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# A Culturally Relevant Opening Weeks Curriculum: Seeking To Engage All Students To Succeed In The Middle School Science Classroom

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# A CULTURALLY RELEVANT OPENING WEEKS CURRICULUM: SEEKING TO ENGAGE ALL STUDENTS TO SUCCEED IN THE MIDDLE SCHOOL SCIENCE CLASSROOM

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# Abstract

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The research question addressed in this project was *How can a culturally relevant opening weeks unit help all students to succeed in the middle school science classroom?* Topics explored in the literature review include challenges, themes, engagement of all students, gaps between students of color and their white peers, students of color and disproportionality trends in discipline, youth positions as hip-hop or survival mode, social construction of black inferiority, curriculum as windows and mirror, culturally responsive classroom management, using citizen science and student-driven investigation, restorative practices and restorative circles in the science classroom, shared responsibility for the classroom community, and teacher and cultural competence. These topics guided the creation of an opening weeks unit designed to be culturally relevant and build community, using restorative circles, community building activities, and authentic scientific inquiry across the eleven lessons.



*Keywords: culturally relevant pedagogy, science education*

# CHAPTER 1: INTRODUCTION

The bell has rung and the “Do Now” is displayed on the front of the classroom projector as students take their seats with their notebooks and writing utensil in order to begin engaging in class. The expectation is for students to begin doing the “Do Now” upon entering the room and getting their materials. However, not all students get their notebooks upon entering class. Learning time is ticking away, conversations are building, and the teacher is working to get all students to quiet down and ready to go. Fast Forward to lab time, the teacher explains what we to do, checks in with random students for comprehension, and then students go to their lab groups. A few groups attempt to do the work but are interrupted by a few students making a commotion at the table nearby. While checking in with groups, most don’t understand what to do, are lost, and are engaged in conversations with their peers. Lab time is over. Very few students have completed the task and very few seemed to have learned anything.

The above scenario is the common story of my everyday experience teaching Life Science. Life Science is the regular pathway science course for about half of the 7th grade students in the school I work at. The classes tend to have a majority of students of color compared to the accelerated pathway courses. The primary research questions in this study is: *How can a culturally relevant opening weeks curriculum engage All students to succeed in the middle school science classroom*?

Throughout this chapter, the reader will gain an understanding of why I am asking this question and what learning more about culturally responsive practice would mean for me as a teacher. I will also discuss why it is important for my students and colleagues that this research occurs. My passion lies with trying to understand the intersection of the complex issues of race, engagement, success, cultural relevance, gender, and science instruction. I desire a curriculum that is culturally relevant and engages my students to find success. This chapter builds a foundation for my research and the chapters that follow.

I remember writing a story in high school that involved a character that I had created to resemble what my future self would be like. The character predicted that I would go to college at the University of Minnesota to study science. The character would find love, get married, and pursue a career outside of teaching in order to gain experience that would be valuable to bring back to the classroom when the time came. My initial interest in science truly began because of my $7^{th}$ and $8^{th}$ grade science teachers. My $7^{th}$ grade teacher had invited me to be in an extracurricular science program in the summer between $7^{th}$ and $8^{th}$ grades. I remember being very excited to meet up with the group of other science loving students and doing things we did not get to do in regular school. I think subconsciously, the above experience is when I first considered becoming a science teacher. The partially fictional character lives on in my story I wrote during another creative writing class I took in college. I do plan to publish the fictional story based upon my life and the visions for what this character's life would be like. Like my character, I did pursue other careers before getting back to teaching, but always was there a tie to teaching and working with people. In college, I focused on pre-med for a while, then studied fisheries and wildlife studies toward the end of my bachelor degree process. For a period of time, I moved away from academics working in the fields of fitness and recreation, working jobs as personal trainer, as a manager, and running my own fly-fishing guide/instruction business. All of these jobs brought me the most happiness when I was teaching. When the opportunity presented itself to go back to school to become a teacher, I became a stay-at-home dad. I fast-tracked myself, taking extra classes where I could and finished student teaching a year and a half later.

My initial thoughts leading to this research began during field observations while completing my initial licensure program at Hamline University. After visiting a wide variety of schools, I kept hearing a common theme from the schools that "African American boys seem to struggle the most to find success in the classroom." We hear the above assumption often stated on the news, read it in reports reports, and see it in the high stakes testing results. However, it appears that no matter how many dollars are invested to tackle the problem, the gap in achievement between students of color and their white counterparts does not seem to be improving, especially here in Minnesota where--according to the 2017 Nation's Report Card--8th grade black students average 11% lower on reading scores and 14.25% lower in math compared to their white counterparts (NDE Core Web, 2017).

I entered my first classroom as a newly licensed teacher middle school science teacher in January 2013, a mid-year start. I took over for an established teacher who left to take a district level coaching position. I had three classes of $7^{th}$ grade life science with demographics of approximately 50% African American, 25% Asian, 15% Hispanic/Latino, 8% White, and 2% Native American. One class was co-taught with a special education teacher and the other two I taught by myself. I was excited to have my own class but a bit worried due to the mid-year start. Quickly after a few weeks, the majority of my African American students were failing my classes. I struggled to build relationships and teach the science standards I was hired to teach. I was questioning my abilities, practice, and thinking. The school culture took a turn for the worse at the same time. I witnessed seven fights in my own classroom, most of them in my co-taught class, not to mention another two dozen or so I had to break up in various places of the school. Students often ran in the hallways and classrooms throughout the school. I kept trying to build the relationships and celebrated in the successes that some of the students were experiencing but battling the school atmosphere slowed our progress and the year ended. My colleagues advised me that next year would be better, as it is hard to enter mid-year especially considering the other factors going on in the school. All of this did not stop me from questioning what I could do differently. I did not find the answers I was looking for. I was looking for answers that would engage all of my students, help me progress to become the teacher I envision, and show my students that science is a valuable asset for their toolbox.

Going back, I was anxious to start the new school year. The entire staff was participating in a team building/ icebreaker activity when I noticed a few of the African American educational assistants were sitting out. The staff at the time contained one African American teacher and several Educational Assistants and Teacher Aides who were African American. When the facilitator asked them why they removed themselves, one stated, "that was white people stuff, just not for me." The statement got me thinking, as some of my students did a similar thing sometimes without the verbalization of their actions. I reflected about how I see the world from my white suburban-raised male perspective. I grew up in a mostly white community and was taught by all white teachers. Whiteness surrounded my upbringing and that is what I have experienced; this experience is what assisted me in attending the university of my choice and securing employment of my choice throughout. I have always loved school and learning, and science was the most interesting of the subjects. I forget sometimes that not everyone loves school or science. I don't think I realized until college that other people have drastically different experiences with life. These differences in experiences are playing a role in how I teach and my students learn. The rest of the school year was a learning year for most of my students but the theme of African American boys struggling to succeed academically continued. The year ended with one fight in my room late in the year and only two fights elsewhere all year. Although the physical fights decreased, the amount of verbal disrespect and disruption throughout the school increased. The hallways were better managed but suffered towards the end of the year as the school picked up over 110 additional students including several behavioral transfers.

The start of year two as a full-time teacher in the same school had been going well. I continued to build confidence and rapport with the students, continued taking classes to improve as a teacher. There were noticeable changes in the school atmosphere. Most of the students seem to be engaged in learning but, again, it was the majority of my African American boys in Life Science who seemed to be experiencing the most challenges in the classroom. My African American male students are not the only group who are struggling academically, but they are the majority in that category.

I continued to reflect on what I was doing as a teacher to provide learning opportunities to all students to engage and experience success in science. From there, I thought about what does "all students" mean and look like? I desire for all students to be able to see themselves as scientists and that science is for them. I want to be able to present compelling stories that draw my students into what we are studying. I don't want to be viewed as "that white teacher" who only teaches about old or dead white males and only in white ways. I did not have the knowledge base to effectively embed diverse voices and experiences into my curriculum. My teacher education program and professional development has pushed us to be culturally relevant, but I kept wondering what does that mean? What does that look like? This project will hopefully answer those questions so that I can bring it to my practice and organize the information so that other colleagues can access it as well.

My courses during the initial licensure begin to set the framework for this capstone, especially my cultural diversity class. This course built on my previous self-exploration and thinking about race, culture, and diversity I had participated in while working at the YWCA of Minneapolis. Before working at the YWCA--whose mission is to empower women and eliminate racism--I had never thought about my whiteness or maleness and the privileges that came with them in U.S. society. There is a strong push for all students to succeed in society; however, the majority of society does not acknowledge that people of color face a struggle that is different from those who happen to be born with lighter skin.

I want to help all students learn what they need to be successful in mainstream society while also maintaining their home culture grounding. I think it is important for teachers, staff, and students to learn how to switch how they operate depending upon the environment in order to work in a system that tends to communicate differently than they do. I do not think it is fair or just for a student to have to give up their values they grew up with just to align with school or dominant culture. They should be allowed to freely navigate between and be encouraged to do so.

Recently, I have found myself ill-prepared to be a culturally relevant teacher to all of my students. My hopes are that by completing this mixed-methods research project, I will be able to improve my ability to be culturally relevant, improve student engagement, and increase student achievement in science. My capstone thus explores the question of

*How can a culturally relevant opening weeks unit help all students to succeed in the middle school science classroom?*

Through reflection, I realize that my life as a K-12 student was fairly different than many of my students. I began to truly realize this when one of my colleagues suggested that many of my students do not see themselves in science. The colleague named a few scientists that I had never heard of, making me think that I need to immerse myself into making myself more culturally relevant and aware.. As much as I think I am aware of my teaching practices, I realize how much I desire to improve and become the teacher I want to be and all of my students need me to be. I realize I alone am not going to eliminate racism in this country, but I can do my best to help dismantle the individual and institutional racism that the majority of my students face on a daily basis in my classroom. I also acknowledge that the gap is a bigger problem than what I am able to do as a teacher. However, I want to do my best to close these gaps within my classroom and share my successes with my colleagues.

Following my first two years of teaching, I found myself still desiring to be more successful and effective for all students in my science classroom which motivated me to seek more professional development. I've participated in many professional developments since then. From Restorative Practices, I have learned how to run a restorative circle in my classroom and how this way of interacting with students empowers students to feel like they have a voice in the classroom. I continued this work when I was asked to be on the Restorative Practices Committee that our school formed after I began this project. The Restorative Practices Committee is a group of Teachers who work together to plan lessons for foundations (homeroom) and professional development around restorative practices. The restorative practices of community and learning circles resonate with me because there is a focus on restoring relationships and providing an avenue for healing and shared perspectives. As I have been holding circles in the classroom they seem to help the classroom be more connected and owned by the students. Giving time and space to allow each participant an opportunity to voice their opinion and have others hear what they have to say can be a powerful thing in the classroom.

I participated in a training about the Innocent Classroom (Pate, 2018). The approach was launched by Alexs Pate in 2012 with an underlying philosophy that all of us do everything for that one "good" we value the most. The "good" is the thing that which all decision are made. For me, my "good" is to be successful; almost all decisions I make are related to being the best teacher, father, and husband I can be. The problem in a classroom is that "good" might be showing up in ways that are not conducive to the classroom, like seeking their "good" validation. This might be showing up as anger or attitude when the student shared an answer or was raising a hand but was not called on. Often it shows up as a student playing the role of the guilt, doing poorly to validate to themselves that students of color are not smart. Or we might see them as being a clown or taunting, so that they can be validated by their peers for their negative behavior. Sometime and often with our students their desire to get their good has been corrupted and is no longer innocent. The Innocent Classroom defines innocence as the condition that results from the reduction, minimization, neutralization or elimination of the guilt that develops from stereotypes, popular negative narratives and iconography. They define guilt in two ways, the first the internalized negative perceptions of people of color that affect attitude and behavior. The absence of innocence. The second way is this feeling of guilt is more of a translation of the negative expectations that envelope their lives than it is a statement of fact. Unfortunately most our children are aware, at a very early age of this feeling of guilt and exhibit its negative consequences before they even know what it is that motivates their behavior.  This was one of the pieces where I really started to become interested in culturally responsive teaching.

I found myself relating to a book by Christopher Emdin (2017), For White Folks Who Teach in the Hood...and the Rest of Y'all Too, a book about reality pedagogy and urban education.  As you will see in my curriculum, I learned that giving students roles beyond student in the classroom is important to their feeling apart of the classroom.  I learned that in order to get true buy-in I need to let my students have voice in how they are taught.  This book allowed me to start connecting with ideas that I have had but didn't know how to verbalize and enact.

Last summer I took a course called Driven to Discover hosted by the University of Minnesota and was a course focused on getting students to be citizen scientists.  We participated in turning questions into scientific questions in an organic way that I could see how it was transferable to students. We then did some background research on pollinators reframed our question, designed a field study, analyzed the data, and shared our results with the other science teacher groups that were studying different areas like dragonflies, birds, and phenology. The course inspired me to petition for a citizen science elective, which I was granted, to teach this upcoming school year. All of these enrichments have been melded together in this curriculum in a way that helps a teacher start the year off doing culturally relevant lessons that will help all students find success in the science classroom.

By attempting to find answers to my research question, I intend to help all of my students be engaged and find success in my classroom. Since the majority of my students are from ethnic and racial groups underrepresented in the field of science, I hope to provide many opportunities that will allow them to see themselves in the future as a scientist or related field. At the very least, by being engaged and successful, I hope they will leave my room better equipped to be citizens in a democratic society and that the skills of science can be helpful in their lives outside of science. My hopes would be that this engagement would spread to their families and that my students would be able to self-advocate for anything helpful in their communities related to science. The significance of this research would help my colleagues also learn how to be more culturally relevant to engage all learners to achieve in their middle school classrooms.

