agree to allow your child to participate in this research study.

_____ _____

Parent/Guardian Printed Name Date

_____ _____

Parent/Guardian Signature Date

Información del Participante de la Investigación de Ciencias

Investigadores principales: Adriane M. Slaton, asistente graduada y Angela Calabrese Barton, profesora del departamento de la educación de maestros de la Universidad del estado de Michigan.
Título del studio: Modelo de la excelencia : Profesores urbanos de la ciencia

Estimado padre/Guadián legal:

El maestro/a de su hijo/a ha decidido participar en un estudio de la investigación durante el semestre de la primavera del año escolar 2009-2010. Este studio es para ayudar a mejorar la ciencia de cómo enseñar con equidad y acceso. El propósito de este estudio es entender mejor cómo los estudiantes entienden la ciencia y cómo el maestro de ciencias de su hijo/a se compromete en la ciencia y como promueve el compromiso del estudiante durante la clase .

Como parte de este proyecto, trabajando en dos unidades académicas, quisiéramos:

- Colectar muestras del trabajo de su hijo/a en clase de ciencias
- Grabar en video durante clase de ciencias
- Condicir entrevistas a estudiates selectos

La participación en este proyecto no tomará tiempo de instrucción de los lestudiantes. Al elegir participar o no participar en este proyecto, no afectará ningún grado o evaluación otorgada, ya sea positivamente o negativamente.
Si usted elige participar o no, ésto no tendrá ningún afecto en el grado o la evaluación de su hijo/a.

Los datos colectados durante este proyecto de investigación serán mantenidos estrictamente confidenciales. El trabajo, los videos, y las entrevistas del estudiante serán utilizados solamente por los investigadores de este proyecto y mantenidos en un lugar seguro y con la contraseña protegida. Los resultados del estudio no serán utilizados por el estudiante, maestro, escuela y nombres del distrito en ninguna presentación o publicación. La confidencia será protegida al grado máximo permisible por la ley.

La participación de su hijo/a en este estudio es totalmente voluntaria. Usted es libre de retirar su permiso de participación en cualquier momento y por cualquier razón sin penalidad. No hay riesgos sabidos de los participantes. Usted es libre de solicitar cualquier cosa que su hijo/a diga en clase, que esté grabado en video y que no se utilize en el estudio de la investigación. Si usted decide que hijo/a no participe, el investigador/a evitará de grabar la imagen de su hijo/a en cámara fotográfica y de video y cualquier cosa comentada por su hijo/a no serán utilizada en el estudio de la investigación.

Si usted tiene preguntas sobre este estudio, como asuntos científicos, o cómo formar parte de ello, o de reportar una lesión, favor de contactar a los investigadores/as: Adriane Slaton, 116D Erickson Hall, Michigan State University, East Lansing, MI, 48824-1034, XXX.XXX.XXXX,

slatonad@msu.edu o a Angela Calabrese-Barton, 1188B Erickson Hall, East Lansing, MI, 48824-1034, XXX-XXX-XXXX, acb@msu.edu.

Si usted tiene preguntas sobre cuál es su deber y sobre los derechos como participante de la investigación, o si desea someter una queja sobre este estudio, usted puede contactactar en anónimo si usted desea a: Michigan State University's Human Research Protection Program al tel. 517-355-2180, el fax 517-432-4503, o por e-mail: irb@msu.edu o a la dirección física: 207 Olds Hall, MSU, East Lansing, MI 48824.

Gracias por su tiempo y atención,

Adriane M. Slaton
Colegio de Educación
Universidad del Estado de Michigan

Forma de Consentimiento
Para Participar en la Investigación de Ciencias

Investigadores/as: Adriane M. Slaton, estudiante graduado y Angela Calabrese Barton, profesora del departamento de la educación.
Título del estudio: Modelo de la excelencia: Profesores urbanos de la ciencia

CONSENTIMIENTO DEL ESTUDIANTE. Su firma abajo significa que usted acuerda voluntariamente participar en este estudio de la investigación.

_____ _____
Nombre impreso del estudiante Fecha

_____ _____
Firma del estudiante Fecha

CONSENTIMIENTO DEL PADRE /GUARDIAN LEGAL
_____Yo, permito que mi hijo/a participe en el estudio de la investigación de ciencias. Ustedes pueden grabar su imagen en el video con el propósito del el proyecto de investigación.

_____Yo, no permito que mi hijo/a participe en el estudio de la investigación de ciencias. Usted no pueden grabar su imagen en el vídeo con el propósito de el proyecto de investigación y el investigador/a no puede utilizar ningun comentario que mi hijo/a haga en el salón de la clase de la ciencia.

