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A Capstone Project Concerning Social Justice In Secondary Science Education

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A CAPSTONE PROJECT CONCERNING SOCIAL JUSTICE IN SECONDARY SCIENCE EDUCATION

by

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Abstract

Skerletts, J. How Can Secondary Science Teachers Bring Social Justice Into The Classroom In Order To Help Close The Achievement Gap? (2021)

Minnesota began collecting and analyzing the graduation rates of different student demographics starting in 2012. This has led to the exposure of the Achievement Gap, in which students of color graduate from high school at an alarmingly low rate compared to white students. Minnesota ranks nationally at the bottom for the graduation rates of students of color. This Capstone Project had the driving question of, *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* The literature reviewed showed that effectively using Culturally Responsive Pedagogy and Disaggregate Pedagogy can increase intellectual capacity and increase student understanding of concepts being taught. A six part professional development series was created as part of this Capstone Project. This professional development allows ample opportunities for teachers to implement these pedagogical practices into daily lessons to best support students of color.

To my wonderful partner, Katie, for her patience, understanding, and support during my licensure and Master's journey. Not bad for having 12% of a plan. Without you, I would surely be lost. Thank you to my Capstone Committee for pushing me to be better. Special thanks to Mubanga Kalimamukwento at the Hamline Writing Center for your help and positive reinforcement.

"All instruction is culturally responsive. The question is: to which culture is it currently oriented?" - Gloria Ladons-Billings

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CHAPTER ONE

Introduction

This introductory chapter involves my personal experiences both before and after moving to Minnesota. It starts with how I began working with students of color in several public schools in Minnesota, as well as my experience working with families and colleagues from different cultural backgrounds. It will elaborate on the experiences that have brought me to Minnesota and Hamline University to begin my teaching career. This chapter also addresses how I believe science teaching should be restructured to best support students of color to help close the Achievement Gap. The Achievement Gap is the disparity in graduation rates seen in different groups of students (Ansell, 2011). The question that this capstone will answer is: *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?*

Background Experiences

I am originally from a town in New Jersey with a mostly white population. This was reflected in the demographics of my classmates. In my freshman year of high school, a new family moved to my town and, for the first time, I had a Black classmate. After I graduated from high school, I graduated from the University of Vermont (UVM). While attending UVM, I began making friends from different walks of life; people from different countries, with different ethnicities, with different sexual orientations, and who celebrated different religions. It was a stark contrast to what I had grown up with in my hometown in New Jersey. During the 2011-2012 school year, I realized that staying in my hometown was not meant for me. After graduating from UVM, I spent the next nine years working with children of color at summer camps, outdoor education centers, and

Disney Cruise Line. Not only was I working with people of color in various capacities, but I was also working as a part of a multicultural team in each of my jobs.

My first summer camp experience was working at a state-run charity camp in New Jersey. All of the campers were a part of impoverished families or in the foster care system and attended this camp for free. Most of the campers and the staff were Black or Hispanic and resided in the immediate area surrounding the camp. My second summer camp experience was working in Vermont. We would have some international campers from Mexico, Canada and some immigrants from Somalia. While working on Disney Cruise Line, I was one of about sixty Americans out of 1500 hundred crew members, which represented 60 countries.

Once I left Disney Cruise Line, I worked at an outdoor education camp in Southern California in which most of the students were Latinx or Filipino. It was at this time that I had applied for and been accepted into the Hamline MAT program. After I moved to Minnesota, I started working as a paraprofessional in school districts north and south of the Twin Cities. During my time as a pre-service teacher, I took a course that involved implementing Social Justice into lessons and curriculum. This course also introduced me to the embarrassing past of Minnesota with regards to the treatment of Native People and other people of color. This was very eye-opening to me as a non-native of Minnesota. Learning about the inequities that people of color faced, especially in education, made me realize that I wanted to do the best that I can as an educator for those students. To do this, I have taken professional development courses on how to be an equitable educator from the National Science Teacher Association (NSTA), as well as reading literature from Gloria Ladson-Billings and Zaretta Hammond. These two

educators are considered to be the leading authority on best practices and mindsets to work with Black students, and other historically neglected demographics, in an educational setting. From this journey of work experience and research, I realized that humanizing the education process is one of the most important things to do as an educator.