**Summary**

My passion for education and improving my own practice to improve the lives of my students is very important to me. It bothers me greatly that I do not seem to have the answers that I need to engage all students to achieve success in the science classroom. My question will also help me reflect on what I am doing in the classroom that may be disrupting or perpetuating institutional racism of society? How can I create a learning community where multiple perspectives are presented and present through my students' engagement? And how can I design a unit of instruction to be more culturally relevant for all of the students that I serve? Being able to answer these questions will assist me in ensuring that all of my students engage and achieve in science. Leading this research will be my findings in the upcoming Literature Review where I will look to see what others have found in individual areas of engagement, achievement, self-efficacy as scientists, and cultural relevance. I plan to look at research to inform myself from multiple perspectives.

# CHAPTER TWO

## Literature Review

### Challenges

In the science classroom, there are many societal issues that play out in the engagement of the students who walk through the doors. Major issues that plague our public schools: the opportunity gap; the overrepresentation of students of color in special education programs; and the underrepresentation of this same group in accelerated programs (Nieto, 2000). Emdin (2006) acknowledges that in the United States, the general population is conditioned to envision schools as a militarized, orderly place where all students (particularly in science classes) look, sit, and interact in a certain way, learn specific information, and then hopefully graduate. Schools function under the premise of western, middle class ideals that mirror economic productivity models of knowledge creation and dissemination determined by the scholars in a specific 'academic' field (Diamond, 1999). The science classroom is a place where students are trained to be successful at specific tasks and learn a prescribed amount of predetermined information so that they might one day utilize this information to benefit society (Tyack & Cuban, 1995; Ravitch, 2000). As a result of the rigid science classroom practices, few students in the United States are pursuing studies in the scientific disciplines despite the increasing importance of science within society (Atech & Charpentier, 2014).

The primary question this research is asking is; *How can a culturally relevant opening weeks unit help all students to succeed in the middle school science classroom?*

Additionally, how does a culturally competent teacher positively impact all students? If a teacher feels unprepared to work with different ethnic and racial groups, how can these skills be learned and integrated into their practice? How can a middle-class teacher who is also a white male break down the social injustices inside his classroom to provide an atmosphere where all of his students can learn? What changes need to happen to the typical urban science classroom to promote the learning of all students? How does one create positive change in a cash-strapped classroom to promote science inquiry and hands-on learning?

## Themes

Embedded throughout the research and literature are themes that all relate to the primary research question and to the secondary questions as well. These themes are engagement of all students, the underachievement of students of color compared to their white peers, the disproportionate representation of students of color who are referred for disciplinary action, positioning of youth as "hip-hop" or "survival mode," the social construction of black inferiority, curriculum as window and mirror, and the importance of cultural competence of the teacher. During the remainder of this chapter, each of these themes will be discussed and connected to the research question and the challenges they present.

### Engagement of All Students

Research has shown a strong correlation between factors such as interest, engagement, motivation, persistence, self-identity, and the ability to understand scientific concepts and develop skills in science and engineering (Next Generation Science Standards Lead States, 2013). A student's personal interests, experiences, and enthusiasm, which are critical to acquiring scientific knowledge in school or other settings, are associated with future educational and career choices (National Research Council, 2012).

We are "engaged" when we are entirely present and not focusing our attention elsewhere (Axelson & Flick, 2011). Finn (1993) defined engagement as a two-faceted construct that includes a behavioral component (participation) and a psychological component (identification). Specifically, Finn (1993) described engagement as a cyclical process beginning with the behaviors of participation, such as attending school and responding to the teacher during class, which under favorable circumstances leads to a psychological feeling of belonging in and identification with school. Fredricks and colleagues (2004) described engagement as a multidimensional construct comprising three forms: behavioral, emotional, and cognitive. Behavioral engagement refers to students' direct actions and participation in activities associated with the school and classroom learning environments. Emotional engagement refers to students' affective reactions to peers, teachers, and the overall school context influencing students' feelings of connectedness and identification with the school. Last, cognitive engagement refers to students' levels of effort, investments in learning, and willingness to use complex learning strategies and processes needed to master and comprehend various ideas (Fredricks et al., 2004). Although there are three distinct components of school engagement, their interrelated nature constitutes a dynamic process that influences student learning and achievement (Wang & Holcombe, 2010).

Often, students who are placed in the lower-track science and courses that are composed mainly of students of color have little, if any, laboratory or work with manipulatives. Content is often transmitted using a didactic approach instead of using a more cognitively engaging instructional method. If students of color are placed in an environment where teachers have low expectations, their students are more likely to experience a less rigorous curriculum, be given low standards, and placed in special education classes (Harris, Brown, Ford, & Richardson, 2004).

As Axelson and Flick (2011) state that we need to know more about why some students, and some student groups, appear to disengage in the learning environment under certain circumstances and what to do to prevent disengagement (Axelson & Flick, 2010). This statement really connects to the deeper levels of the research question: connecting the level of engagement of students in the science classroom to culturally responsive teaching.

**Gaps Between Students of Color and their White Peers**

The statistics appear ubiquitous: students of color are underachieving academically compared to their white peers. As predicted by W.E.B. Dubois (1903) in the early 20$^{th}$ Century, race will continue to be a paramount issue for Americans in the twenty-first century. In our public schools, there is a great concern about the lower graduation and dropout rates, especially among African American students (Rothstein, 2008). There is a pronounced gap in achievement and educational attainment between African American and White students (Glass, 2008). The 2014-15 national graduation rates show that 87.6 % of White students, 90.2 % of Asian students,  78% Hispanic students, 75 % of Black students, and 72% of Native American and Native Alaskan students graduate from high school. African American students are not the only ones who appear to be underachieving in this system that is not designed for their success *(NCES, 1018)*.  In  Minnesota, the 2015-16 graduation rates look a little different: 87% of White students, 83.6% of Asian students, 52.6% of Native, 65.1% of Black students, and 65.3% of Hispanic students graduate from high school (Minnesota Department of Education, 2016). Native Americans tend to have too small of a part so are often viewed as statistically unimportant (Faircloth & Tippeconnic, 2010). Latino students seldom are placed in rigorous courses and are not always encouraged to enroll in more academically challenging courses because secondary teachers considered work ethic, peer relationships, laziness, and a lack of discipline as the basis for poor academic achievement and failure of the teacher to recognize that a student's academic failure could very well be indicative of deficiencies in their own teaching. (Madrid, 2011). Among Hispanic 16- to 24-years-old in the United States, 17.6 percent were high school dropouts in 2009, compared with 9.3 percent of African-Americans and 5.2 percent of Whites in the same age group, though the rate for Hispanics has steadily improved, according to The Condition of Education 2011, published by the U.S. Department of Education. Despite the best efforts of White teachers, many Hispanic students are failing in

American schools not because they lack the motivation or intellectual capacity but because they are not able to relate to the White middle-class Anglo culture that is valued at school (McCollough & Ramirez, 2012). Among racial/ethnic student groups, variation in academic adjustment and perhaps in academic decline may be attributable in part to variation in racial/ethnic identity (Byrd & Chavous, 2009).

Middle school is a time of major change in students' identities, cognitive abilities, and bodies. Unfortunately, many youth in the United States find middle school socially, emotionally, and academically difficult; research suggests that, on average, students' academic motivation and performance decline during this period (Burchinal, Roberts, Zeisel, & Rowley, 2008; Dotterer, McHale, & Crouter, 2009; Wigfield & Eccles, 1994). Researchers and theorists commonly view early adolescence as an especially sensitive developmental period because of dramatic biological and cognitive shifts (Inhelder & Piaget, 1958; Kuhn, 2009; Lerner & Steinberg, 2009), changes in self-understanding (Harter, 1986; Harter, Stocker, & Robinson, 1996), and shifts in social relationships with parents and peers (B. B. Brown & Larson, 2009; Laursen & Collins, 2009). Wigfield and Eccles (1994) found that youths' perceptions of academic competence and the importance of education declined over the transition to middle school and continued to decline further across the middle school years.

With all that going on in mainstream youths' lives, to add on the challenges of race related issues poses a complex and multifaceted situation for students of color. Race/ethnicity-related phenomena may be especially salient in contributing to variation in academic declines among racial/ethnic minority youth because of pervasive negative stereotypes about these youths' intellectual capabilities (Kang McGill et. al, 2012). The challenges seem to even more adversely youth who are living in lower socioeconomic status because of reasons like the passive "I give up" posture may actually be learned helplessness, shown for decades in the research as a symptom of a stress disorder and depression (Jensen, 2013).

The statistics related to academic gaps between students of color and their white peers, and socioeconomic status are known and extensively discussed in the public venue, maybe to the detriment of the very students whom the data represent. The attempts to "fix the system" appear to be failing and new lenses need to be used when looking at the many facets. The images that seem to be missing are the multiple perspectives involved. Most of what is publicized seems to follow upon the lines of "what can we do to fix these poor kids with poor family values doing nothing but living on the public's welfare dime?" What are students, parents, and teachers at the front lines of the achievement gap saying? What do these front line perspectives, added inputs, and true involvements mean for achievement of all students?

**Students of Color and Disproportionality Trends in Discipline**

Students are sent to school to become educated citizens. However, the statistics show there may be significant disconnects between some students' backgrounds and the rituals of traditional urban schools. According to Losen and Martinez (2013), the U.S. Department of Education data finds that nationally, on average, 36% of all Black male students with disabilities who enrolled in middle schools and high schools were suspended at least once in 2009-2010. In the 1972-73 school year, Black students were suspended in secondary school at a rate of 11.8% which grew to 24.3% in 2009 (a 12.5% increase); White student suspensions grew from 6% to 7.1% (a 1.1% increase) over that same time (Losen & Martinez, 2013). In a 2010 report by Losen and Skiba (2010), the highest rate of suspension for middle school students were the African American males at 31%. In addition, African American females were suspended at higher rates than males of any other racial/ethnic subgroup in middle and high school levels (Losen & Skiba 2010).

The Academy of American Pediatrics (AAP) concluded that “out-of-school suspensions and expulsion are counterproductive to the intended goals, rarely if ever are necessary, and should not be considered as appropriate discipline except the most extreme and dangerous circumstances, as determined on an individual basis rather than as a blanket policy” (AAP, 2013 p.1005). Research demonstrates that schools that suspend students of color at higher rates reap no gains in achievement, but they do have higher dropout rates and increase the risk that their students will become embroiled in the juvenile justice system (Balfanz, 2013; Fabelo, 2011; Schollenberger; 2013). One in four African American males is expelled from school each year, and moreover, a disproportionate number of Black males are in special education and remedial reading classes (Lee, Winfield, & Wilson, 1991; Gardner & Talbert-Johnson, 2000). .

There needs to be a way to bridge the needs of our students and the position of urban school. The pipeline from education to incarceration needs to end as well. In order to makes steps towards doing that, education professionals will need to look at the identities of the students who come into their classroom. Understanding the student from where they are coming from could reduce the number of referrals outside of the classroom. More time in the classroom hopefully equates to more learning by those students who typically are pushed away from their education.

**Youth Positions as Hip-Hop or Survival Mode**

According to Losen and Martinez (2013), research suggests that for many disengaged youth, getting suspended may simply reinforce their misbehaviors and make any re-engagement with school less likely (Losen & Martinez, 2013). Youth who are transitioning to middle school are becoming adolescents, and thus are more likely to challenge authority figures. (Losen & Martinez, 2013). The middle school years are a time of identity formation and realization.

Corprew and Cunnigham (2012) discuss a poem by Paul Laurence Dunbar titled "we wear the mask" the mask denotes the protective cover used by many urban males to hide the vulnerabilities associated with growing up in stressful contexts. These contexts may include many challenges (in addition to being an adolescent) like racism and discrimination, economic deprivation, and living in high-risk environments (mixture of family dynamics, crime, inadequate school structures, low number of positive influences)(Corprew & Cunnigham, 2012). Cassidy and Stevenson (2005) infer that many urban males employ "bravado attitudes" as a means externalizing rejection, sensitivity, and depression. Chronic poverty, unemployment, substandard housing, family instability, and exposure to violence are all factors that may impact their social and psychological worlds (Children's Defense Fund, 2004). During a professional development meeting in 2012, Dave Wilmes, Program Director for St. Paul Youth Services, identified "survival based" thinking as a way of seeing the world that has come to define the experience of many children growing up in urban communities. These are some factors in their lives:

- parent/care-providers who are not always available to support their children;
- unresolved trauma (significant loss, victim of violence, witnessing violence);
- unmet basic needs (food, shelter, clothing, etc.);
- uncertain futures: immediacy is the only time-frame considered;
- dangerous environments that may be physically threatening.

Beliefs of students with "survival-based" thinking often include:

- Individual needs trump group priorities (Take what you can now because there is never enough to go around);
- The system is corrupt, racist, and not a source of help (If you don't help yourself, no one will);
- Loyalty is extreme and granted only to a very close group of friends (Trust is not generalized or assumed);
- Choices are based on immediacy (The future is a luxury); organizational and follow through (time, things and processes) are not assumed;

- Respect from others is primary (Identity is defended and proven…never assumed);
- Posturing is constant (You can be no greater than how you allow others to treat you).

When one looks at all the factors that might be affecting students, it is easy to see how school might be challenging them.

Emdin refers to these children from a different light, he refers to a student modality as Hip-Hop their self-described identity or embodiment. In his 2010 book *Urban Science Education for the Hip-Hop Generation*, he explains that many urban youth are culturally immersed in a generally communal and distinctly hip-hop based way of knowing and being. He states that the shared realities that come with being from socioeconomically deprived areas brings urban youth together in ways that transcend race/ethnicity and embrace their collective connections to hip-hop. Throughout the book, Emdin discusses how many White teachers falsely interpret hip-hop as counter to the objectives of school. This perspective puts the traditional urban educator at odds with the students who walk through the doors. Teachers trying to be strict by only focusing on managing behaviors think they are doing what is best for urban youth but they are limiting the learning environment. These actions often stifle the thoughts and engagement of the very youth the teachers are trying to reach. Emdin states that students who are a part of a hip-hop way of knowing feel the effects of the negative ways they and their culture are portrayed and perceived. It is these feelings that affect their abilities to connect with a classroom and fields like science.