Appendix B: Teacher Consent Forms

Investigators: Adriane M. Slaton, Graduate Student and Angela Calabrese Barton, Professor, Department of Teacher Education, Michigan State University
Study title: Model of Excellence: Urban Science Teachers

DESCRIPTION OF THE RESEARCH: You are invited to participate in a research study that looks at teaching practices of urban science teachers. The purpose of this study is to better understand how you, an urban science teacher, understand your role as urban science teacher, what kind of teaching you practice, and most importantly, how you promote student engagement in science.

If you decide to participate, you will be asked to participate in the following activities:

- Classroom observations: I will be observing in your class for one full unit every day (for biology).
- Video-taping: For purposes of note-taking and documenting class—I will be video-taping class. You can ask me to turn off the video-tape at anytime.
- Interviews: You will be interviewed three times, once at the beginning of the study, once in the middle and once at the end, for about one hour each time, during between January-June, 2010. The interviews will focus on your pedagogical stances (what kind of teacher you are), experiences with curriculum creation, your ideas about and strategies for involving students in science, and why you are an urban teacher. The interviews will be audio-taped. You may decline to be interviewed at any time.
- Collection of written work: We would like you to share any written work you may have to help us paint a clear picture of your teaching.

You may be at risk of embarrassment and nervousness upon telling me about your beliefs about your science instruction or to have your actions observed. To lessen these risks, you will be reminded before any interview that you may refuse to answer any questions, and that you may have the researcher strike your responses from the record, and you may end the interview at any time simply by stating such a request.

Similarly, if you need me to leave or to strike observations made during a given lesson, you have that right. Please state such a request and that material will not be used.
In terms of benefits, you may learn more about your teaching practice. The larger education community will learn about the science education needs and concerns of urban teachers and parents. The data from this study will be used to develop and enhance curricular and pedagogical strategies used in urban settings with the intent of improving the science education experiences of all. Refusal to participate will involve no penalty or loss of benefit to which the subject is otherwise entitled.

During the course of the study all data will be secured in the PI's locked office and access to the data will only be granted to those research assistants working on the project. Data may be published in journals or used for other professional educational purposes and will be masked to protect the identity of subjects in the research. Your confidentiality will be protected to the maximum extent allowable by law.

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researchers: Adriane Slaton, 116D Erickson Hall, Michigan State University, East Lansing, MI 48824-1034, XXX.XXX.XXXX, slatonad@msu.edu or Angela Calabrese-Barton, 118B Erickson Hall, East Lansing, MI, 48824-1034, XXX-XXX-XXXX, acb@msu.edu.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 207 Olds Hall, MSU, East Lansing, MI 48824.
Sincerely,

Adriane M. Slaton
847-308-8363
slatonad@msu.edu

Investigators: Adriane M. Slaton, Graduate Student and Angela Calabrese Barton, Associate Professor, Department of Teacher Education, Michigan State University
Study title: Model of Excellence: Urban Science Teachers

Your signature below means that you voluntarily agree to participate in this research study.

_____	_____
Teacher Printed Name	Date
_____	_____
Teacher Signature	Date

Appendix C: Interview #1

Basic Interview questions:
Name:
Age:
Race:
Religion:

Interview questions

Perceptions of others

1. Tell me about your classmates in Ms. Theresa's first period class.
   Who is the funniest, smartest, best at arguing, best at school, person people like the most, etc. What do you think people think about you?
2. Tell me about Ms. Theresa as a science teacher.

3. What do you think Ms. Theresa believes is ethical for stem cell research? Why do you think she thinks this way? (evidence for her opinion)

Thoughts and Ideas on Stem Cells

1. After this unit, do you think you understand both the science and the ethical issues of stem cell research? Explain.

2. How do you feel about the ethics of stem cell research? Is some stem cell research okay and others are not? Explain.

3. Did your opinion change throughout the unit? What was your opinion at the beginning of the unit? (clarify that this is the same now). (if yes, why do you think it changed?)

4. Which team were you on (pro stem cells, anti-stem cells)? During the debate, were you on the "side" you wanted to be on (yes or no)? Did Ms. Theresa place you there or did you pick? How did you feel about your placement? Did this make it easier or harder to argue your point.

5. How did you do in the debate?

Thoughts on Unit in Science

1. How as this unit in science compared to your other units in science—was this harder, easier, more or less interesting, personal connection, how were your grades?

2. *What is your grade in this unit? Is this a good or bad grade for you?*

3. What helps you learn in science class? Did this happen this unit?

4. Did your work in this unit make you proud?

If time and if appropriate

1. Do you feel you could safely voice this (pro or against) opinion in class? Why or why not?

2. Tell me about a time you thought you were unable/able to voice your opinion in class.

Specific to students:

Molly and Stephanie: How do you feel about embryonic stem cell research?

Molly, Bob, Stephanie: you asked to move to this class—why? Are you glad you did?

Bob and Molly: watching the movie, you said you both were interested in becoming scientists—specifically one who works with stem cells. Is this still true?

Michael: During the debate, you didn't want to read the portion about testing on rats and testing on humans—why did you ask Jacob and Stephanie to read that?