Rationale

Since graduation rates started being collected in the 2011-2012 school year, the disparity in graduation rates between white students and students of color has become more visible (Minnesota Report Card, 2021). There have been as many as 19 percentage points that separate the graduation of black students from their white classmates during the standard four-year high school experience (Minnesota Report Card, 2021). Since this data collection began, Minnesota has consistently ranked 50th in the country in regards to the graduation rate of students of color (Minnesota Report Card, 2021).

Closing this Achievement Gap is an essential part of creating Social Justice in American society, and doing so would help provide more opportunities for people of color to raise their societal standings to that of their white counterparts. This is important for all educators and administrators in all districts throughout Minnesota. They will need to all be on board with this restructuring in order for it to be effective in all schools throughout the state. In my professional opinion, there needs to be reform with regards to how students are taught in schools. This change needs to happen by implementing Social Justice into classrooms so that students can see that the content can be applied to their lived experiences. This is also more specifically aimed at science classrooms due to the fact that science has remained stagnant in the way that it has been taught (Allchin, 2013).

Restructuring science teaching, the implementation of Social Justice practices, as well as using Culturally Responsive Pedagogy and Disaggregate Pedagogy will lead to more and more students of color being included because of the change of culture (Brown, 2019; Hammond 2015). This change in culture will go from praising individuals and their successes to focusing on whole group learning and group successes. For this to happen, there needs to be a change in how teacher educators train future teachers in licensing programs (Ayers, Quinn, & Stovall, 2009). For the teachers who are well into their careers, there needs to be a professional development series for them to attend in order to feel empowered to bring these pedagogical changes into their classrooms. They will need to be taught how to effectively implement these practices and shown that the practices are backed by data and are therefore best practices.

Conclusion

This chapter highlighted my experiences working with students of color and how my views on Social Justice have been shaped. These experiences have shaped my resolve to help restructure how science is taught in order to help close the Achievement Gap in Minnesota. The next three chapters address the question, *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* In Chapter 2, I dive into the Achievement Gap in Minnesota, what Social Justice is and its uses, the effectiveness of Culturally Responsive and Disaggregate Pedagogies in relation to supporting students of color, and how teacher programs need to be restructured to foster Social Justice practices in teachers that are entering the workforce. In Chapter 3, I describe the scope and sequence of a professional development that current science teachers should take in order to implement the Culturally Responsive and Disaggregate

Pedagogies. In Chapter 4, I describe the professional development that I created for science teachers to participate in and how they are able to implement Culturally Responsive and Disaggregate Pedagogies into their lessons.

CHAPTER TWO

Literature Review

Introduction

In the field of education, there has been little effective innovation and meaningful change in the United States. The average American child begins their time in school starting at 5 years old and graduates at about 18 years old. There have been attempts to reform the education system at the Federal level with the implementation of No Child Left Behind (Gaille, 2017). This however, some argue, has made the education system worse. There was a hyperfocus on teaching students to pass standardized testing and less of a focus on teaching students to understand the content (Gaille, 2017). No Child Left Behind was effectively replaced by the Every Student Succeeds Act (ESSA) in 2015 and took effect in the 2017-2018 school year (Klein, 2016). The ESSA seems to allow states to have more flexibility in creating their own goals for graduation rates and calls for actionable plans to monitor goal progression with evidence-based planning (Klein, 2016). The United States is ranked 38th in education despite being one of the richest and most diverse countries in the world (World Population Review, 2021). In fact, other countries have studied the American education system in order to improve their own education systems (World Population Review, 2021).

The demographics of the children that go to school in the United States are, indeed, quite diverse. Each year, there are a number of students who drop out of school or fail to earn enough credits in order to graduate on time. In the state of Minnesota, the graduation rates and demographics of those students are published each year so that they can be seen by educators, stakeholders, and the general public. The lower graduation

rates disproportionately apply to students of color. The graduation rates between white and Black students differ by 20 percentage points (Minnesota Report Card, 2021).