If teachers understand that many of the students who enter the urban classroom typically have identities that are different from their own, they will be in better positions to meet their students' needs. Building a community that meets the norms of its members' multiple perspectives will allow students to connect with science in a way that doesn't seem like they are giving up on their identify. A teacher who can accomplish this with students can then begin to work on rebuilding the social construction of students' identities. Often these identities do not correlate with doing science or being good at science,; they perceive science as for old, "smart" white guys wearing white lab coats.

**Social Construction of Black Inferiority**

Wallace and Brand (2012) argue that the root of the post-Brown versus Board of Education problem is the effect of the myth of Black inferiority on the perceptions of teachers and students, and how the problem impacts teaching and learning. (Wallace & Brand, 2012). Viewing children of color and poor children from a *deficit frame of reference* - one which inhibits cross cultural understanding and prevents teachers from being able to effectively interact with diverse students (Villegas & Lucas 2002). According to Wallace and Brand (2012), the depictions and characterizations of African Americans as intellectually inferior are ingrained in American society and perpetuated through the media and other social institutions so much that it has been imposed as part of African American identity. This identity, fueled by a legacy of racism, is part of the hidden curriculum that has shaped the plight of the twenty-first century African American student.

Early social constructs of African Americans portrayed them as physically gifted, lazy, happy-go-lucky, mentally incapable sexual predators due to genetics (Mutegi, 2012). According to Mutegi, a study 24 years ago reported that non-Black respondents regarded Blacks as less intelligent, less patriotic, and lazier than whites. 78% also believed that Blacks "prefer to live on welfare." More recent studies corroborate these sentiments. People of African ancestry are presented as inferior others across a broad range of social circumstances (e.g., they are improvident and do not plan, they are unpatriotic, and they are lazy); across a broad span of time (from at least the 16th century at least until 2012); by a broad range of academic disciplines (e.g., political science, theology, the natural sciences, and popular media); and for a broad range of reasons (e.g., genetics, psychology, culture, and upbringing)(Mutegi, 2012). This institutionalized identity of African Americans is a systemic problem to their success in education. Teachers, administrators, and counselors may sub-consciously or accidently further this system by not understanding the social constructs of the systems their students are coming from when they come to school. Conscious and unconscious stereotypes held by teachers and parents about students of color may lead to behaviors and interactions that discourage students from pursuing math and science and cause them to internalize negative stereotypes (Perry et al, 2012).

Mutegi (2013) challenges science researchers to think, “How does the image we hold of African Americans influence their science education?” Boys who are reared in communities plagued by poverty, limited opportunities, and high rates of incarceration enter the adult world economically and politically emasculated (Livingston and Nahimana, 2006). How can we expect our students to accept losing their identity or having their identity further exploited as other? Our children do not exist in a vacuum but are affected by the negative stereotypes and assumptions the dominant culture has about them (Livingston and Nahimana, 2006).

**Curriculum as Window and Mirror**

In the article “Curriculum as Window and Mirror”, Style (1988) tells a story of a boy who sees his uncle as a great man who he and his family were proud of; and shared stories with each other of this success and greatness. His perspective was challenged when his uncle passed by the boy’s school and his classmates viewed the uncle as some insignificant, lesser-than-them being. He could no longer see his uncle for who he was, only as others saw him that day. The problem Style brings up is that the boy’s narrative was not recognized; thus, others “see out his window.” The 'mirror' in Style's metaphor was the boy seeing himself in his uncle's image : if others saw the uncle as unfavorable, and if the boy is his uncle's nephew, then the boy, too, must be a lesser being. .

During students' education they do not need to see themselves in that mirror all the time. Likewise, a democratic school curriculum is unbalanced if a black student sits in school year after year and is forced to look through the window upon the (validated) experiences of whites while students of color seldom (if ever) have the mirror held up to the particularities of their own experiences. Such imbalance is harmful not only to black students, but also to white students whose view of humanity's different realities is profoundly obscured (Style 1988).

Wee (2012) discusses how it is one thing to ask teachers to elicit and work with everyday ideas the children bring to the science classroom; it is quite another to legitimize everyday ideas as windows into children's worlds, worlds where their ways of thinking and understanding are neither naïve nor inaccurate but a collection of meanings attributed to real events and phenomena encountered in their lives. The United Nations Children's Fund (UNICEF) (2002) declares that authentic child participation must start from children and young people themselves*, on their own terms, within their own realities* and in pursuit of their own visions, dreams, hopes, and concerns…authentic and meaningful participation requires a radical shift in adult thinking and behavior – from a world defined solely by adults to one in which children contribute to building the kind of world they want to live in (p. 5).

Science identity as described  by Carlone and Johnson (2007) is composed of three dimensions: competence, performance, and recognition. Mutegi points out that the role that science professionals play in limiting the access that Black Americans have to a science career, arguing that recognition emerges as the biggest dimension pointing out that sometimes it was not just feeling overlooked and neglected but were sometime outright rejected by science professionals. And still, 75% of all scientists and engineers in the United States are White and 60% are male (National Science Foundation, 2011). Moreover, the number of African American scientist holding a PhD is less than 2% and that number has changed little in 27 years (National Science Board, 2012). Science education research has been unable to explain what it is about being African American that leads a student to take fewer mathematics and science courses, or to be differentially influenced by mathematics and science teachers (Lewis, 2003). More than half of our society's population--all girls and boys of color--are trained in science by looking through windows at others who are viewed as the *valid* participants in science and through an exclusionary curriculum (perpetuated by the unaware teacher) that holds no mirrors for them to see themselves in science (Style 1988).

**Culturally Responsive Classroom Management**

Much of the literature to this point was about the student. Being a student-centered educator is what is needed to meet the needs of their students. "We perceive of culturally responsive science teaching as the integration of content, pedagogy, and knowledge of students into one cohesive framework where content refers to traditional science content, pedagogy refers to teaching methods and strategies, and knowledge of students constitutes the instructor's understanding of stu-
dents' cultural backgrounds as well as their learning styles and abilities (Horowitz, Domzalski, Elizalde-Utnick, 2018.)" The essential elements of culturally responsive classroom management (CRCM) were developed by Weinstein, Tomlinson-Clarke and Curran (2004). and contain a five-part concept of CRCM: recognition of one's own

cultural lens and biases; knowledge of students' cultural backgrounds; awareness of the broader social, economic and political context; ability and willingness to use culturally appropriate management strategies; and commitment to building caring classroom communities. The goal of CRCM is to create an environment in which students behave appropriately from a sense of personal responsibility, not from a fear of punishment or desire for a reward. As such, the environment must acknowledge and be responsive to who the students are (cognitively, socially, and emotionally), and create a safety net that responds to them equitably.

Students are more likely to succeed if they feel connected to school; a positive, respectful relationship with teachers helps create such an environment. Poor classroom management threatens school connectedness because a poorly managed classroom cannot provide a stable environment for respectful and meaningful student relationship (Blum, 2005.) To foster this type of relationship with students, teachers can do a few simple things: greet students with a smile and kind comment at the door, ask for feedback, initiate conversations about students' lives outside of school, and be aware and visible (Mcglynn, 2018.)

**Using Citizen Science and Student-Driven Investigation**

"Citizen science" is a term used to describe scientific experiments that use people without formal scientific training to collect the data (or, in some cases, mark up already collected data) needed for the experiments (Scripa & Moorefield-Lang, 2013). The benefits of citizen science programs in developing student achievement and career motivation align with social cognitive career theory, which examines how the interaction among the individual, behavior, and environment affects overall performance within a particular context (Zimmerman & Schunk, 2003.) Specifically, citizen science programs that encourage volunteers to collect data to assist scientists in studying population trends across a large geographic span (Snäll et al., 2011) afford unique opportunities to refine scientific skill sets with modeling, immediate feedback, and problem-solving relevancy. An underpinning of citizen science programs is the use of scientific observation skills to collect information for professional databases. These skills require refinement by way of field expert modeling in order to generate viable data points (Hiller & Kitsantas, 2014). An advantage to providing students an opportunity to participate in citizen science programs as part of a formal school program is that individuals have an opportunity to heighten scientific interest, participate in purposeful activities, and develop identities as capable members of a scientific community (Michalchik & Gallagher, 2010.) Citizen science projects can be effective ways to teach science by allowing students to be scientists while working with relevant data to explore real-world problems (Brunvand & Bouwman, 2018).

**Restorative Practices and Restorative Circle in the Science Classroom**

Restorative Practices are a framework for building community and for responding to challenging behavior through authentic dialogue, coming to understanding, and making things right. Restorative practices cultivate a culture in which everyone feels like they belong. They build a particular sense of community in which every member--students, teacher, parent volunteers, aides--feel that they are *seen, heard*, and *respected ( San Francisco Unified School District, 2013).* Restorative responses to misbehavior can take a variety of forms that are centered on several core principles: 1) focus on relationships first and rules second; 2) give voice to the person harmed and the person who caused the harm; 3) engage in collaborative problem-solving; 4) enhance personal responsibility; 5) empower change and growth; and 6) include strategic plans for restoration/reparation (Amstutz & Mullet, 2005). The cumulative effect of these strategies is to offer students, teachers and administrators the possibility of a dignified response to misbehavior and a way to make amends and repair the harm caused (Schiff, 2013). A restorative practices circle has a general purpose of creating a space and process where all voices can be heard. There are multiple forms that a circle practice may be implemented into a classroom: community building circle, responsive circle, harm repair circle, fishbowl circle, feedback circle, spiral circle, wheelhouse circle, and small group/student lead circle.

**Shared Responsibility for Classroom Community**

Creating a sense of shared responsibility for the classroom is a key component to getting all students engaged in the classroom. In order to understand the importance of shared responsibility to student engagement, it is important to understand role the brain plays in student feelings of safety. According to Hammond (2015),

> [t]he brain takes its social needs very seriously and is fierce in protecting an individual's sense of well-being, self-determination, and self-worth

> along with its connection to community. We cannot downplay students' need to feel safe and valued in the classroom. The brain will not seek to connect with others if it perceives them to be threatening to its social or psychological well-being based on what they say and do.

It is important for the teacher to recognize that without students' feeling safe, building a classroom community with be extremely difficult. Christopher Emdin (2016, p.107) suggests one of the first things a teacher needs to do in the school year is to identify the possible roles that everyone who comes into the classroom can take on to help it function properly. This includes roles tied to classroom learning, as well as those related to social, emotional, and physical functioning of the classroom. He states that these "non academic" responsibilities are just as important as those involving learning content. Emdin refers to these classrooms as *cosmopolitan classrooms* which are spaces where each student is a full citizen, responsible for how well the class meets the collective academic, social, and emotional goals. The shared responsibility of the classroom community should allow for all students to feel part of classroom and take ownership for the ongoings of the class. Unfortunately, traditional views of science teaching position the teacher as the central classroom authority and view science learning as transmission of theory and logic, or an accumulation of knowledge, rather than a negotiation of content and shared norms (Stroupe, 2014.)

**Teachers and Cultural Competence**

A teacher is students' access point to the curriculum. When the science teacher does not look like the majority of their students and has not lived a similar life, a rift may occur. Weisman and Garza (2002) found that after taking one multicultural education course, pre-service teachers overall had a positive orientation to diversity; however, most did not have an understanding of oppressive systems entrenched in society and their potential for negatively influencing the educational outcomes of students of color. The emphasis of multicultural education was redirected from social issues to celebrating all ethnic cultures by teacher educators. These trends toward inclusiveness minimized the emphasis on race in the definitions of multicultural education, yet the historical events that defined race relations in American society created inequities that elusively plague today's schools. (Wallace & Bland, 2012).

The introduction of pre-service teachers to concepts of multicultural education may be positive, but teachers with only limited background information about diversity still lack knowledge about factors influencing schools as an enterprise within society: school reformation, educational equality, and institutional change (Sleeter, 2001). Culturally responsive teachers need much more than simply awareness and appreciation for cultural diversity; they must have sociocultural awareness, an affirming view of students; constructivist views about teaching and learning; instruction that builds on what students already know while stretching them beyond the familiar, and familiarity with students' prior knowledge (Villegas & Lucas, 2002)

Irvine (2002) notes that teachers operate from their own personal frames of references. Thus, their beliefs and interactions with students are based upon how the world makes sense to them, which is based upon their individual and personal histories (Irvine, 2002). Mutegi (2012) finds that, while science education researchers position themselves in the midst of African American places (schools, neighborhoods, and communities); shoulder to shoulder with African American participants (in the form of students, parents, and teachers); face to face with African American problems, yet blind to the racial implications of those places, participants, and problems. Science education researchers fail to account for the very characteristics that make the group distinct. In order to be socioculturally grounded, explanations for current social conditions must give priority to the historical enslavement and colonization of African people as the most important sociocultural feature of current African American existence (Mutegi, 2013).According to Johnson (2011), “the majority of practicing science teachers today have not been prepared to adequately address diversity and issues of equity within their classrooms” (p. 172).

Teaching science to build scientific literacy, therefore, requires all perspectives (no matter how different or unlikely) to be recognized and validated. With this in mind, science teachers should not be held to traditional roles as knowledge providers but, instead, become social developers, guiding children and themselves to establish connections between what is experienced in the world and science content (Wee, 2011). Preparing science teachers to challenge their own practices and develop culturally relevant pedagogy is difficult because the identities of teachers, students, and the school community intersect in ways that make classrooms sites of cultural reproduction that resist change (Levinson et al., 1996).