Michael: At the breakfast, you started a prayer session. What made you think to do that? How did you determine who talked and said grace (Eric) and who started it?

Mismin and Cookie: At the beginning of the unit, you two discussed religion in stem cell research. What do you think the relationship between religion and stem cell research? Should this have been a bigger discussion in the science classroom? Should religion be part of science and the science classroom?

Appendix D: Data Collection

Participant	Date(s)	Topic
Mismin	4.7.10	Interview: Semi-structured (with Cookie)
	5.14.10	Interview: Video Events (with Cookie)
	6.3.10	Interview: Video Events (with Cookie)
Molly	4.12.10	Interview: Semi-structured (with Stephanie)
	5.12.10	Interview: Semi-structured/Video Events (without Stephanie)
	6.4.10	Interview: Video Events (with Stephanie)
Michael	4.6.10	Interview: Semi-structured
	5.6.10	Interview: Video Events
Kevin	5.3.10	Interview: Semi-structured
	6.4.10	Interview: Video Events
	6.8.10	Interview: Video Events
Theresa	3.9.10	Interview
	5.8.10	Interview
	8.3.10	Interview
Other Students (Not Focal in this Study)		
Bob	4.12.10	Interview: Semi-structured
	5.12.10	Interview
	5.14.10	Interview: Video Events
Myra	5.4.10	Interview
	5.13.10	Interview Video Events
Eric	5.4.10	Interview: Semi-structured
	5.13.10	Interview Video Events
Jacob	5.10.10	Interview: Semi-structured
	5.13.10	Interview Video Events

Table 8. Interview Schedule

	Dec 09	**Jan 10**	**Feb 10**	**Mar 10**	**Apr 10**	**May 10**	**Jun-Aug 10**
Preliminary Observations	•	•					
Focus Class Observations				•			
Collection of Student Work				•	•	•	
Semi-structured Teacher Interviews				•		•	
Informal Teacher Interviews				•	•	•	•

Table 9. Data Collection Timeline

Table 9 (cont'd)

Student Focus Group Interview					•	•	•
Student Video Discussion					•	•	•
Teacher Video Discussion					•	•	•

Appendix E: Case Study Heart Transplant v. Stem Cells

October 16, 2005

Stem Cells, Regenerative Medicine and the Heart
Dr. Mike Magee (Health Politics)

The road from basic science to clinical practice can be a rocky one. A perfect case in point is our current struggle on both sides of the Atlantic to realize the benefits of utilizing regenerative medicine as a treatment for damaged hearts.

When Dr. Piero Anversa from New York Medical College and his colleague Dr. Donald Orlic from the National Institutes of Health announced in April 2001 that stem cells from bone marrow injected into the damaged hearts of mice had morphed into cardiac cells, implanted in the damaged tissue, and laid the seeds for regenerative healing, the news was met with great enthusiasm.

All understood this was a starting point. But the finding supported early beliefs about the promise and challenge of using stem cells – that they might work before we fully understand why; that if you put them in the right place, they will do the rest; and that if they worked in a damaged heart, they would work in other damaged organs as well. Now, four years later, the scientific community is in full gear trying to answer basic questions and simultaneously save lives. And both the issues and emotions involved are complex and deeply personal.

If one were to choose to explore the promise of regenerative medicine, the heart would be a logical starting point. Hearts weakened by chronic or acute loss of blood supply are exceedingly common. The condition, called Congestive Heart Failure, affects some 4.8 million people in the United States, and there are 400,000 new cases each year. The major contributor to the development of this condition is a heart attack. More than a million Americans suffer heart attacks each year. Out of those who subsequently develop Congestive Heart Failure, half die within 5 years as a result of their severely weakened hearts.

For many years, the commonly held belief was that heart cells did not divide. That has now been proven false. As Dr. Anversa has said, “For years there has been a general belief that the numbers of cells in the heart was established at birth. But how could anyone believe that the heart could contract so many years using the same cells?”

That said, all agree that normal cell division is not an adequate response in the face of the broad and extensive damage that rapidly occurs following an acute blockage of a coronary artery. In fact, evidence supports that the body’s initial attempts to address the acute insult can actually extend the area of injury.

The work of Drs. Anversa and Orlic suggested that reparative stem cells existed in the spaces between normal heart cells and in bone marrow. Others over the past 4 years have been unable to confirm their experiments. During this same period, clinicians in at least 10 different studies have harvested bone marrow and peripheral cells, cultured them to expand their numbers,

and injected them or deposited them into the damaged areas of patients' hearts, then watched, waited, and measured with variable and not fully conclusive results.

To all of this, Dr. Irving Weissman, stem cell basic scientist at Stanford University, has responded, "These studies are premature and may in fact place a group of sick patients at risk." He and other bench researchers want more answers. What is the natural role of stem cells in the heart? How do heart cells normally repair themselves? Which cells in the bone marrow are most effective in heart repair? Can peripheral cells work as well as bone marrow cells? Does the stem cell system age and become less effective as you age? Are there homing systems that guide stem cells to the damaged areas?