There is a growing concern that the graduation rates of students of color are continuously not at the same level as the graduation rates of white students. This has commonly been referred to as the Achievement Gap (Ansell, 2011).

When students are not able to graduate on time or drop out of school completely, this closes so many opportunities for those students to enrich their lives. In recent years, school districts have recognized the importance of closing the Achievement Gap in order to best support students of color. Being able to close the Achievement Gap is something that will increase the quality of education and also potentially increase the opportunities that students of color will be able to achieve when they go forth into society. The next step for school districts is to be able to identify specific and actionable steps for teachers to take in order to close this gap.

The purpose of this capstone is to identify those specific and actionable steps that teachers are able to take in order to help close the Achievement Gap. This capstone discusses the different philosophies and pedagogical approaches that have been developed to best work with culturally and linguistically diverse students and it will also investigate these philosophies and pedagogies through the lens of a science classroom in the state of Minnesota. These pedagogies are known as Disaggregate and Culturally Responsive Pedagogies. They can be used in the science classroom to create a Social Justice environment in order to help students of color feel more included in science. The field of teacher education and teacher licensing programs is also addressed in what

changes need to be made in order to help continue the work of Social Justice, not only in the science classroom but also in all classrooms.

Achievement Gap

In recent studies, the education system in Minnesota has been ranked in the top 10 in the nation (McCann, 2020). It currently sits 7th, according to Wallethub (2020). The study took into account the overall quality of education in Minnesota (6th) and the safety factor of the state (22nd) to come up with the overall ranking of 7th. The Blue Ribbon award, given to schools with outstanding academic scores, was anointed to 109 schools in Minnesota (McCann, 2020). These are, of course, surface level statistics. When the statistics are analyzed a little more closely, there is a different story that is told. That is, the story of education for students of color in the state of Minnesota.

Studies have shown that Minnesota ranks as one of the worst states in terms of graduation rates for students of color. In terms of graduation rates amongst Black students, it ranks 49 out of 50 (Severson, 2019). For Hispanic students, 50 out of 50. For Native American students, 49 out of 50 (Severson, 2019). These are truly worrisome numbers. The data has shown that, in recent years, the graduation rate has increased by two percentage points from the year previous (Severson, 2019). However, this still puts Minnesota at the bottom of the state rankings. What is the reason for this? Why is Minnesota ranked so poorly in this regard? What can be done to make things better? This capstone is interested in finding potential solutions in order to answer the third question.

The Minnesota Department of Education has graduation rates of high school students across the state from the 2011-2012 to 2018-2019 school years (Minnesota Report Card, 2021). While the graduation rate of white students is quite high from year to

year, the graduation rate of students of color is the opposite. This refers to the collective categories of students that are listed in the graduation rates on the Minnesota Department of Education website (2021). The categories include Asian, American Indian/Native Alaskan, Pacific Islander/Native Hawaiian, Black, and Two or More Races. The graduation rate of white students each year has been in the 80% range (Minnesota Report Card, 2021). The graduation rate for students of color varies depending on which specific category that is being looked at. The highest graduation rate is for Asian students which has been comparable to that of white students — around 85% (Minnesota Report Card, 2021). The graduation rate for American Indian, Hispanic, and Black students have been consistently in the 50-60% region (Severson, 2019). This data shows a disparity of over 20% in terms of graduation rates. This disparity is also one of the highest in the nation compared to other states (Severson, 2019). So what is being done to help students of color close the Achievement Gap?

Finances

Minnesota has been noted as being above average in terms of money spent on students per year. Minnesota, as a state, ranks 19th in money spent for schools, which is about 13,000 dollars per student (McCann, 2020). Granted there are districts that spend more money per student than other districts but that comes down to how well those districts are able to manage their finances and have good ties with the community to increase property taxes. One of the reasons why suburban school districts are better off is due to the “White Flight" out of the cities into the surrounding suburbs (Kaul, 2019). The term White Flight is used for white families moving out of the Twin Cities due to the influx of African Americans during the Great Migration in the early 20th Century (Kaul,

2018). Even with property taxes and operating levies being passed, districts are losing money due to operational costs, infrastructure repairs, and staffing costs among other factors (Magan, 2019). This has caused school districts to make budget cuts amongst licensed staff and other support staff. As a result, there has been an increase in class sizes in under-resourced schools to help students (Redding & Nguyen, 2020). This has led to more inequities in the school system, despite the amount of money that is spent on students each year, the graduation rate of students of color continues to be poor compared to white students. This indicates that there needs to be some kind of change in the way that education is structured in Minnesota.