## Summary

At the depths of the research question is the identity of the student and how it interacts with the teacher's identity. This study hopes to provide insight into how to make the transition from a teacher with fairly limited knowledge of his students' identities and experiences within his classroom to a more versed, culturally responsive teacher. The transition will begin with validating the perspectives and identities in the classroom, then move into the curriculum by reflecting the identities of the students in the room.

# CHAPTER THREE

## Methods

### Research Question

In the previous chapter, a multitude of challenges for the middle school student and science teacher were presented. The research project strives to answer the overall question of *how to engage all students to succeed in the middle school science classroom*. Typical science classroom where strict procedures, safety guidelines, quietness, and cookbook labs are the tradition do not fully supports students' learning or align with their cultural norms. The science classroom is where this "rubber meets the road" friction between middle school students on the one hand, and their science teachers on the other. How can the classroom capitalize on, for example, hip-hop oriented pedagogy and still be attentive science skills and safety? Emdin (2010) states that lower achievement is not solely related to factors of fewer resources, more inexperienced teachers, or lower funding, but is rooted in the differences between the cultures of most science teachers and their students (Emdin, 2010). In order to bridge these differences, the teacher will need to embody the meaning of culturally responsive teaching throughout all aspects of her or his practice. This study looks to involve the three daily participants in the science classroom: the students, the teacher, and the curriculum. All play a pivotal role in the success of each other. Academic performance is one statistic that measures the success of all students in the science classroom, so too do the daily interactions of the teacher and all of the students in the classroom. The goal will be to engage all students in science by embedding culturally responsive teaching within the curriculum, norms, and routines within the classroom.

## Setting

The researcher will collect data at an urban middle school in the Midwest. The researcher teaches mainly 7$^{th}$ grade students who are in their second year at the school. The majority of all 7th graders will attend the middle school for all three grades. Demographically, this Midwestern urban school has over 700 students, approximately 35% of whom are White, 30% African American, 18% Asian American, 16% Hispanic, and 1% Native American. From a socioeconomic status standpoint, the school ranges from very affluent to impoverished, with about 63% of the students qualifying for free/reduced lunches. The school is strongly supported by the community with heavy parental involvement especially from those living in the school's neighborhood; however, the involved parent group does not mirror the diversity of the student body.

The teacher is in his 3$^{rd}$ year as an educator at the school. The classroom is an outdated science room with sinks that don't work and drawers that don't open. While there are (seven) separate lab stations, the sink and faucet in the center of each station makes them not very conducive to a lot of the group work that needs to go on at them.. Moving around the room is challenging due to the need for many desks and the awkward layout of the lab stations.

## Curricular Guides

### Unit Planning: Understanding by Design

The Understanding by Design® framework (UbD™ framework) offers a planning process and structure to guide curriculum, assessment, and instruction. Its two key ideas are contained in the title: 1) focus on teaching and assessing for understanding and learning transfer, and 2) design curriculum "backward" from those ends (Wiggins & McTighe, 1998). The UbD framework offers a three-stage backward design process: first determine objectives based on standards; second, write assessments; third, design learning activities. A key concept in UbD framework is alignment; all three stages must clearly align not only to standards, but also to one another. In other words, the stage one content and understandings must be what is assessed in the second stage of planning and what is taught in the third (Wiggins & McTighe, 2011).

### Minnesota State Standards

The introductory unit that is the focus of this project will center on engaging students in scientific inquiry. Specifically, it addresses Minnesota State Science Standard 7.1.1.2 "The Practice of Science" in the middle school *Nature of Science and Engineering* standards:

STANDARD 7.1.1.2 Scientific inquiry uses multiple interrelated processes to investigate questions and propose explanations about the natural world.

This standard includes these benchmarks:

7.1.1.2.1 Investigation Methods

Generate and refine a variety of scientific questions and match them with appropriate methods of investigation, such as field studies, controlled experiments, reviews of existing work and development of models.

7.1.1.2.2 Controlled Experiments

Plan and conduct a controlled experiment to test a hypothesis about a relationship between two variables, ensuring that one variable is systematically manipulated, the other is measured and recorded, and any other variables are kept the same (controlled). *For example:* The effect of various factors on the production of carbon dioxide by plants.

7.1.1.2.3 Scientific Conclusions

Generate a scientific conclusion from an investigation, clearly distinguishing between results (evidence) and conclusions (explanation).

7.1.1.2.4 Evaluating Explanations

Evaluate explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, and suggesting alternative explanations. (Minnesota Academic Standards, 2009).

**A Framework for K-12 Science Education**

In alignment with those benchmarks, the unit also is guided by the scientific and engineering practices as laid out in A Framework for K-12 Science Education (National Research Council, 2012). The Framework identifies the following eight practices to be essential elements of the K-12 science and engineering curriculum:

1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations (for science) and designing solutions (for engineering).
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

**The 5 Model**

The 5E model stands for engage, explore, explain, elaborate, and evaluation. The model creators had these things in mind; to begin with an instructional model that was research-based, realized that the constructivist view of learning required experiences to challenge students' current conceptions (i.e., misconceptions) and ample time and activities that facilitated the reconstruction of their ideas and abilities, provide perspective for teachers that was grounded in research and had an orientation for individual lessons, and tried to describe the model in a manner that would be understandable, usable, and memorable for teachers (Bybee, 2014). The 5Es model is based on the psychology of learning and the observation that students need time and opportunities to formulate or reconstruct concepts and abilities (Bybee, 2014). In Figure 1 you can see how Bybee (2014) explains each aspect of the 5E model.

**FIGURE 1.**

Summary of the BSCS 5Es instructional model.

**Engagement**
The teacher or a curriculum task helps students become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.

**Exploration**
Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions, and design and conduct an investigation.

**Explanation**
The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. In this phase teachers directly introduce a concept, process, or skill. An explanation from the teacher or other resources may guide learners toward a deeper understanding, which is a critical part of this phase.

**Elaboration**
Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept and abilities by conducting additional activities.

**Evaluation**
The evaluation phase encourages students to assess their understanding and abilities and allows teachers to evaluate student progress toward achieving the learning outcomes.

## Prior Knowledge and Formative Assessment

Students enter the classroom with a wide range of past experiences and knowledge. To get a better understanding of what students already know, think, and can do, teachers should use formative assessment to probe student thinking (Keeley, 2008). All students are shaped by their cultural backgrounds, which in turn affect how they think about phenomena and influence their beliefs about “doing science.” Keeley (2014) notes that to acknowledge and respect the students who come from different cultures, names in the probes should be changed to reflect the students’ cultures. This small but important change helps students recognize that students of all cultures, including their own, think and talk about their scientific ideas (Keeley, 2014). Scientific words and patterns of discourse can be new to English-speaking students as well as those whose primary language is not English. For that reason, formative assessments should avoid the use of technical terminology and use contexts that are familiar to students in their everyday lives.

## Summary

As I move into writing the curriculum unit for this project I am reminded of the basis and purpose for this project. My goal of writing an opening week curriculum that is culturally relevant to all of my students. The curriculum will incorporate the five tenets of culturally relevant pedagogy, use the minnesota science standards & the Framework for a K-12 Science Education to guide the lesson objectives, and apply assessment strategies to ensure student understanding.

# CHAPTER FOUR

## Curriculum

### Target Audience

The target population for this curriculum is middle school science students in grades 6-8. The curriculum is intended to be used at the beginning of the year as a way for the teacher to start building community and engagement in the science classroom.

### Curriculum Design

The unit was designed using the frameworks and guidelines of the 5E lesson design model and contains 11 lessons. The lessons are designed for a 50 minute class period and could be altered to fit other time structures. Each lesson has a variety of activities and parts that work together to build community, allow students to derive and answer their own questions, and create opportunities for the teacher to learn more about each individual student. The lessons are designed to be sequential; however, some parts may be flexible. The lesson plans have been put into the 5E format (see Table 1) borrowed from Hu et al (2017).

Table 1.

| Phase | Requirements and key points of instructional process design |
|---|---|
| Engagement | Creating a scene to promote student curiosity |
| | Eliciting students' prior knowledge |
| | Creating students' cognitive conflicts |
| | Organizing students' thinking and finding problems to explore |
| Exploration | Providing students with a common base of activities |
| | Initiating of activity by teacher and allowing students time and opportunities to investigate |
| | Probing questions when necessary, and guiding students indirectly |
| | Creating a sense of "wanting to learn" and giving students time to raise questions when exploring |
| Explanation | Encouraging students to discuss and analyze the process themselves |
| | Asking students to provide explanations about new concepts |
| | Introducing (by the teacher) of scientific or technological explanations in a direct, explicit, and formal manner |
| | Using student experiences as the basis of explaining new knowledge |
| Elaboration | Creating new and unfamiliar problem situations for student applications |
| | Encouraging students to participate in discussions for strengthening the understanding of new knowledge |
| | Guiding students to analyze problems from multiple angles and expanding new knowledge |
| | Guiding students to summarize the corresponding knowledge, processes, and methods |
| Evaluation | Allowing the students to reflect and evaluate their own knowledge and skills when learning |
| | Observing and evaluating the students' new knowledge and skills |
| | Assessing students' knowledge and skills and giving them suggestions |
| | Evaluating the students' gradual development of understanding in every teaching phase |

## Unit Plan

### Outline

| Lesson # | # of Class Periods | Learning Target(s) | Activites | Description | Assessment |
|---|---|---|---|---|---|
| 1 | 2 | Students will be able to make observations.<br><br>Students will be able to classify observations as qualitative or quantitative | Class Bingo<br><br>Demo Observation Days<br><br>Observation Game<br><br>Compass | Various science demonstrations | Day 1: Students share their observations upon returning to their pods. Teacher listens to students during their sharing to assess their understanding of observation. |

| | | | | | |
|---|---|---|---|---|---|
| | | | Partners | | Day 2: Teachers is wandering room observing what students are underlining and circling. Reteaching where necessary |
| Lesson # | # of Class Periods | Learning Target(s) | Activities | Description | Assessment |
| 2 | 1 | Students will be able to infer based on an observation. | Demo Inference Day and Demos<br><br>2 Truths and a Lie | Students make predictions and inferences related to the demonstrations | Share out an inference from the lab (one per table group) |
| 3 | 1 | Students will be able to locate important things in the classroom<br><br>Students will be able to share information about themselves with the teacher. | Room Scavenger Hunt<br><br>Self Interview | Students fill out bio about themselves as a scientist | Learning Circle:<br>Round 1: Students will share one item they think they will never use again the rest of the year.<br>Round 2: Students share what they like about the class so far and why.<br>Round 3: Share your answer to what would they like to see changed |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | going forward and why. |
| 4 | 1 | Students will be able to describe a scientist that matches their interests | Research a Scientist<br><br>Quizlet: Signup and View Scientists | Students explore their interests and identify scientists that are similar to their interests. | Students will compare the facts learned about their type of scientist with peers.<br><br>Students will share their reasoning why this type of scientist interests them. |
| 5 | 1 | Students will create a visual and biography of themselves as the scientist of their choice.<br><br>Students will be able to participate in a community building game: Controller | Me as a Scientist<br><br>Team Building: Controller | Students create a bio of themselves as a scientist either current or a future version of themselves. | Students will share what their scientist is currently working on in small groups. |
| 6 | 1 | Students share responsibility for the classroom community | Classroom Jobs<br><br>Pollinator Walk and Question | Students share responsibility for classroom Students work to identify questions | Testable question from "Elaboration" phase. |

| | | | | | |
|---|---|---|---|---|---|
| | | with rotating jobs.<br><br>Students will be able to identify a testable question. | Parking Lot. Classifying Questions | related to pollinators to share on post-its. | |
| Lesson # | # of Class Periods | Learning Target(s) | Activites | Description | Assessment |
| 7 | 1 | Students will be able to identify "good" scientific questions. | Writing a "Good" Question<br><br>Scientific Question Notes | Students will be able to identify a "good" scientific question. | Students will reevaluate their groups' question from the previous lesson. Once their question is revised they will exchange their question with another group to judge against the criteria of a "good" question. |
| 8 | 1 | Students will be able to write a procedure to investigate their group's "good" question. | Choose Group Question and Write a procedure | Students will write a procedure to investigate their group question. | Students will run a test of their procedure and edit to improve the procedure to match what they were investigating. |
| 9 | 2 | Students will create a data table to | Making a Data Table | Groups create a data table | The teacher will be able to notice if each groups |

| | | | | | |
|---|---|---|---|---|---|
| | | match their investigation. | and Collecting Data | Groups Collect Data (at least 3 trials) | data table matches their investigation. If they notice a data table that needs editing they will let the group know. |
| 10 | 1 | Students will be able to use an appropriate statistical test. | Analyzing the Data, What does it mean? | Students will practice analyzing data techniques then apply those skills to their collected data. | Teacher is watching throughout but will know if students used the analysis correctly if they are talking about significant p-values of 0.05 or less. |
| 11 | 2 | Students will be able to communicate the results of their investigation | Group Poster<br><br>Poster Session | Groups will finish their tracking sheet and prepare to share it by assigning roles.<br><br>Groups share their investigation to peers and will prepare an inquisitive question for each group. | The teacher will listen and watch for understanding and will check for completion of investigation sheet.<br><br>Students will also complete a reflection sheet about how they worked in a group. |

**Content of Lessons and Possible Considerations.**

**Lesson 1.**

This lesson is meant to kick the school year off. Students will start doing science on the first day of school. Often the first day is filled for students with class after class of going over the syllabus and classroom expectations. Students will come in and sit in their pods (a grouping of desk that students are assigned to). In my room the pods are labeled by parts of the city the students are familiar with, tying in the sense of place versus "group 1" or "group B." This lesson begins getting the students to make observations (what do you see, hear, smell, etc.). After some short review of observation , students head to stations where they observe the demonstration equipment for the 3 chosen demos (see Appendix). All materials are set out on a tray for students to observe and students record their observations on their worksheets. When done with three rotations, students head back to their pods to share some of their observations with their neighbor. Students will next test out their observation skills during an observation game. In order to start building some community, the students to play classroom bingo where students have bingo cards that have various things like "walked to school today" or "plays a musical instrument." The students are forced to talk to peers to learn different things about them. I have small prize for three single bingos, three double bingos, and two middle square or big square bingos.