All good questions, of course. Yet the need is urgent and real, and it is concurrently driving experimental studies in humans. Dr. Emerson Perin of the Texas Heart Institute explains, "The basic science guys don't see patients that are going to die, but I have to look them in the face every day. It's ludicrous to say we must understand the molecular mechanisms before we can try anything."

While there is certainly disagreement on the pacing and order of studies, there is no disagreement on the potential promise of regenerative medicine for treating heart disease. The NIH says, "Scientists are interested in exploring this ability to provide replacement tissue for the damaged heart. This approach has immense advantages over heart transplant." Certainly, regenerative medicine would be less invasive and less expensive. Beyond this, it would resolve a nagging supply and demand crisis. As of September 2005, there were more than 85,000 Americans awaiting organ transplants. The year before, nearly 7,000 Americans died while awaiting an organ.

Dr. Nabil Dib of the Arizona Heart Institute voiced a common hope for stem cell use in heart disease when he said, "If this proves efficacious, this will replace heart transplants." Dr. Dib will be participating in a roundtable of leading experts put together by the American Federation for Aging Research (AFAR), a group that strongly supports stem cell research and wants to help sort out the questions it poses. According to Dr. George M. Martin, AFAR's scientific director, "We want to learn more about the relevance of stem cell research in understanding the basic mechanisms of aging and its regenerative applications for heart disease, cognitive repair and cell renewal in aged tissue."

Making reasonable progress in the face of uncertainty requires data transparency, reliance on high quality and ethical research practices, and open communication and dialogue between scientists, clinicians and health consumers. There is a role for optimism, as there is for action. Progress can be messy and still be progress. As it occurs, the focus sharpens and the questions gain clarity. Some of the questions out there now, according to the NIH, include: How long will replacement cells function? Do rodent findings reflect what will happen in humans? Can we harvest and deliver the cells in time in the face of an acute heart attack? Could a vulnerable patient donate and bank cells ahead of time?

Are we taking two steps forward and one step back? Perhaps! But it's progress still the same!

For Health Politics, I'm Mike Magee.

Appendix F: Case Study Katie Dyd

Katie Dyd was an active, playful and energetic little girl. She was always running about, climbing trees, or gathering all of the neighborhood children to play team sports or run races in the yards up and down the street. Katie had a zest for life and actively pursued it. Mysteriously, Katie began to feel run down, tired and sick overall. After extensive medical tests and many trips to the doctor, it was determined that her kidneys were failing and that she would need a transplant. Day after day the Dyds watched helplessly as Katie's health faded away and her condition became critical. Although Katie was immediately placed on the transplant list, they were told that it could be years until she received a donated kidney. There were simply too many other people on the list and a very limited supply of donated organs. The Dyds mounted a desperate search to find a medical professional or scientist that could tell them something different or offer an alternative to a donated transplant. Their one ray of hope came in the form of a controversial technique that would involve therapeutic human cloning to create embryonic stem cells for use in growing a replacement organ. Stem cells are "blank" cells that can differentiate to form any type of cell in the body. In Katie's case, stem cells would be stimulated to differentiate into the cells that create kidney tissue. The differentiated cells would be grown in a carefully controlled and sterile environment until the tissue formed a complete kidney. The kidney would then be transplanted into Katie's body. Researchers have told the Dyds that the success rate for organs grown from embryonic stem cells is higher than with any other type of cell. The transplant is even more successful if the embryonic stem cells used are an exact genetic match to the recipient. To achieve this, the doctors would use one of Katie's somatic cells to produce an embryonic clone from which the stem cells would be harvested. Because this is such a controversial technique, this form of treatment must first be approved by the Hospital's Ethics Committee before the team of scientists and medical professionals can begin.

Appendix G: Focal Students' Debate Opening Statements

Mismin: Okay. Good morning ladies and gentlemen of the debate team, "debate team" (makes air quotes). (students laugh). I would like to introduce you a case about heart disease and stem cells. Stem cells are used, our team, we agreed of no heart, no um stem cells in the heart (this is very jumbled). People have heart damage problems, the reasons, some points, that I have wroten (sic) is, um, that hospitals have short supplies of stem cells, and that stem cells are being tested on humans without the FDA agreement. This is very important 'cause it could also damage patients, it's a high risk, because if these places don't know what they're doing – then it'll be dangerous for us and the whole community of people of the world. Um, and then, also, stem cells, I would like to add that stem cells is un-religiously for many people 'cause stem cells came from unborn babies. It's like saying that… it's like having an abortion which is wrong for many religious reasons. 'Cause its like killing another person. Thank you.