The amount of money that is spent on students seems to be one of many factors that needs to be taken into consideration when discussing the disparity in graduation rates. The other factors that need to be taken into consideration are Social Justice, Culturally Responsive Pedagogy, Teacher Training Programs, as well as science teaching. Education is a multifaceted institution that requires multifaceted changes in order to make meaningful progress towards closing the Achievement Gap. The previously stated factors have been chosen because of the broad impact that they can make. The reason for focusing on science teaching is due to the fact that there is a glaring underrepresentation of people of color in the field of science (NSF 2021; Theobald et al., 2020).

The Capstone question is, *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* Although the Achievement Gap is focused on the overall graduation rate, this capstone focuses on what science teachers can specifically do to help support students of color in their classrooms

at the secondary level. Something that can be implemented into the science classroom, indeed among all classrooms, is Social Justice.

Social Justice

Social Justice, in regard to public education, has been a concept that was first discussed by Paulo Freire in his book *The Pedagogy of the Oppressed* (1968). Freire (1968) incorporated Social Justice into his Critical Pedagogy as a means of the learners being able to critically analyze their education setting and relate it to social reformation. This type of teaching has been picked up by educators in the United States and is something that has had difficulty in being accepted. Proponents of it believe that it is a means for racism, sexism, homophobia, islamophobia, anti-semtism, and white supremacy to be challenged and for greater social reformations to take place (Ayers, Quinn, & Stovall, 2009). Indeed, feminism, civil rights concepts, queer theory, indigenous rights, and human rights have all been molded into the concept of Social Justice with the goal of making social transformation to make the lived experiences of all people fair, celebrated, respected, and to raise the social status of all people to the same level of power and influence (Hammond, 2015). The opponents of Social Justice believe that it is too politicized and inappropriate to incorporate into public education (Ayers, Quinn & Stovall, 2009). They believe that public education should be as neutral as possible for all students and that the only thing that should be taught is the content in the curricula without any broader societal context (Skubikowski, 2009).

This neutral stance in education has been the de facto operation despite the very existence, purpose, and funding of schools being immersed in politics (Skubikowski, 2009). The purpose of schools is to educate young adults in becoming contributing

members of society; a society that is governed and controlled by politics at the local, state, and national levels. The funding of schools comes from multiple sources, all of which are politically influenced. Some funding directly comes from the state government as well as the federal government. The rest of the funding comes from the property taxes of the local community. When schools seek greater funding, the local community comes together to vote to increase their property taxes. This process is inherently political.

While there are opponents of Social Justice in the education system, this capstone focuses on the benefits of Social Justice as vastly outweighing the critiques. The reason for this is the fact that the purpose of Social Justice is inherently good and is meant to elevate the voices of marginalized people and their status in society (Finkel, 2018). For the purposes of this capstone, there needs to be a framework of what Social Justice is, specifically using an educational lens. Social Justice is about maintaining the commitment to challenging the status quo and the cultural, social, and economical inequalities that exist in education. These inequalities exist between students of color compared to white students at interdistrict and intradistrict levels.

The literature shows many benefits for incorporating Social Justice into the classroom. In order for Social Justice to be used effectively, there needs to be a cultural shift for the students. Most of the time in schools, students are used to the idea of individualism (Brown, 2019). That is, being self sufficient and looking out for themselves. There needs to be a shift to a culture of collectivism in which the students in the classroom are a collective that learn from each other (Brown, 2019). When there is this kind of shift, there can be social perspective-taking. This encourages all students to be able to challenge their previously held notions of other groups. This challenging of

preconceived notions helps foster discourse around the experience of oppression and how that can be dismantled. When the teacher is able to help develop this kind of thinking and perspective taking, the students can internalize this and are therefore able to help improve society as they become participating members upon graduation (Calabrese & Barton, 2003). When students are able to engage in this kind of discourse, they become more and more exposed to the lived experiences of their fellow classmates and come to the realization of what equity and equality are (Hammond, 2015).