On Day 2, students will start out by answering the "Do Now," "What was your favorite part of yesterday's class? What are you looking forward to today?" Following that, students will take some short notes on Quantitative and Qualitative Observations. After notes, they will head back out to add quantitative and qualitative observation details to their worksheets. Once the station rotations are complete, students return to their desk for a "Turn and Talk" to quick refresh and clarify the meanings of qualitative and quantitative observations. Students will then go through their worksheets underlining their qualitative observations and circling their quantitative observations. Next, I will pass out compass partner sheets. I tell the students that they get to pick (N, E, W, & S) and I will assign their (NE, SE, NW SW). I make sure that if Student A has Student B as their "North" partner, that Student B has Student A as their "North" Partner. I then them all so that I can add the other partners. They will get them back soon to tape in their notebooks.

**Lesson 2.**

During the second lesson, students will be able to explain and make inferences. As students enter, they will grab a notecard for the community-builder "Two Truths and a Lie." After the "Do Now," the students will take notes on inferences. Following notes the teacher will collect the notecards and begin to play the game with students. There is only time to do two-three students today, but I hang on to the rest of the them until all students/adults in the class have been identified. This game allows students to make inferences about their peers while they guess who's card it is. Once they figure out whose card they can begin asking questions to figure out which ones are the truths and which is the lie. This allows for students to share but only what they are comfortable with.

The teacher will then demonstrate the stations (due to safety concerns/lack of time to have all safety contracts in). While the demonstrations are going on, the students record their observations. Then, the students move into groups to make inferences about how the demo worked. Students might make inferences like, “He blew the candle out when we weren’t looking,” even though I make it very obvious that my mouth is closed and directed away from the candle. Students will share out their inferences for their favorite demo.

**Lesson 3.**

The third lesson is focused on getting to know the students and for them to get to know the classroom. Class is started out with students thinking about questions they would like to know about the teacher. The teacher will use an online random number generator to select students (I number the desks prior to the first day to help students find their seat the first day) to ask him questions (which he then answers). This sets the tone for the relationship, that it is okay to share information with each other. Then the lesson transitions to the room scavenger hunt. The teacher can give clues, I allow for one free clue after that I use a “fee” for doing so, like requesting the student sing you a line or two from a song or a physical activity like jumping jacks. The first three to complete it get a “fabulous prize” (mechanical pencil or cool folder). The focus is less on the competition aspect and more on the fact that everything on the sheet could be meaningful to them at some point during the school year. At the end of class, I go over what "learning circles" are and the guidelines for learning circles. A learning circle is similar to a community building or restorative circle except that the prompts are related to the content and students share what they know and think related to the prompt. In this first circle, I prompt the students to share the item they thought was going to be most important to their school year from the scavenger hunt. The second prompt is related to have students share what they like about the class so far. Followed by the third prompt of what would they like to see changed going forward. I tied this in to incorporate student voice and Emdin's (p.109. 2016) cosmopolitanism.

**Lesson 4.**

In Lesson 4, the students are being asked to start to see themselves as scientists. This is the first day that I require the students to have their notebook or I help them get one. As they enter the room they will pick of a Goal and Problem of the Day (POD) Sheet that will get taped in their notebooks each week. This is when I have students add their name to a popsicle stick. I model the job of POD (person who pulls sticks to read the goal, POD, and 3-5 more sticks to hear their peers answers). During this lesson their task will be to explore their interests and see what scientists investigate things similar to their interests. They will also spend some time on quizlet.com looking at flashcards about different scientists and what they do. Students will record three facts about one type of scientist to finish the worksheet. They will share with a neighbor what scientist they have similar interests to and explain their reasoning for picking that type of scientist.

**Lesson 5.**

During this lesson, students will take what they learned during Lesson 4 and create a biography of themselves as a scientist.  Students can choose to complete this as a current biography or as some future version of themselves.  Students should take their time, shading and coloring their pictures.  The biographies will be posted in the classroom for all to see.

Following the biography postings, the class will play the team-building game, “Controller.”  This game works on observation and movement.  The class sits in a circle. One volunteer--the “detective”-- steps outside the classroom.  Inside the classroom the circle will pick one “controller” to follow.  All students should be following the movements of the controller--though looking all around the room to help conceal the controller’s identity.  The detective is asked to come in and gets three guesses as to who the controller is.  Once the controller is identified, they become the detective and a new controller is determined once the detective leaves the room.

**Lesson 6.**

The lesson starts off with students thinking about questions and why scientists ask them.  The teacher should emphasize that asking questions is fundamental to science and they way of understanding natural phenomena.  The goal is to get students to start asking questions about the world around them.  The class will go on a walk to take observations and ask questions about those observations. The walk helps them make observations that can lead to questions that a student-driven investigation can attempt to answer.  Upon returning from the walk, students will write down “wonderings,” which are the things they noticed and have further questions about--two to four per student--each on a separate sticky notes.

Following the collection of “wonderings,” students will learn about the types of questions they will soon classify the post-its into. Students will get into groups and sort the sticky notes into one of four categories: “look it up,” “not answerable,” “testable but not practical,” and “testable.” The teacher will supply a few questions to guide the whole class through to ensure understanding of the task. After the sorting, the groups will look at the remaining testable questions and choose one to investigate (or write a testable question they are interested in). Once they have a question they think is testable, the students should submit it to the teacher for feedback and approval.

**Lesson 7.**

During this lesson, students will explore scientific questions and have a better understanding of what a “good” scientific question means. They watch a TEDx Talk on YouTube (Talks, 2013) that is intended to inspire the students to realize that many discoveries started with wonderings and asking questions. They will also work independently on some sample problems, using the criteria to determine if a question is “good.” Students will evaluate the question from the end of Lesson 6 and incorporate any suggestions from the teacher. After updating and checking their own question against the criteria, they will exchange with another group of students to check to see if each other’s question fits the criteria of a “good” scientific question.

**Lesson 8.**

The focus of this lesson is to get the students to write a procedure that matches their group question. The procedure is not the overall focus--investigating a student-driven question is the focus--but the procedures still need to have some quality to them. Groups will write their draft procedure and then run a pilot trial to see if they all understand what they are doing. After the pilot, they will edit the procedure to implement over the upcoming lessons. Groups should fill in the steps completed onto their investigation sheet.

**Lesson 9.**

This lesson is for two days and involves the data collection. Students should be reminded that the more replication they have of their investigation, the better support of outcomes they will have. Students would begin to put data into a data table after discussing and sharing.. Students will look at some sample data collection sheets and data tables; ideally, these would be from professionals that collect data in the field of their investigation.

**Lesson 10.**

During this lesson, students will be learning to statistically analyze their data. They will be using websites to enter data on a few statistical tests that might be common to student-driven questions. Once done learning how to use the sites, groups will decide which statistical tests are best for their investigation and implement the analysis.

**Lesson 11.**

This is the final lesson in this unit and it culminates in each group communicating their investigation and what they found.  Students look at scientific studies to find communality with the sections. The teacher will review with sections to show and provide an example of a finished presentation slide. Students will finish up their group investigation sheet and prepare a single slide presentation to present to the class.  Groups will want to assign each section to involve all members of the group.  While groups are presenting, the listening groups are recording their noticings and wonderings.

# CHAPTER FIVE

## Reflection

### Affordances

In order to create this plan it helped that I am a passionate and driven educator. I care a lot for my students and I work hard to try to present the most culturally relevant curriculum, teacher, and classroom I can. I value the ways I was educated and came into a love for science but I also value that there are many truths about science and education, knowing that multiple perspectives is an opportunity to learn more about myself and my students. I have a vision about what learning in my classroom should look like and I strive to bring that vision into a reality for my students. The vision includes a vibrant dialogue about the content. Students are able to question and discuss with each other in respectful and informed ways. As the teacher, I am often learning new things as these inspired young scientists dig deeper and share their new knowledge. Past students come back to visit reminiscing about the authentic experiences we had in lab or during student-driven investigations. They then share about their excitement about being accepted into the college program (science related) of their choice. We take a walk to check out the different student-driven projects that came to life in the years they were here and since: pollinator gardens throughout the school grounds; our outdoor classroom at a local park where students can see aspects of Minnesota's Biomes, including the recently student-designed stormwater rain garden; the small pear and apple orchard; the student cared-for vegetable garden. As we pass the solar arrays, I get punched in the arm as they say " Wow, you finally did it. After all those years of sharing your dream, you made it happen." We chat a little more but they share a general message of before being in my class, not seeing science as an option for themselves.

They could see themselves in what I was teaching them. That changed it all for them and they hope someday they can do that for their students.

This project would not be possible without the supportive administrations I have had at my school. The trust that I have always had the best in mind for my students and has led me to get approval to take professional development courses that allowed me to experience a wide variety of influences that appear in this curriculum plan. I do believe that if I didn't have such a supportive and encouraging administration, I would not have experienced the professional development that I have.

My peers in the Science Department have been very supportive in encouraging me to take the professional development I am interested in. The staff have mentored me to dream and showed me how to make some of those things realities. The department is willing to try things and make student-driven decisions. It has been rewarding to see my colleagues try some of my ideas and find success. They have also given me feedback about challenges they have had or different ways they implement strategies.

## Constraints

The hardest part of putting this plan together was keeping the focus as I continued to grow and learn. I love to bring new things to my school and sometime find myself over-extended. This year I started a new FTC robotics team to the school, in addition to coaching lego league, co-leading National Junior Honor Society, serving on the Wolf Ridge and Restorative Practices committees, participating in Minnesota Trout Unlimited Trout in the Classroom, partnering with the Twin Cities Raptor Center, working to bring in Classroom Partners from the University of Minnesota into my classes, creating a new elective Citizen

Science, and trying to coordinate a second pollinator garden. It is part of my personality I have to keep in check but it is all about trying to create opportunities for my students.

My classroom is a very old, designed for high school chemistry. The structure of the room makes it difficult to do grouping and also allow students to not feel cramped or clustered. This added stress makes it difficult for students to feel apart of the classroom and resistant to learning in my room. I would love to remove some of the fixed lab tables and replace with more mobile and flexible seating lab tables.

Finding culturally relevant materials and resources can be very difficult. The presence of mainstream culture throughout education appears to leave little room for teachers like myself to gain access to cultural collateral that would be positive in my classroom. I can't go out and purchase a book with culturally relevant material for all lessons I might want to teach.

**Where to?**

I have several things I want to get to in the future. I would like to get to where most of my lessons are self-paced, allowing me to take on much more of a "guide on the side" rather than "sage on the stage" role. I want to continue to look at Emdin's Cosmopolitan Pedagogy and try implement aspects like his Cogen (co-generated group of students created to impact teaching practices). I think this unit is step towards starting the year out being more culturally relevant that I had been. I have been looking into MNSTeLLA, a Professional Development about storyline and lesson analysis. This Professional Development interests me because it relates science to storytelling and focuses on lesson summary, which has been an areas of growth for me. I want to take what I have learned and continue to integrate them into everything I do in the classroom because I want to see all of my students be successful in science.

## Wrap-Up

My mentor teacher often says, “ I want to be like you when I grow up.” This always brings a smile to my face because they have showed me the way. Getting to where I am now has been a long journey, but looking back, I am now a much more well-rounded and prepared teacher. I do still have challenges, but they are different and the students seem to be responding positively to the changes I have been making based on my research for this project. I don’t think I imagined myself as the teacher I have become, but I didn’t know about teaching this way when I was a student. I hope that the work I put in inspire students to pursue science and possibly teaching science. I hope that I can inspire a student to be the teacher my life experiences couldn’t offer them, someone who can close the gaps between peers and change who is represented in education.

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**APPENDIX**

**Lesson Plans**

**Lesson 1**

**Subject / grade level: 7**

**Materials:** Classroom bingo cards (1 for each student )and Prizes for each class.
Demo Stations Packets for each student, 6- demo stations (2 of each, go 1, 2, 3, 1, 2, 3 not 1, 1, 2, 2, 3, 3)

**Lesson objective(s):**
Students will be able to make observations.
Students will be able to classify observations as qualitative or quantitative

**ENGAGEMENT**

Day 1:
Make at least 5 observations (what do you see, hear, smell, etc.): "I observe…"
-share out with pod groups
Last 10 minutes of class – Community Building Classroom Bingo

Day 2: What was your favorite part of yesterday's class? What are you looking forward to today?
Last 10 minutes of class -- Compass Partners (student choice -N,E,W,S)
(teacher choice -NE,SE,SW,NW)

- make sure students get that each directional partner should match meaning that if student A has student B for North Partner that Student B has Student A down for North also.
- No repeats.