Kevin: Kevin: k, um. Morning. According to the case study, it is a fact that the process is premature and place a group of sick patients at risk. The only basis for the process is works is that it works on mice and it shouldn't be assumed that the process would also work on humans because a study on artificial sweeteners, showed that Splenda, um, causes tumors to grow in mice, which is, of course, not the same in humans. And also, the process is unfair to the people who will undergo the process first and die as guinea pigs for the progress of the process. Comparing the situation now where people want to be first in line, awaiting organ transplants when the process is initiated are the same people who first in line for an organ transplant wouldn't want to be first in line for the process. Right, cuz the, because the ones who undergo the process first have less chance of success than those who go later. And um, to argue that a messy progress is progress none-the-less is the same argument that the Nazi's used to justify their cruel experiments. Let us keep in mind that the ends does not justify the means and not subject people to this premature process.

Bob: Well my name's Bob and our group is on the case of Katie Dyd and we're against the use of stem cells in the production of kidneys mainly because, well, its defeating natural selection, well, her kidney's malfunction because over the years, every organism in earth, on earth, is going through changes that might benefit them in the rest of life. The, using stem cells to make a kidney is horrible idea because not only do you need, as stated in the article, an exact copy for it to be a really high chance for succeeding, and if you have a bad copy, wouldn't that mean the new kidney, the supposed new kidney, would have the same malfunctioning items or things that the old one had. Its making another bad kidney for her. You should just wait for the same amount of time that you would wait for the surgery, just wait for a transplant. And it also states in the article that… (grabs the article), that "because it is such a controversial technique, this form of treatment must first be approved by the Hospital's Ethics Committee before the team of scientists and medical professionals can begin." If even the hospital can't trust their doctors to succeed at this, why should the parents put their child's life at risk? This is just another way people are taking (gets distracted because his time is over). This is just another way people (inaudible) because they are scared as well. (Bob sits down).

Stephanie: Hello, my name is Stephanie- good morning, respected scientists and judges. There are several things I would like to focus, though my time is limited. I am speaking on behalf of Katie Dyd and her family along with every other human being in the same position. Just like a lot of people, Katie's kidney's are failing and sadly, Katie, just like a lot of other kids, has an expiration date and (?) on what they can and cannot do. I am advocating for every person who is in this situation and has to wait for extensive periods of time in order to get their life back. There is an alternative, though. But not a lot of people know of it. Not only that, but it's also shunned upon for no apparent reason. This incredible life saving alternative would involve therapeutic cloning in order to create embryonic stem cells and growing Katie's own replacement organs, *which* would be compatible with her body. The amazing thing is that the success rate for organs grown from embryonic stem cells is higher than any other type of cell. Meaning that Katie and everyone else that may be exposed to this benefit (misreads), can benefit greatly and will be able to live a long and healthy life. I hope you take what I say into great consideration and let this procedure become part of society because such a process like this can save millions and millions of lives, money, and time. Thank you.

Jacob: (stands) Alright, good morning. My name's Jacob. And I'm for Katie and her kidney. And um, what? (I think Cookie told him he was too quiet, pointed to her ear). Sorry. And um, I'm saying that I'm for it because if she were to wait for a kidney transplant imagine how long it would take the doctors – they're saying it would take years. And she is such a young girl and she has a good life, why waste, you know? Why would anyone want to take her life away with waiting, especially her parents? She doesn't have her own decision since she is so young. And um, with this, with the stem cells, it is going to grow in a safe community and she's gonna be allowed to have her life back again and it would be the same exact clone its going to be her, basically her original kidney, just in a better, healthy form. And she will be able to have her life back again. Yeah. (he sits down).

Michael: Hi, I'm Michael and I am for kidney stem cell research. Stem cells are in our whole body. Stem cells (inaudible) Stem cells help recreate damaged areas: If your skin is burned, we can re-create your skin. Or patch it up (inaudible). If your kidney starts to fail, there can be an alternative as this. You don't want to wait, that whole time, not being sure if you are ever going to find a kidney. Lives are precious. We need to save them now, if we do this experimental and it works out, we've got people who we can save their kidneys for. You've got another kidney alternative. But as long as waiting, let's say never finding a kidney, a life is already lost. So what is the harm in taking that chance? (sits down).