The Capstone question is, *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* There seems to be a disconnect in what Social Justice looks like, even amongst the educators who are advocating for Social Justice. One big disconnect is just how far people need to go. One train of thought is that Social Justice is just the equal distribution of resources to all groups of people (Ayers, Quinn, & Stovall, 2009). The falsely held idea is that once the resources are distributed equally, that is the end of Social Justice. The other train of thought is implementing it into curricula and maintaining Social Justice year in and year out. In order for it to be effective, both forms of Social Justice will need to be implemented (Ayers, Quinn, & Stovall, 2009). This is so that students can be ensured to get the necessary resources throughout the school year despite adverse experiences that can happen, such as homelessness, parental divorce, moving between districts, etc. This can be especially important in the science classroom in order to reconstruct how science teaching has traditionally been done in order to best serve students of color and to help close the Achievement Gap.

Science Teaching

This section touches upon the traditional way that science has been taught, the more modern notion of the *Nature of Science*, and also the newer iteration of science standards known as the *Next Generation Science Standards* (NGSS). There is also a section on two different pedagogical approaches that can be integrated into daily lessons that will improve the way science is taught and why they are a good fit for science teaching.

Science has, historically, been known for so much new vocabulary that it was seen as a different language (Allchin, 2013). The heavy use of proper scientific language usage has proven to alienate students because of language identity according to Bryan Brown (2019). His work on Disaggregate Pedagogy has shown the benefit of teaching scientific processes in everyday, accessible language in order to include linguistically diverse students in the classroom discourse. Once the concepts have been introduced in this manner, the scientific vocabulary is then introduced and students are given the opportunity to use this scientific language in discourse activities with their classmates and with the guidance of the science teacher. Zaretta Hammond (2015) and her work in Culturally Responsive Pedagogy shows that teachers need to be *warm demanders* of all of their students. Using the culture of the students in the classroom and being able to make the connections of the content to the background and experiences of the students in the classroom will prove effective in increasing intellectual capacity (Hammond, 2015).

Traditional Science Teaching

Traditionally speaking, the science class has been taught in a very specific way that makes it seem alienating to some students. The students are seen as blank slates

whose minds need to be filled with information by the teacher. This is known as the *banking model* in which students passively sit and listen to the teacher as the teacher deposits information into the students (Freire, 1968). The teacher is seen as the *sage on the stage* and is the ultimate authority figure in the content that they are teaching (Ladson-Billings, 2009). Lessons were taught without any regard or meaningful application to students' lives and cultures. The lessons themselves were lecture based and also taught exclusively from a designated textbook. This style of teaching is something that many people have grown accustomed to and believe is the correct way to teach. This style of teaching has also been linked to behavior outbursts from students who benefit from a different mode of instruction (Hammond, 2015). The constant fast paced note taking and the sink or swim style of learning benefits only a few students and alienates the rest (Hammond, 2015). In addition to the banking model of education, success in the classroom is measured in terms of personal performance. Students are graded on an individual basis and there is little room for collective learning or being graded as a group. This culture of individualism is rooted in the education system which goes against the culture of collectivism that many students of color have grown up with (Brown 2019; Ladson-Billings 2009).

In terms of science, the content is taught as if it were a stagnant body of knowledge that is filled with vocabulary terms (Allchin, 2013). The scientific processes and the scientific vocabulary are taught at the same time (Brown, 2019). This proves incredibly difficult for many students because of the fact that they are trying to sift through twice as much information in the same amount of time as other classes (Brown, 2019). This language use and the classroom culture of *sink or swim* causes alienation and

therefore students feel that science is a subject that they are not meant to be a part of. Science is also seen as just learning about vocabulary terms and each lesson being taught is the teacher playing the game of "guess what is inside my head?" (Brown, 2019, p. 32.). Luckily, there are better standards and practices that are being implemented with the Nature of Science and Next Generation Science Standards.