**EXPLORATION**

Day 1: Demo Lab Station Rotations – Sketch and Label each station

Day2: - Brief Notes on Quantitative and Qualitative Observations
-Demo Lab Station Rotations – Add details including quantitative and qualitative observations

**EXPLANATION**

Day 1:
- Students will share examples of observations in the science classroom.
- Observation NOTES

Day 2: Turn n Talk: -Partner A listens while Partner B explains what qualitative means for 30 seconds.
-Partner A repeats what B said and confirms or offers an alternate definition.
-If definitions are different, discuss to reach agreed upon definitions.
- Partner B listens and Partner A Explains what qualitative means for 30 seconds

| |
|---|
| - Partner B repeats what A said and confirms or offers an alternate definition<br>-If definitions are different, discuss to reach agreed upon definition. |
| **ELABORATION**<br>Day 1: Teacher listens to Turn n Talk to identify understanding of observation<br>Day 2: Students will underline their qualitative observations and circle quantitative observations on their observation sheets. |
| **EVALUATION**<br>Day 1: Students share their observations upon returning to their pods. Teacher listens to students during their sharing to assess their understanding of observation.<br><br>Day 2: Teachers is wandering room observing what students are underlining and circling.  Reteaching where necessary |

Demonstration Stations Name: ___________________

Station #1:

______________________________________________________________________

| | |
|---|---|
| **Observe:** materials | **Describe:** after demonstration |
| **Predict:** | **Infer:** Why |

Station #2:

______________________________________________________________________

| | |
|---|---|
| **Observe:** materials | **Describe:** after demonstration |
| **Predict:** | **Infer:** why |

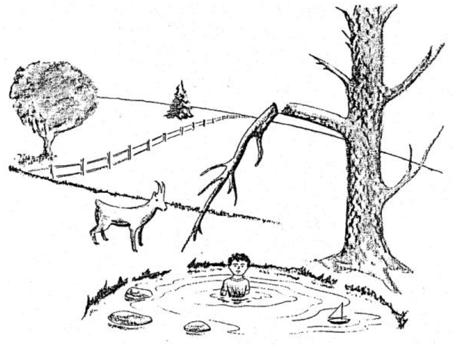
Station #3:

______________________________________________________________________

| | |
|---|---|
| **Observe:** materials | **Describe:** after demonstration |
| **Predict:** | **Infer:** why |

**Lesson 2**

| **Subject / grade level: 7** |
|---|
| **Materials: Demo Materials,** |
| **Lesson objective(s):**<br>Students will be able to infer based on an observation. |
| **ENGAGEMENT**<br><br>**Show picture in "Problem of the Day" and have students write down answers**<br><br><br><br>What is this boy looking at? How do you think he feels?<br><br>What probably caused the window to break?<br><br>Who do you think did this?<br><br>Later in the lesson Following notes : Students write 2 truths and 1 lie on a notecard with their name on the back. Students try to infer who the student is. Once they figure it out. They guess which one as the lie and then the student shares revealing a little about themselves to the class. |
| **EXPLORATION**<br>- Goat Image Inferences |



Source: https://middleschoolscience.com/2015/06/25/boy-in-the-water-observation-vs-inference/

Students will make predictions about what they expect to happen during the demonstrations on their student worksheet.

Demonstrations:

1. CO2 & Candle: pour vinegar into baking soda in a small beaker or pitcher. For added amusement pour the “nothing” into an empty beaker. Then Pour the accumulating CO2 down onto a lit candle (it extinguishes). https://www.stevespanglerscience.com/lab/experiments/co2-extinguisher/

2. Egg in a bottle: place lit paper in erlenmeyer flask, then put moist hard-boiled egg on top of flask (eggs is pushed into flask). https://www.stevespanglerscience.com/lab/experiments/egg-in-bottle/

3. Coffee mug tied to a string with washers tied to the other end: use finger, ring stand with bar or lab apparatus to give you a horizontal bar. Lower the cup to show students the string is longer than the height between the bar and the table. Raise it up until the cup is at the bar, the string should be leaning back towards you slightly. Let go of the washers and watch them wrap around the bar before the mug can break (use a plastic mug just in case)
https://www.stevespanglerscience.com/lab/experiments/magic-pendulum/

**EXPLANATION**
- Notes on Inferences

**ELABORATION**
- Work in table groups to discuss inferences. What inferences did/can you make based on observations of the demos. (10 minutes in group discussion, 5 minutes share out)

**EVALUATION**
Share out an inference from the lab (one per table group)

## Lesson 3

| |
|---|
| **Subject / grade level: 7** |
| **Materials:** Scavenger Hunt clues, room map copies, & Self Interview copies |
| **Lesson objective(s):**<br>Students will be able to locate important things in the classroom<br><br>Students will be able to share information about themselves with the teacher. |
| **ENGAGEMENT**<br>Pod discussion:: What are some questions you would like to know about the teacher?<br>Use an online random number generator (google has one that pops up when you google it) |
| **EXPLORATION**<br>-Room Scavenger Hunt (see below) |
| **EXPLANATION**<br><br>Teacher will review each item on the Hunt and where it is located. |
| **ELABORATION**<br><br>Students will pick 3 things they learned (1 safety, 1 supplies, and 1 procedural) about the classroom and explain why they think it is important to know where it is in the classroom. |
| **EVALUATION**<br><br>Learning Circle:<br>Round 1: Students will share one item they think they will never use again the rest of the year.<br>Round 2: Students share what they like about the class so far and why.<br>Round 3: Share your answer to what would they like to see changed going forward and why. |

Self Interview Name: ____________________
Hour: _________

1. Name three heroes/heroines.
2. Name three villains.
3. What makes you happy?
4. What are you an expert at?
5. List three things you believe in.
6. List three things that you definitely don't believe in.
7. List one thing that is right and one thing that is wrong.
8. How many people do you live with?
9. One thing that is fair and one that is not fair?
10. What did you eat for dinner last night?
11. Who was your favorite teacher?
12. What did that teacher do to make them your favorite?
13. Who was your <u>least</u> favorite teacher?
14. What did the teacher do to make them your <u>least</u> favorite?
15. What are three things you want me to know about you?
    a.
    b.
    c.

BONUS: What is one thing you want to know about me?

Room 2110 Scavenger Hunt

On your map of the classroom you will write down the number of the clue where it is located in the room.

Clues

#1 - Head to this cabinet if you are doing an experiment with chemicals, fire, glass, or other potentially dangerous materials.

#2 - If we have a gas problem, head here to turn it off.

#3 - Go here to get rid of waste; we may have more than 1 location for the receptacle.

#4 - If your pants are on fire, toss this on to put out the flames.

#5 - If we need to clear the air, we need to flip this switch.

#6 - Head here to wear something to keep things off your clothes.

#7 - Need a Pencil?

#8 - Have some spare time? Grab a book to read!

#9 - Need a wondering answered? Post it here!

#10 - Life (pencil) a little dull? Go Here.

#11 - What did we do yesterday? (2 locations)

#12 - Flames in our way? Teacher uses this to clear it away.

#13 - Need to get rid of some paper? Find “Ol’ Blu”--there might be two.

#14 - Something serious in your eye? The teacher will help you get a splash at the ___.

#15 - Need to turn in your work? Go here to find your hour’s turn in bin.

#16 - Water-based chemicals soak you from head to toe--get teacher and head for this.

#17 - Classroom Job assignments are found here.

** On back of this I put a sketch of the walls, doors and major items found in my room. Students write the clue number where they found the corresponding thing in the room.*

## Lesson 4

| |
|---|
| **Subject / grade level: 7** |
| **Materials:**<br>Copies of Research A Scientist |
| **Lesson objective(s):**<br>Students will be able to describe a scientist that matches their interests |
| **ENGAGEMENT**<br><br>What are things in your life that interest you?<br><br>Students write their names on a stick color of their choosing. |
| **EXPLORATION**<br><br>Students will use their iPad to complete *Research A Scientist* Worksheet (see below). |
| **EXPLANATION**<br><br>Students will compare the facts learned about their type of scientist with peers. |
| **ELABORATION**<br><br>Students will use quizlet to explore different types of scientists<br>https://quizlet.com/_5o73ag<br><br>Students will share their reasoning why this type of scientist interests them. |
| **EVALUATION**<br><br>Students will compare the facts learned about their type of scientist with peers.<br><br>Students will share their reasoning why this type of scientist interests them. |

# Research-A-Scientist Worksheet

Name: _________________

**PART A**

List **4** interests or things you like to do:

1)
2)
3)
4)

Choose **1**: ____________________________________________

**PART B**

*To answer the next question, google:*

> Hint: "ist" means "an expert of."
> These are all types of scientists (experts of science):
> -biologist -kinesiologist
> -physicist -behaviorist
> -chemist -psychologist

*"Scientist that studies ______________________________"*
*(your interest/thing you like to do)*

*"Science job that uses ______________________________"*
*(your interest/thing you like to do)*

**Write down the type of scientist you could be one day**: ______________________
(if you can't find anything for your chosen interest, pick a different one)

**PART C**

*To answer the next question, google one or more of these sentences:*

*"What does a ______________do?"*
*(type of scientist from PART B)*

*"How much does a _______ make?"*
*(type of scientist from PART B)*

*"How to become a _____________?"*
*(type of scientist from PART B)*

*"What is a _________________?"*
*(type of scientist from PART B)*

*"Jobs for a __________________."*
*(type of scientist from PART B)*

*"The life of a -________________."*
*(type of scientist from PART B)*

**What are 3 facts about the scientist you could become one day?**

1)
2)
3)

*Take a picture of the complete worksheet and submit to the Schoology assignment: "Research a Scientist"*

**Quizlet List of Scientists**

oceanographer - studies Earth's oceans
environmental scientist - one who studies the effects of human activities on Earth's land, air, water, and living things & tries to solve resource problems
astronomist - studies outer space, solar system and the objects in it
biomedical engineer - designs and builds body parts and devices
biologist - studies all forms of life
zoologist - studies animal life
ecologist - studies living things and the way they interact with environment
ornithologist -studies birds
hematologist - studies blood
lepidopterist - studies butterflies
taxonomist - studies classification
paleontologist - studies dinosaurs and fossils
seismologist - studies earthquakes
chemist - studies composition & properties of matter
ichthyologist - studies fish
entomologist - studies insects
mammalogist - studies mammals
microbiologist - studies microscopic organism
physicist - studies motion and energy of matter
parasitologist - studies parasites
mycologist - studies fungi
botanist - studies plants
geologist - studies rock, minerals and earth
audiologist - studies hearing
meteorologist - studies weather
marine biologist - studies the life forms living in the ocean
anthropologist - studies remains of human life
volcanologist - studies volcanoes
virologist - studies viruses
hydrologist - studies water
kinesiologist - studies athletic movement
computer scientist - studies the use of computers to solve problems.
ludologist - studies games, the act of playing them, and the players and cultures surrounding them

# Lesson 5

| |
|---|
| **Subject / grade level: 7** |
| **Materials:**<br>Copies of Me as a Scientist |
| **Lesson objective(s):**<br>Students will create a visual and biography of themselves as the scientist of their choice.<br><br>Students will be able to participate in a community building game: Controller |
| **ENGAGEMENT**<br><br>What kind of scientist would you be if you had to be a scientist? |
| **EXPLORATION**<br><br>Students will share their reasoning why they would choose that type of scientist. |
| **EXPLANATION**<br><br>Students will answer the self-interview questions. |
| **ELABORATION**<br><br>Students will draw themselves or their work as a scientist |
| **EVALUATION**<br><br>Students will share what their scientist is currently working on in small groups. |

______________________________

(Your Name)

Type of Scientist: ______________________________

Education:

______________________________

______________________________

Past Accomplishments in Science:

______________________________

______________________________

Currently Working On:

______________________________

______________________________

Would like to do in the Future:

______________________________

______________________________

Interests:

______________________________

______________________________

Affiliations/Clubs/Memberships:

______________________________

______________________________

Other:

______________________________

______________________________

Me as a Scientist

## Lesson 6

| |
|---|
| **Subject / grade level: 7** |
| **Materials:** sticky notes (several per student), copies of *Question Definition Sheet* |
| **Lesson objective(s):**<br>Students share responsibility for the classroom community with rotating jobs.<br><br>Students will be able to identify a testable question. |
| **ENGAGEMENT**<br><br>Why do scientists ask questions?<br><br>What questions do you have about pollinators? |
| **EXPLORATION**<br><br>Students will write down their questions from the "engage" onto sticky notes. The class will take a walk outside to the pollinator gardens to observe and jot down some more questions/wonderings. |
| **EXPLANATION**<br>Back in the classroom.<br>Go over the different types of questions from the *Question Definition Sheet*.<br>Give students a few examples and have the class help you classify it.<br>Gather all the post its and distribute throughout all the groups to classify ( I typically keep all of my other class periods mixed in as the day goes on). |
| **ELABORATION**<br><br>Students will begin to see if any of the questions were testable. If so, they should decided if they would like to use one of those or try to write a new one. If not, they will work in group to come up with a testable question to be completely ready for Lesson 7. Groups that get the okay from the teacher may support other groups in completing their testable questions. |
| **EVALUATION**<br>Testable question from "Elaboration" phase. |

University of Minnesota: Driven to Discover

# Questions can be answered many ways…

### LOOK IT UP

Question has been answered authoritatively. Use reference material or ask an expert.

EXAMPLES:
What are bird egg shells made of?
What countries are monarch butterflies found in?

### NOT ANSWERABLE

Often "Why?" questions. May depend on coincidence or an observation that can't be replicated.

EXAMPLES:
Why are there so many kinds of sparrows?
Why did that monarch fly away?

### TESTABLE BUT NOT PRACTICAL

Good research question but not feasible to test with the time/materials available.

EXAMPLE:
Do robins vocalize more in their summer breeding season than in the winter?

### TESTABLE

Questions whose answers are observable, measurable, and repeatable.