Molly: When it comes to stem cells, there are many kinds. There are embryonic, there are clones, there is um, the stem cells that come from the umbilical cord, and there are adult stem cells. When it comes to the ethical concerns it's mainly related around embryonic stem cell simply because it destroys the embryo and thus cannot develop into a human being. But this has nothing to do with that. Therapeutic cloning: this involves taking cells from the patient's body, whether healthy or not, cloning and culturing it, to create any cell needed for the body. When it comes to reproduction, when a person reproduces, that persons illness or the disease or anything is not passed on to the clone or the or child, it only copies the genetic information. So when we clone stem cells, its not passing on the disease or sickness, it's passing on genetic information creating a perfect match for that kidney. And also, Katie was a child who had a zest for life and

she was very active. We do not know her opinion and we should. But looking up information, I think she would want to live and I think she'd risk any chance she could take that opportunity to live longer. She's a ticking time bomb. She doesn't have the years to wait for a kidney. And as low as supplies are, there's a chance she won't have one. And as time goes by, she'll only get sicker and sicker and the chance to act will not be even possible. Transplants are less invasive (corrects herself) transplants are more invasive. A stem cell injection is not a transplant. They do not cut her open like severely and they do not replace her organs. It's a small injection (points to her side) and way less invasive. And also, it is not the hospital , the hospital- (stumbling over words). There is no information claiming that the hospital is against or for the treatment, they simply have to make a decision. Whether that should be up to the parents or not seems wrong, it should be up to the parents- not the community. The communities are not the ones going to lose their baby. (stops, and Theresa smiles when she sits down.)

Gloria (walks in late and rolls her eyes—another student is speaking). Gloria (bangs the desk with her fist before she starts talking as she stands up). My name is Gloria everyone (claps) and my view about this is that a child, in Katie's case, we should wait until she gets a kidney because we don't, they don't as much we do not have enough information on these stem cell researches. I want to point out that when I was reading over this, there are three different kinds of stem cells. (is stuttering over her words—not sentences) Its, ugh. (puts her hands on her face and leans backwards). I'm just, we're not dealing with an experiment, we're not trying to experiment on people, let's just use the resources we have now instead of trying to see what's going to happen. (inaudible) and see what is her reaction. It's just too much for us to start handling. (Gloria and Theresa are looking at her papers).

Appendix H: Stem Cell Test

Name _____ Per _____ Date _____

Stem Cell Test (40 points)

Directions Use Figure A to answer questions 1-5 and choose the best-fit answer. Explain your choice. (2pts each)

(image of ell differentiation on original, did not copy well for this dissertation)

1. The fertilized egg follows the developmental sequence of
   A) a zygote to a mesoderm then to a blastocyst and finally to a gastrula.
   B) a zygote to a blastocyst and finally to a gastrula.
   C) an ectoderm to a mesoderm and finally to an endoderm.
   D) an endoderm then to a mesoderm and finally to a germ layer.

2. A scientist at Stanford isolated some of the stem cells from the blastocyst. She cultivated the cells and after some time, she found the stem cells have become sperm cells.
From what layer did she obtain her cells?
A) Endoderm layer B) Ectoderm layer C) Mesoderm layer D) Germ layer

3. From which layer of stem cells do red blood cells form?
A) Endoderm layer B) Ectoderm layer C) Mesoderm layer D) Germ layer

4. Stem cells located in the ectoderm layer can become
   A) Neuron cells
   B) Cardiac Muscle cells
   C) Thyroid cells
   D) Egg cells

5. The inner cell mass of the blastocyst is arranged in layers. The layers are arranged in the order listed, beginning with the outer layer.
   A) Mesoderm, Endoderm, Ectoderm
   B) Endoderm, Ectoderm, Mesoderm
   C) Ectoderm, Mesoderm, Endoderm
   D) Endoderm, Mesoderm, Ectoderm

Directions Match the following terms. Place the corresponding letter on the line. (1 point each)

6. _____ multipotent	A. the process where mRNA and tRNA make a protein
7. _____ pluripotent	B. the hollow ball of cells developed after the zygote
8. _____ totipotent	C. cells found in the zygote and blastocyst
9. _____ differentiation	D. cells found in the umbilical cord and placenta
10._____blastocyst	E. genetic potential to create any cell
11._____ embryonic stem cells	F. the process where a cell become specialized

12._____ adult stem cells	G. cells found in the body that have the ability to differentiate
13._____ cord stem cells	H. the process where mRNA copies DNA
14._____ translation	I. genetic potential to almost any type of cell
15._____ transcription	J. genetic potential to differentiate into limited types of cells

Conflicting Viewpoints
Directions. Read the following passage and choose the best fit answer for questions 16-20. Underline and number the parts of the passage that you are using to defend your answer choice.

Introduction: The road from basic science to clinical practice can be a rocky one. A perfect case in point is our current struggle on both sides of the Atlantic to realize the benefits of utilizing regenerative medicine, the ability to use stem cells as a treatment for damaged hearts. If one were to choose to explore the promise of regenerative medicine, the heart would be a logical starting point. Hearts weakened by chronic or acute loss of blood supply are exceedingly common. The condition, called Congestive Heart Failure, affects some 4.8 million people in the United States, and there are 400,000 new cases each year. The major contributor to the development of this condition is a heart attack. More than a million Americans suffer heart attacks each year. Out of those who subsequently develop Congestive Heart Failure, half die within 5 years as a result of their severely weakened hearts.