Nature of Science and Next Generation Science Standards

As previously mentioned, science was seen as a stagnant body of knowledge that people had to learn and would learn by rote memorization vocabulary terms. There has been a shift in how science is viewed and how it should be taught in schools. Science is now viewed to be not only a body of knowledge but also as a way of wondering, investigating, questioning, data collecting, and analyzing. This is referred to as *The Nature of Science* (Nature of Science in NGSS, 2013). The Nature of Science has been adopted and integrated into the Next Generation Science Standards (NGSS). The NGSS is the new set of standards that were created, in a concerted effort, by the National Research Council (NRC), The National Science Teacher Association (NSTA), and the American Association for the Advancement of Science (AAAS) (Nature of Science in NGSS, 2013). With the implementation of the Nature of Science into the NGSS, science will be taught using naturally occurring phenomena to help students learn about the world that they live in (Nature of Science in NGSS, 2013). When students learn about how the world works around them, they then have the opportunity to develop technology to be used to improve human life (Nature of Science in NGSS, 2013). In addition to this, students will become more scientifically literate so that they will be able to make more

informed decisions for the betterment of their fellow citizens (Nature of Science in NGSS, 2013).

The NGSS are the new standards that teachers are expected to use in their lessons. However, in order to best support students in the classroom, there are certain pedagogical practices that can be used to help deliver those standards. The next section will go into what science teachers can do to build an inclusive classroom to best support students of color.

What Science Teachers Can Do

There seems to be a trend in education that students who struggle with learning will have a lot of the work done for them. This might be due to the fact that it is easier for the teacher to just do the work for them and hope that the student is able to learn something from the process (Ladson-Billings, 2001). What the students seem to learn from this ongoing experience is that when things are too difficult for them, they will ask the teacher for help and the teacher will do it. This in turn fosters learned helplessness, which is the phenomenon of students immediately asking the teacher to do the work for them because they feel they are incapable of doing it on their own. This seems to be happening with a lot of students of color and other underserved student populations (Hammond, 2014; Ladson-Billings, 1995). There are times where teachers view cultural differences as intellectual deficits or disadvantages in student learning and therefore believe that the student is not capable of learning in the classroom (Ladson-Billings, 2009). This loops back to the fostering of learned helplessness on the part of the student. Educators need to reshape how science is taught and create culturally inclusive classrooms that will benefit all students (Ladson-Billings, 1995).

The Capstone question is, *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* Science teaching needs to shift from the way it is traditionally taught and more towards teaching science as a process. In addition to this, there needs to be meaningful integration of student culture into the lessons. These lessons can be easily created when two pedagogical practices are implemented. This can be done with Culturally Responsive Pedagogy and Disaggregate Pedagogy.

Culturally Responsive Pedagogy

Culturally Responsive Pedagogy is a student-centered teaching method that incorporates the different cultures of the students in the classroom and ties it into the content that is being taught. This creates greater student engagement in the classroom and anchors the lives of the students into the content that they are learning (Hammond, 2015; Ladson-Billings, 2009). As previously stated, science has been traditionally taught to students without any regard to the personal lives of the students and their individual cultures.

Effectively using Culturally Responsive Pedagogy creates a mindshift in teaching that will celebrate the cultural backgrounds of the students and help aid in information processing to help build brain capacity (Hammond, 2015). This information processing is about taking in information, understanding it, making connections with it to one's personal life, and being able to actively recall that information. This shift in mindshift can be done by constant validation for the students, teaching self-efficacy and advocating skills, and reframing mistakes as learning opportunities. This will help build confidence and independence for the students and help with their information processing skills

(Hammond, 2015). There are two components that need to be expanded: the neuroscience of information processing and also the building of intellectual capacity (Hammond, 2015).

In regard to information processing, there are three stages for anyone to go through. There is input, elaboration, and application (Hammond, 2015). For teachers, the input stage is about the brain focusing on something that causes a strong emotional response or general curiosity. For students in a science classroom, this can be a myriad of natural processes that occur. The elaboration stage is making meaningful connections with the content and having it go from short term memory to working memory. The application stage is focused on having opportunities for students to use the new information and apply it in meaningful ways which will entrench the information in their long-term memory. Knowing the three stages of information processing can lead into how a Culturally Responsive teacher might structure their lessons and help build intellectual capacity (Hammond, 2015).