EXAMPLES:
Do monarch females prefer to lay eggs on the top side or underside of the milkweed leaf?
Which type of feeder do birds prefer?

| | |
|---|---|
| Look it up! | Not testable! |
| Testable but not practical | Testable! |

## Lesson 7

| |
|---|
| **Subject / grade level: 7** |
| **Materials:** copies of Scientific Questions worksheet |
| **Lesson objective(s):**<br>Students will be able to identify "good" scientific questions. |
| **ENGAGEMENT**<br><br>What makes a "good" scientific question?<br>Students will discuss with their peers things that they think make a "good" scientific question. |
| **EXPLORATION**<br>Watch How To Ask Good Questions: David Stork at TEDxStanleyPark 0:00-3:14<br>https://www.youtube.com/watch?v=PkcHstP6Ht0<br><br>Why should you ask "good" questions? What benefit do "good" questions provide? |
| **EXPLANATION**<br>Students will take the Scientific Questions Notes. |
| **ELABORATION**<br><br>Following notes, students will apply this understanding to the Question Worksheet. Let students know that they will use this criteria to identify if a question is testable. |
| **EVALUATION**<br><br>Students will reevaluate their groups' question from the previous lesson. Once their question is revised they will exchange their question with another group to judge against the criteria of a "good" question. |

**Scientific Question Worksheet** **Name:_______________ Hr:__**

**Due Date: ____________**

**Part A**

1a. Describe characteristics of a good scientific question.

**Part B**

**A variable** is ____________________________________________________

A **dependent variable** is ____________________________________________

An **independent variable** is __________________________________________

**Part C: Identify the variables in the following questions by CIRCLING the dependent variable and UNDERLINING the independent variable?**

1. How does the amount of light affect plant growth?

2. What is the effect of the size of paper on the time it takes for the egg to drop in the bottle?

**Part D: Identifying "Good" Scientific Questions**

1. **Does it matter if the egg is from a chicken?**

| Characteristic of Question (Each worth 10 pts) | Points Earned |
|---|---|
| Is it a yes/no question? (if yes = 0 pts, no = 10) | |
| Is it testable? (if yes = 10 pts, no = 0 pts) | |
| Is it measurable? (if yes = 10 pts, no = 0 pts) | |
| Do the variable relate to each other? (if yes = 10 pts, no = 0 pts) | |

If the question earns 40 points you have a good question.

A. Was it a good question? Yes or No ( If "no" go to B, If "yes" move onto next question,.)

B. What could you change to make it a good questions?

2. **How does length of a butterfly's wings affect how fast it flies?**

| Characteristic Question (Each worth 10 pts) | Points Earned |
|---|---|
| Is it a yes/no question? (if yes = 0 pts, no = 10) | |
| Is it testable? (if yes = 10 pts, no = 0 pts) | |
| Is it measurable? (if yes = 10 pts, no = 0 pts) | |
| Do the variable relate to each other? (if yes = 10 pts, no = 0 pts) | |

If the question earns 40 points you have a good questions.

A. Was it a good question? Yes or No ( If “no” go to B, If “yes” move onto next question,.)

B. What could you change to make it a good questions?

3. **How can lions run so fast?**

| Characteristic Question (Each worth 10 pts) | Points Earned |
|---|---|
| Is it a yes/no question? (if yes = 0 pts, no = 10) | |
| Is it testable? (if yes = 10 pts, no = 0 pts) | |
| Is it measurable? (if yes = 10 pts, no = 0 pts) | |
| Do the variable relate to each other? (if yes = 10 pts, no = 0 pts) | |

If the question earns 40 points you have a good questions.

A. Was it a good question? Yes or No ( If “no” go to B, If “yes” move onto next question.)

B. What could you change to make it a good questions?

## Lesson 8

| |
|---|
| **Subject / grade level: 7** |
| **Materials:** copies of Investigation sheet |
| **Lesson objective(s):**<br>Students will be able to write a procedure to investigate their group's "good" question. |
| **ENGAGEMENT**<br><br>Students will be prompted in the "Do Now" to write a procedure for washing their hands (an everyday task they all know how to do) including materials. |
| **EXPLORATION**<br><br>Get a couple volunteers to bring their notebook up and have me do their procedure. I try to do literally do exactly what they say. If they say "put the soap on your hands," I put the bar or bottle of soap on my hands. If they say to "wash the soap off ," I will grab the soap container and wash it off. The students typically frantically try to fix their procedure and get it right |
| **EXPLANATION**<br><br>We create a list of qualities that a "good" procedure should have. I guide students to include being step-by-step, being clear and descriptive, using words and pictures, indicating quantities and qualities. |
| **ELABORATION**<br><br>Students are directed to write a procedure to investigate their group question. |
| **EVALUATION**<br><br>Students will run a test of their procedure and edit to improve the procedure to match what they were investigating. |

RESEARCH TEAM:

BACKGROUND

CONCLUSION

DISCUSSION

OBSERVE & WONDER

QUESTION

HYPOTHESES

DATA

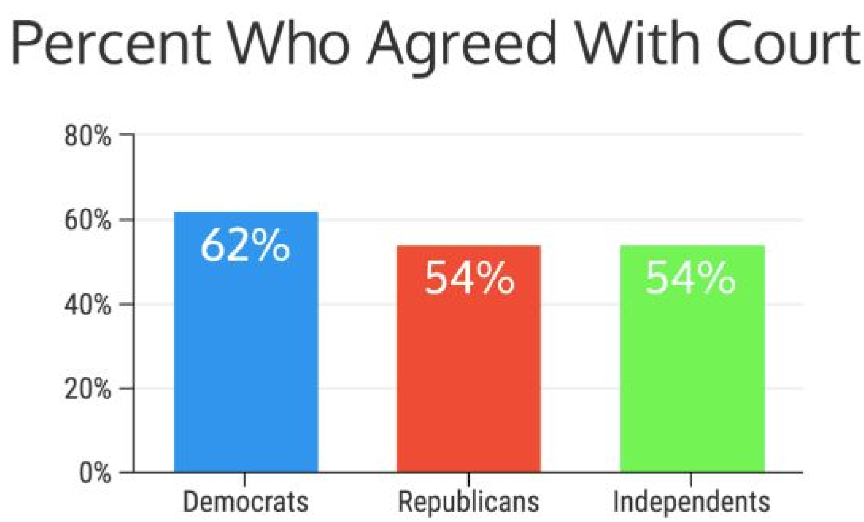
PROCEDURE

MATERIALS

# Lesson 9

| **Subject / grade level: 7** |
| --- |
| **Materials:** lab and field data collection examples |
| **Lesson objective(s):**<br>Students will create a data table to match their investigation. |
| **ENGAGEMENT**<br><br>"Do Now": What are ways to organize data during an investigation? |
| **EXPLORATION**<br><br>The teacher will supply group with examples of lab and field studies data collection sheets.<br><br>Groups will be prompted to list their noticings, wonderings, and surprises. |
| **EXPLANATION**<br><br>Students will share their noticings, wonderings, and surprises.<br><br>The teacher will point out that the data tables could stand alone and tell the whole story of what the question is investigating. |
| **ELABORATION**<br><br>Students go collect data. Their group should get at least 3 trials during the 2 days of data collection. |
| **EVALUATION**<br><br>The teacher will be able to notice if each groups data table matches their investigation. If they notice a data table that needs editing they will let the group know. |

# Lesson 10

| |
|---|
| **Subject / grade level: 7** |
| **Materials:**<br>Statistical Analysis Practice worksheets, Guide Practice Stats sheets, data for teacher explanation. |
| **Lesson objective(s):**<br>Students will be able to use an appropriate statistical test. |
| **ENGAGEMENT**<br><br><br>Do Now: What does this graph say? What doesn't it tell you? Why is that important to understand? |
| **EXPLORATION**<br>Students work on Statistical Analysis Worksheet |
| **EXPLANATION**<br>Teacher will show how to analyze a data set from the a previous investigation using the same sites students are using for worksheet. The teacher will model using the included data set, hypotheses, and scientific question. Students will follow along on Guided Practice Worksheet.<br>How does ornamental vs. native garden affect the diversity and abundance of pollinator types?<br>$H_1$ Native gardens have *more* diverse pollinators than ornamental gardens.<br>$H_2$ Native gardens have *less* diverse pollinators than ornamental gardens. |

$H_3$ Native gardens have *more* abundance of pollinators than ornamental gardens.
$H_4$ Native gardens have *less* abundance of pollinators than ornamental gardens.
$H_0$ The type of garden does not affect the diversity and/or abundance of pollinator types.

| Planting type | Planting Location | Observation start time | Observer | Total Number of flower visitors | Total number of flower visitor types | Total number of bees | Total number of bee types | Temperature F | CloudCover % | Wind |
|---|---|---|---|---|---|---|---|---|---|---|
| Native | CampusNativeGard | 3:06 | Elaine | 12 | 6 | 8 | 3 | 75 | 20 | 0-10 |
| Native | CampusNativeGard | 3:13 | Sheryl | 9 | 3 | 0 | 0 | 75 | 20 | 0-10 |
| Native | CampusNativeGard | 3:05 | Nick | 34 | 6 | 7 | 2 | 75 | 20 | 0-10 |
| Native | CampusNativeGard | 3:13 | Thom | 48 | 3 | 7 | 1 | 75 | 20 | 0-10 |
| Native | ArboretumPrairie | 3:48 | Elaine | 10 | 4 | 2 | 1 | 75 | 90 | 0-10 |
| Native | ArboretumPrairie | 3:55 | Sheryl | 3 | 1 | 0 | 0 | 75 | 90 | 0-10 |
| Native | ArboretumPrairie | 3:48 | Nick | 26 | 3 | 10 | 1 | 75 | 90 | 0-10 |
| Native | ArboretumPrairie | 3:55 | Thom | 63 | 3 | 6 | 1 | 75 | 90 | 0-10 |
| Ornamental | TornandoGarden | 2:40 | Elaine | 41 | 5 | 28 | 3 | 75 | 20 | 0-5 |
| Ornamental | TornandoGarden | 2:49 | Sheryl | 24 | 4 | 13 | 2 | 75 | 20 | 0-5 |
| Ornamental | TornandoGarden | 2:41 | Nick | 80 | 6 | 20 | 3 | 75 | 20 | 0-5 |
| Ornamental | TornandoGarden | 2:49 | Thom | 76 | 4 | 14 | 2 | 75 | 20 | 0-5 |
| Ornamental | ArboretumVisitorCer | 3:27 | Elaine | 25 | 5 | 4 | 3 | 75 | | |
| Ornamental | ArboretumVisitorCer | 3:33 | Sheryl | 18 | 3 | 0 | 0 | 75 | | |
| Ornamental | ArboretumVisitorCer | 3:26 | Nick | 43 | 8 | 9 | 2 | 75 | | |
| Ornamental | ArboretumVisitorCer | 3:33 | Thom | 22 | 4 | 6 | 1 | 75 | | |

**ELABORATION**

Students will analyze their data from lesson 9 to learn if their finding supported their hypotheses and how strong was that support

**EVALUATION**

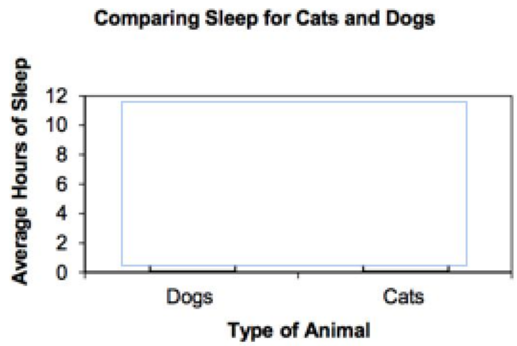
Teacher is watching throughout but will know if students used the analysis correctly if they are talking about significant p-values of 0.05 or less.

**<u>Statistical Analysis Practice</u>** Name: ________________

*<u>t-test</u>*

1. Which household pet sleeps more? **Graph** the average hours slept for each animal type.

| Pet | Dogs sleeping | Cats sleeping |
|---|---|---|
| 1 | 8 | 14 |
| 2 | 9 | 5 |
| 3 | 5 | 7 |
| 4 | 8 | 8 |
| 5 | 7 | 7 |
| Avg. | 7.4 hours/day | 8.2 hours/day |

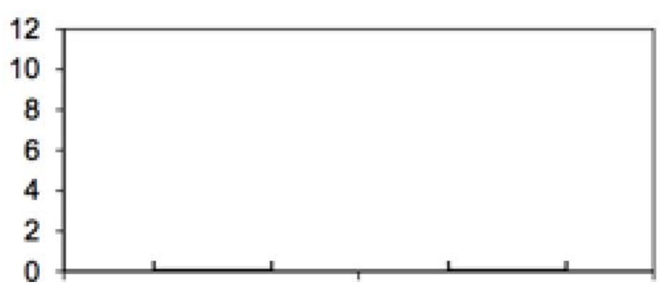



2. By looking at the graph and data table, what do you conclude?
_______________________________________________
_______________________________________________

3. Now go to this website [https://www.graphpad.com/quickcalcs/ttest1.cfm](https://www.graphpad.com/quickcalcs/ttest1.cfm)
    a. Enter the data from the above data table into - “2. Enter data” and rename Groups
    b. Choose the unpaired t test
    c. Click Calculate Now
    d. Record your two-tailed P value here _________ df= ______ standard of error = ________
    e. If your P value is less than 0.10 there is a hint that your difference is significant. If your P value is less than 0.05 than the difference is significant and you can reject the Null Hypothesis. If your P value is greater than 0.10 your findings were nonsignificant.
    f. Check the appropriate box for this experiment : ⏭ Significant ⏭ Non Significant

4. Who gets the most sleep? **Graph** the average slept for each category and **LABEL** the Graph.

| Subject | Teens Sleeping | Adults Sleeping |
|---|---|---|
| 1 | 10 | 7 |
| 2 | 11 | 8 |
| 3 | 14 | 9 |
| 4 | 12 | 6 |
| 5 | 10 | 7 |
| Ave | 11 hrs/day | 7.4 hrs/day |