Scientific Community 1
Experiments using stem cells from bone marrow injected into the damaged hearts of mice had morphed into cardiac cells. Stem cells implanted in the damaged tissue laid the seeds for regenerative healing. The finding supported early beliefs about the promise and challenge of using stem cells – which they might work before we fully understand why; that if you put them in the right place, they will do the rest; and that if they worked in a damaged heart, they would work in other damaged organs as well. The results of the experiments suggested that reparative stem cells existed in the spaces between normal heart cells and in bone marrow. The need is urgent and real, and experimental studies in humans are necessary since the regenerative medicine would be less invasive and less expensive and has immense advantages over heart transplant. Beyond this, it would resolve a nagging supply and demand crisis which causes thousands of people to die while awaiting an organ. If this proves successful, this will replace heart transplants.

Scientific Community 2
Others over the past 4 years have been unable to confirm their experiments for regenerative medicine for the heart. During this same period, clinicians in at least 10 different studies have harvested bone marrow and peripheral cells, cultured them to expand their numbers, and injected them or deposited them into the damaged areas of patients' hearts, then watched, waited, and measured with variable and not fully conclusive results. These studies are premature and may in fact place a group of sick patients at risk. More data is needed to find whether rodent results reflect human results. Also in the face of an acute heart attack can stem cells be harvested and delivered in time? How long will replacement cells function? There is a role for action but some questions still exists.

16. What is the basic issue being discussed?

A) Using embryonic stem cell to cure heart disease
B) Reducing the time for heart transplants
C) Using regenerative medicine as a treatment for heart disease.
D) Reducing the use of stem cell therapy

17. Whose argument states that reparative stem cell studies are needed in humans now to counter the growing number of deaths due to patients waiting for heart transplants.

A) Scientific Community 1
B) Scientific Community 2
C) Scientific Community 1 and 2
D) Neither Scientific Community

18. What is the assumption made by Scientific Community 1?

A) Heart disease is too common.
B) The human heart will respond the same way that the mouse heart to stem cell treatments.
C) Healthy heart stem cells are found between normal heart cells.
D) The results for human stem cell regeneration are not conclusive.

19. What is the assumption made by Scientific Community 2?

A) Heart disease is too common.
B) The human heart will respond the same way that the mouse heart to stem cell treatments.
C) Healthy heart stem cells are found between normal heart cells.
D) The results for human stem cell regeneration are not conclusive.

20. What is meant by regenerative medicine?

A) Using generational medicine is better than new medicines.
B) Using stem cells from one's own body to heal it.
C) Congestive heart failure affects more than one million Americans per year.
D) using embryonic stem cells to clone organs.

SHORT ANSWERS Write your answer to the prompt. Use complete sentences. (5 points each)

21. What is the difference between adult stem cell research and embryonic stem cell research?

_____
_____
_____
_____

22. Explain the process by which the inner cell mass found in the blastocyst becomes differentiated cells.

_____
_____

Appendix I: Affinity Spaces in the Sims vs. In Schools

Affinity Space	In Sims	In schools
A common passion-fueled endeavor—not race, class, gender, or disability—is primary	In a passionate affinity group, people relate to each other primarily in terms of common interests, endeavors, goals, or practices—defined around their shared passion—and not primarily in terms of race, gender, age, disability, or social class. (p. 107)	Children rarely share a common passionate endeavor. Too often factors like race, gender, social class, or disability play too prominent a role in school without the choice of the student as how to define and use his or her own identity. (p. 107-8)
Groups are not segregated by age	Passionate affinity groups involve people of all ages. (p. 108)	School is, by and large, segregated by age with only one adult around. (p. 108)
Newbies, masters, and everyone else share common space.	"Passionate affinity groups do not segregate newcomers ('newbies') from masters. The whole continuum of people from the new to the experienced, from the unskilled to the highly skilled, from the slightly interested to the addicted and everything in between, is accommodated in the same space (p. 108)	Schools segregate new comers from more expert students through tracking and grade levels. (p. 108)
Everyone can, if they wish, produce and not just consume.	In a passionate affinity group, people are encouraged (but not forced) to produce and not just to consume; to participate and not just be a spectator. (p. 109)	School stressed consuming what the teacher and textbook says and what other people have done and thought. When students produce (e.g. a writing assignment), they do what they are told because they are told to, not what they want because they have chosen it. (p. 109)

Content is transformed by interaction	The content available in a passionate affinity group (e.g. all the Sims houses, rooms, furniture, clothes, challenges, and tutorials) are transformed continuously through people's social interactions. They are not fixed. People comment and negotiate over content and, indeed, over standards, norms and values. (p. 109)	School content is fixed by teachers, curricula, and textbooks, and the students' interactions with each other and the teacher rarely change anything in a serious way (p. 109)
Both specialist and broad, general knowledge are encouraged, and specialist knowledge is pooled.	Passionate affinity groups encourage and enable people to gain and spread both specialist knowledge and broad, general knowledge. … At the same time, the group encourages and enables people to gain a good deal of broader, less-specialized knowledge about many aspects of the shared passion, which they share with a great many others in the group. The creates people who share lots of knowledge and common ground but who each have something special to offer. (p. 109)	In school, most children rarely get to become experts or specialists in anything. Further, the children in the classroom or school rarely share a lot of general knowledge about something about which they all deeply care, which lays the foundation for each child's development of different forms of specialist knowledge, that they can use to achieve common goals. (p. 110)