There are four components needed in order to help build intellectual capacity. The components are known as *ignite*, *chunk*, *chew*, and *review* (Hammond, 2015). The *ignite* component is done through different methods that the teacher is comfortable with. These are usually done with telling a story or making outrageous claims that tie in with the content. This will generate curiosity or a strong emotional response from the input stage of information processing (Hammond, 2015). The next components of *chunk* and *chew* are tied together in that there needs to be an appropriate amount of content that is being introduced and that there needs to be an appropriate amount of time to process this information (Hammond, 2015). If there is too much information then the students can get

a sense of being overwhelmed and if there is too little then the students will be underwhelmed (Hammond, 2015). The chunking section is ultimately determined by the teacher and how well they know the students in their classroom (Hammond, 2015). There are specific practices for chewing the new information such as classroom discourse, also known as talk to learn, graphic organizers, creating a story/comic etc. (Hammond, 2015). The *review* component is done by reviewing the content in different ways such as creating a project, review games, etc. Being able to actively process the new information is the most important part of Culturally Responsive Pedagogy due to the fact that it must be processed and incorporated into the existing background knowledge and experiences of all students (Hammond, 2015).

The Capstone question is, *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* Using Culturally Responsive Pedagogy is an asset for science teaching because of the complexity of scientific concepts, vocabulary, and the Nature of Science. This pedagogy allows for concepts to be broken down into more manageable pieces, eases the cognitive load on the students and allows for more processing time for the students to retain the information into their long term memory. Using this pedagogy will also tie science into the cultures of different students and allow them to see people like them as scientists. Not only is this good for students' cognitive processing abilities but it also has the potential to have more students of color become interested in careers in science (NSF 2021; Theobald et al 2020).

Disaggregate Pedagogy

The other pedagogical practice that should be implemented in science teaching is that of Disaggregate Pedagogy. This is the method of teaching that will explicitly separate the content and vocabulary and teach them at different times as opposed to at the same time (Brown, 2019). Science content is laden with vocabulary terms and processes that have been, traditionally, taught at the same time, which causes a cognitive overload on the part of the students. The Disaggregate Pedagogy approach lessens the cognitive load for all students by starting with words that students already know and use in their everyday life.There are four phases to implement in Disaggregate Pedagogy. These phases are *Pre-Assessment*, *Everyday Content Construction*, *Explicit Language Instruction*, and *Scaffolding Opportunities for Discourse* (Brown, 2019).

Phase one, *Pre-Assessment*, is about engaging the students in discourse. Much like the "ignite" phase in Culturally Relevant Pedagogy, storytelling and talking-to-learn activities are implemented at the beginning of the lesson to ignite interest in the students (Brown, 2019). This is mainly done by introducing something that can be seen in students' everyday life or posing a question that the students can actively try and answer without fear of being wrong (Brown, 2019).

Phase two, *Everyday Content Construction*, is about offering the *big picture* of the lesson being taught using everyday language that is accessible for all students (Brown, 2019). Specific examples in a science class could be about phase changes and energy transfers but through the lens of cooking food. Using specific, concrete examples that students have experienced will help them be engaged with the lesson (Brown, 2019).

Phase three, *Explicit Language Instruction*, is about adding scientific vocabulary to the content that is being taught (Brown, 2019). Once the students have had the opportunity to talk about the content using everyday language they will be better primed to learn the specific content vocabulary. This phase closely mirrors the "chunk" and "chew" steps of Culturally Relevant Pedagogy (Hammond, 2015).

Phase four, *Scaffolding Opportunities for Discourse*, allows opportunities for students to explain scientific concepts using scientific vocabulary in different activities (Brown, 2019). This closely mirrors the "review" section of Culturally Relevant Pedagogy (Hammond, 2015).

This is critical for science teaching because of the complicated scientific processes that occur in the natural world as well as an incredible amount of vocabulary that students need to learn. This pedagogy breaks down and separates the scientific processes and the vocabulary so that students are able to focus and learn one thing at a time. This is also done by introducing the students to these processes in everyday language that the students understand. Once this is done, the true scientific vocabulary is introduced and students are given ample opportunities to use these vocabulary terms in conversations with their peers and teacher.