5. By looking at the graph and data table, what do you conclude?

______________________________________________________________________

______________________________________________________________________

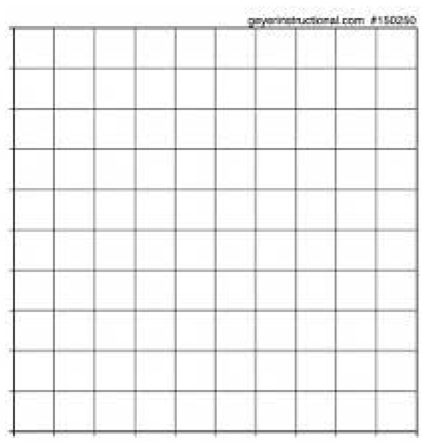
________________________________________

6. Now go to this website https://www.graphpad.com/quickcalcs/ttest1.cfm
    a. Enter the data from the above data table into - “2. Enter data” and rename Groups
    b. Choose the unpaired t test
    c. Click Calculate Now
    d. Record your two-tailed P value here __________ df= _______ standard error = _________
    e. If your P value is less than 0.10 there is a hint that your difference is significant. If your P value is less than 0.05 than the difference is significant and you can reject the Null Hypothesis. If your P value is greater than 0.10 your findings were nonsignificant.
    f. Check the appropriate box for this experiment : ⏭ Significant ⏭ Non Significant

<u>One-Way ANOVA</u>

7. Which treatment do plants prefer? Graph the average height for each treatment and Label the graph.

| | Control | Increased Fert. | Increased Water | Increased Fert.& Water | 2x Fert. & Water |
|---|---|---|---|---|---|
| Plant 1 | 8 | 11 | 9 | 17 | 6 |
| Plant 2 | 9 | 12 | 8 | 18 | 4 |
| Plant 3 | 7 | 9 | 10 | 16 | 7 |
| Plant 4 | 6 | 8 | 11 | 19 | 5 |
| Plant 5 | 9 | 10 | 8 | 15 | 3 |
| Plant 6 | 7 | 8 | 9 | 17 | 4 |
| Plant 7 | 8 | 11 | 10 | 18 | 6 |
| Plant 8 | 6 | 9 | 8 | 19 | 4 |
| Aver. Height/Tx | 7.5 cm | 9.75 cm | 9.12 cm | 17.37 cm | 4.88 cm |



8. By looking at the graph and data table, what do you conclude?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

9. Now go to this site to do a One-Way ANOVA http://vassarstats.net/anova1u.html

a. Number of samples equals the number of treatments (this case is 5)
b. Click or tap Independent Samples
c. Enter the data from each treatment ($t_x$) into each sample column
d. After all treatments are entered, click or tap CALCULATE
e. What is your P Value = ______________________ df = ______
f. If your P value is less than 0.10 there is a hint that your difference is significant. If your P value is less than 0.05 than the difference is significant and you can reject the Null Hypothesis. If your P value is greater than 0.10 your findings were nonsignificant.
g. Check the appropriate box for this experiment : ⏭ Significant ⏭ Non Significant

8. In the *Tukey HSD Test which treatments had a significant P value:*

*<.05 =*_________________________ *<.01* _________________________

10. How does this change your thinking about the data?

______________________________________________________________________

______________________________________________________________________

11. How would you talk about the data in your conclusion and discussion?
See the Question and Hypotheses below. Use the data in the Tukey HSD Test.

S.Q. = How does increasing water and fertilizer affect soybean growth?

Null = Changing the amount of water and fertilizer will not affect soybean growth.
$H_{1\ Pos}$ = If the amount of water increases then the plant will grow more.
$H_{2\ Neg}$ = If the amount of water increases then the plant will grow less.
$H_{3\ Pos}$ = if the amount of fertilizer increases then the plant will grow more.
$H_{4\ Neg}$ = if the amount of fertilizer increases then the plant will grow less.
$H_{5\ Pos}$ = if the amount of fertilizer and water increases then the plant will grow more.
$H_{6\ Neg}$ = if the amount of fertilizer and water increase is doubled the plant will grow less.

Write a conclusion based on the above hypotheses and related P values.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

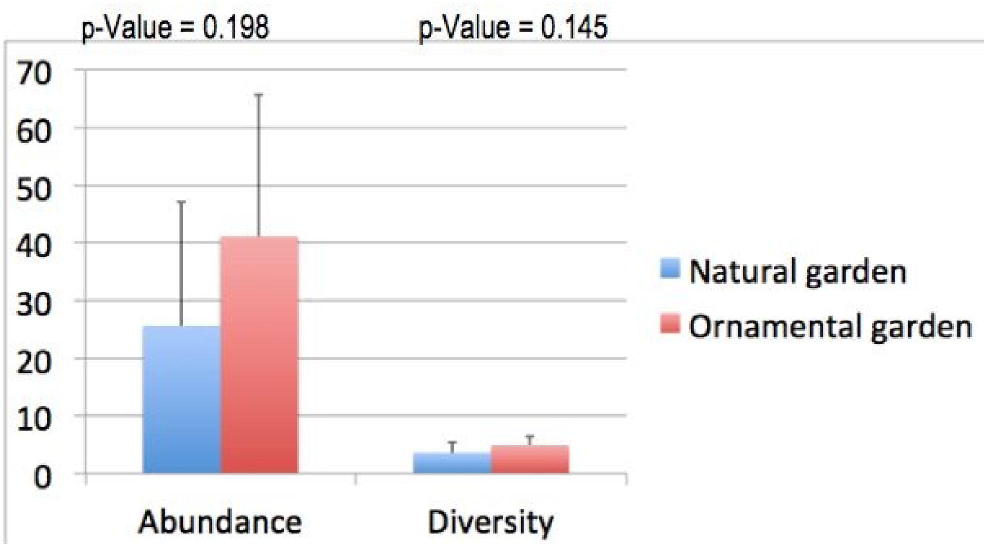
______________________________________________________________________

Guided Practice Stats Worksheet Name: ________________

Q: How does ornamental vs. native garden affect the diversity and abundance of pollinator types?

$H_1$ Native gardens have *more* diverse pollinators than ornamental gardens.
$H_2$ Native gardens have *less* diverse pollinators than ornamental gardens.
$H_3$ Native gardens have *more* abundance of pollinators than ornamental gardens.
$H_4$ Native gardens have *less* abundance of pollinators than ornamental gardens.
$H_0$ The type of garden does not affect the diversity and/or abundance of pollinator types.

Data Table is on Teacher Presentation.




Looking at the graph, what would you conclude?

______________________________________________________________

______________________________________________________________

Now, using the p-Value (Significant difference is less than or equal to 0.05)
How does this change what you conclude?

______________________________________________________________

______________________________________________________________

Why do you think it is important to do statistical analysis on your data before you write your conclusion?

______________________________________________________________

______________________________________________________________

## Lesson 11

| |
|---|
| **Subject / grade level: 7** |
| **Materials:**<br>Copies of Poster Session Note-Catchers, Mini-investigation Reflection sheets |
| **Lesson objective(s):**<br>Students will be able to communicate the results of their investigation |
| **ENGAGEMENT**<br><br>Do Now: Why is it important for scientists to communicate their findings? |
| **EXPLORATION**<br><br>Students will look at scientific studies. Students are looking for commonalities in what the section are. |
| **EXPLANATION**<br><br>Teacher clarifies that all presentations should include Research Team, Background, Observe & Wonder, Question, Hypotheses, Materials, Procedure, Data Tables & Graphs, Conclusion, and Discussion. The teacher will also show an example of a previous years investigation sheet (example included if needed) |
| **ELABORATION**<br><br>Students will assign each section of the investigation sheet to a member of a group. Student use a single slide presentation to create a digital poster.<br><br>Groups practice presenting.<br><br>On Day 2, students will present their investigations. While listening, students will record their noticings and wonderings and will write down a probing question. |
| **EVALUATION**<br>The teacher will listen and watch for understanding and will check for completion of investigation sheet.<br><br>Students will also complete a reflection sheet about how they worked in a group. |

**Poster Session Note-Catcher** Name: _________________

| Group | Noticing(s) | Wondering(s) | Probing Question(s) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# How Does Habitat Affect the Abundance of Pollinators?

## Introduction

We were interested in determining what habitat type supports the most pollinators. We studied the abundance and diversity of pollinators found on flowers in a variety of habitats on the Gustavus Adolphus campus:

- Inner Prairie
- Natural Woodland-Prairie edge
- Managed Lawn-Prairie edge

Our four hypotheses were:

- $H_0$ There will be no difference in the abundance of flower visitors in the three different habitats.
- $H_{a1}$ Inner prairie will have a higher abundance of flower visitors.
- $H_{a2}$ The natural woodland/prairie edge habitat will have a higher abundance of flower visitors.
- $H_{a3}$ The managed prairie/lawn edge will have a higher abundance of flower visitors.

## Methods

1) We identified three habitats:

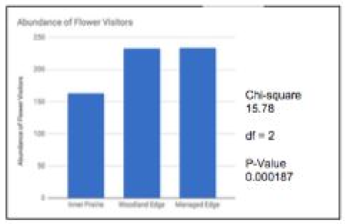

2) Three groups counted flower visitors in each habitat. Observations were conducted at 10:00 am, 11:00 am, and 1:00 pm.

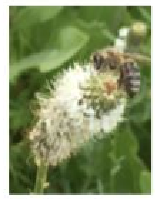
3) Paired observers identified and counted flower visitors within a 1-meter distance while walking a meandering transect, four times in 5 minute intervals. We counted all bees, flies, wasps, beetles, and other flower visitors that landed on blooming flowers during that interval. Ants were noted as present or absent.

Meandering transect with a sight distance of 1-meter

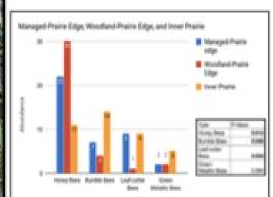
4) Data were collected on abiotic factors and plant species identification at each habitat.

## Results

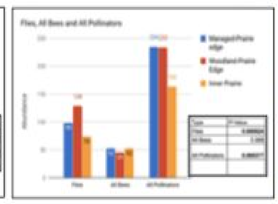


*There were more flower visitors on the edges of the prairie than in the inner prairie.*




*Honey bees were most abundant in the woodland edge.*
*Bumble bees were the most abundant in the inner prairie.*
*Leaf cutter bees were the least abundant in the woodland edge*
*(All comparisons tested using chi-square)*




*Flies were the predominant type of flower visitor in all three habitats. (Comparisons tested using chi-square)*

## Discussion

There were more flower visitors in the edge habitats. We found significantly more flies on the edges than in the prairie. This could be due to the prevalence of predators, including dragonflies and birds, in the inner prairie. However, when considering only bee abundance, there was no difference between the three habitats: inner prairie, woodland edge, and managed edge. This could be due to nesting habits. Many bees nest in the inner prairie. Others nest in hives within a two mile distance, and some nest in wooded areas. This variety of nesting habits drives where the pollinators forage.

Species distribution of bees varied among the different habitats. Bumble bees are ground nesters and were seen burrowing in the inner prairie. We found more bumble bees in the inner prairie compared to the edge habitat. Honey bees nest in hives and forage within two miles of their hives. There were significantly more honey bees in the edge habitats, possibly showing that they conserve energy by traveling to the nearest flower. Another factor that could impact bee distribution is wind speed. Leaf-cutter bees traditionally nest in wooded areas, yet fewer leaf-cutter bees were counted in the woodland edge than any other habitat. This occurrence could be a topic for further investigation.

Agapostemon bee on Black-eyed Susan

Bumble bee on Common Milkweed

## Literature Cited

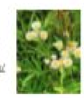
Holm, Heather, *Bees An Identification and Native Plant Forage Guide*. Minnetonka, Pollination Press LLC 2017

*Klein, M.K., Steffan-Dewenter, ., and Tscharnke, T (2003) Fruit Set of highland coffee increases with the diversity of pollinating bees. Proc. R Soc. Lond. B 270 (1) 955-961*

## Acknowledgements

This investigation was completed as part of The University of Minnesota's 2017 Driven to Discover workshop in the Pollinators group. Thanks to Gustavus Adolphus College for use of their facilities. Special thanks to Elaine Evans and Karen Oberhauser for providing expertise and guidance. Funding was provided by National Science Foundation.

## Additional Information:



The Great Sunflower Project:
https://www.greatsunflower.org/
Bumblebee Watch:
https://www.bumblebeewatch.org/
University of Minnesota Bee Lab
https://www.beelab.umn.edu/
Nature's Notebook
https://www.usanpn.org/natures_notebook

**Mini-Investigation Reflection** Name:___________________

Hour:___

Investigation Team Question:

________________________________________________________

A. What was the biggest success your group had?

B. What was the biggest struggle your group had?

C. How did you like participating in the investigation process?

D. Would you like more investigations in the future? Yes No Maybe

E. How did the investigation help you learn?

F. Explain what you liked about the Pollinators (3-5 Sentences)

G. Explain how the Pollinators Mini-Investigation could be better? (3-5 sentences)

**Self-Grading**

Grade each member including you on a 0-4 scale:

0- No Work    1- Very Little Work    2- Some Work    3- Mostly Involved
4- Involved (not distracted & working towards common goal)

| Group Members | Background Observe/ Wonder | Question & Hypotheses | Procedure, Data, and Collection | Analysis & Conclusion | Discussion & Reporting |
|---|---|---|---|---|---|
| Yourself | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

I. Additional information that will justify grade:

II. What were your key contribution(s) to your group

III. How could you improve your contributions in groups going forward?