Both individual and distributed knowledge are encouraged.	"A passionate affinity group encourages and enables people to gain both individual knowledge (stored in their heads) and distributed knowledge (citing Brown, Collins, & Dugid, 1989; Hutchins, 1995). Distributed knowledge is knowledge that exists in other people, material on the site (or links to other sites), or in mediating devices such as various tools, artifacts, and technology to which people can connect or 'network' their own individual knowledge. Such distributed knowledge allows people to know and do more than they could on their own. (p. 110)	In school, individual knowledge is dominant, and distributed knowledge is given short shrift. … Further, students rarely get to trade on each other's knowledge to supplement their own—in school that is often called 'cheating'. (p. 110)
Distributed knowledge is encouraged.	A passionate affinity group encourages and enables people to use dispersed knowledge: knowledge that is not actually on the site itself but at other sites or in other spaces. …When knowledge is dispersed, strict boundaries are not set around the places from which people will draw knowledge and skills. (p. 111)	In school, too often all the knowledge is in the classroom and students are not linked to sources outside the classroom. In fact, many links are banned or heavily policed. (p. 111)

Tacit knowledge is used and honored; explicit knowledge is encouraged.	A passionate affinity group encourages, enables, and honors tacit knowledge: knowledge members have built up in practice, but may not be able to explicate carefully in words. … At the same time, the passionate affinity group offers ample opportunities people to learn to articulate their tacit knowledge in words (e.g. when they contribute to a forum thread or engage in a group discussion about a shared problem) (p. 111)	In school, unlike many workplaces, tacit knowledge counts for nothing. Indeed, students often learn to articulate knowledge (say it or write it down) that they cannot apply in practice to solve problems). (p. 111)
There are many different forms and routes to participation	People can participate in a passionate affinity group in many different ways and at many different levels. People can participate peripherally in some respects and centrally in others; patterns can change from day to day or across longer stretches of time. (p. 111)	In school, by and large, everyone is expected to participate in the same way and do all the same things. (p. 111)
There are lots of different routes to status.	A passionate affinity group allows people to achieve status, if they want it (and they may not), in many different ways. Different people can be good at different things or repute in a number of different ways. (p. 111-112)	In school, there are different routes to status (e.g. being a good student, a good athlete, and other such things). Unfortunately, in the classroom as a community, too often there is only one route to status, that is, being a 'good student', which means being good at being a student, not necessarily being good at solving problems or innovating. (p. 112)

Leadership is porous and leaders are resources.	Passionate affinity groups do not have 'bosses'. They do have various sorts of leaders, though the boundary between leader and follower is often porous, since members sometimes lead and sometimes follow. Leaders in a passionate affinity group, when they are leading, are designers, mentors, resources, and enablers of other people's participation and learning. They do not and cannot order people around or create rigid, unchanging, and impregnable hierarchies. (p. 112)	In school, teachers are leaders and bosses- and often see their role as telling, rather than resourcing learners' learning and creativity—and learners are followers. (p. 112)
Roles are reciprocal.	In a passionate affinity group, people sometimes lead, sometimes follow, sometimes mentor, sometimes get mentored, sometimes teach, sometimes learn, sometimes ask questions, sometimes answer them, sometimes encourage, sometimes get encouraged. (p. 112)	In school, roles are not reciprocal. Teachers teach, mentor, and lead, while students 'learn', get mentored, and follow. (p. 112)
A view of learning is that individually proactive, but does not exclude help, is encouraged.	Passionate affinity groups encourage a view of learning where the individual is proactive, self-propelled, engaged with trial and error, and where failure is seen as a path to success. (p. 112)	Ironically, getting help often counts as 'cheating' and yet few students take on a proactive, self-propelled, and engaged trial and error approach to learning. In a passionate affinity group, getting help of the right sort does lead to such a proactive view of learning (p. 113)

People get encouragement from an audience and feedback from peers, though everyone plays both roles at different times.	The norm of a passionate affinity group is to be supportive and to offer encouragement when someone produces something. This support comes from one's 'audience', from all the people who have responded to ones production. (p. 113)	In school, children rarely have an audience who really cares other than the teacher, and feedback comes, by and large, from the teacher, who is not a peer (not simply in the sense of age, but in the sense of expertise) or someone most students aspire to be like, in terms of what they have a passion for producing and learning. School is not a source of encouragement for many students (p. 113)

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