These two pedagogical practices are relatively new in the world of education. They both require a shift in mindset that many teachers are unwilling to make. This necessary mindshift is multifaceted. There needs to be a change to how teachers perceive students in their classroom as well as a change in how success is measured in the classroom (Morales-Doyle, 2015). That is, changing the focus from individual successes to collective learning and understanding. In other words, switching from the culture of

individualism to collectivism. The world of science is constantly evolving and developing. The teaching of science in public schools, for the most part, has remained stagnant despite the world changing around it. This has proven to be a disservice to many students and especially to students of color (Finkel, 2018). Teachers of science are believed to be gatekeepers of knowledge who should work with students as sharers of knowledge. This mindshift, admittedly, is very difficult for well-established educators. The best way for this mindshift to happen is for teacher programs to "ignite, chunk, chew, and review" these pedagogical practices.

These pedagogical practices are potential answers to the driving question of this Capstone Project. *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* The pedagogies that were reviewed have proven to increase intellectual capacity in students, promote independent learning, as well as making meaningful connections of the content to the lived experiences of the students (Brown, 2019; Hammond, 2015). This may promote engagement in school and ultimately help teachers hold students to high expectations. Therefore, it may help students graduate from high school on time. This has the potential to help close the Achievement Gap that students of color are currently facing in Minnesota. Furthermore, these pedagogical practices could potentially lead more students of color to careers in science, engineering, and technology.

Teacher Programs

The largest demographic of teachers across the country is white, monolingual people (Ayers, Quinn, & Stovall, 2009). Year in and year out, there seems to be a small percentage of teachers of color earning their teaching certification from programs. Data

has shown the positive impacts teachers of color have had on students of color in the classroom (Ayers, Quinn, & Stovall, 2009). Yet, why is the teacher workforce predominantly white? This is a question that teacher programs have been trying to answer while also actively recruiting more people of color to join their programs (Ayers, Quinn, & Stovall, 2009). Three strategies have been used in order to recruit more people of color. One has been to change the admission requirements for undergraduate and graduate programs by focusing on maintaining high academic standards but being empathetic to the experiences of the students (Ayers, Quinn, & Stovall, 2009). The second strategy has been the creation of alternative teacher programs that focus on high need areas such as urban and rural schools (Ayers, Quinn, & Stovall, 2009). The third strategy is about focusing on students in community and technical colleges, which have the highest concentrations of students of color (Ayers, Quinn, & Stovall, 2009). These previously stated agreements are made between the universities and the community colleges which help transition community college students to teacher programs (Ayers, Quinn, & Stovall, 2009). Despite these efforts, the teacher workforce continues to be predominantly white monolingual people. What else can these teacher programs do?

While continuing to recruit diverse teacher candidates, teacher programs should be focusing on working with teacher candidates to promote and include Social Justice and culturally relevant curricula in order to best serve the diverse student population as well as their white classmates (Calabrese Barton, 2003). In addition to this, there should be intentional implementation of assessments that are cognizant of the cultural differences of the students in the classroom so that all students can effectively show what they have learned (Calabrese Barton, 2003). These programs will also need to have a

structural reworking of how teacher candidates are taught and guided during their time. Teacher educators will need to teach and guide Social Justice principles so that teacher candidates can process these necessary practices (Ayers, Quinn, & Stovall, 2009). The concepts of Social Justice, described above, will need to be effectively adopted, implemented, and sustained in all teacher education programs. In addition to this, there will need to be a significant buy-in from teacher candidates in order for this to be effective.

The process of becoming a culturally responsive teacher is ongoing and requires reflection, practice, and development. To start, teachers need to learn how culture is involved in education and also must learn the culture of the students and the community in which the school is placed. They will also need to be able to use the culture of the students as a basis for learning (Hammond, 2015). Teacher candidates will also need to establish and maintain high expectations for all students in order to make students independent learners. This will encourage students to take ownership of their learning and have them be able to make meaningful connections of the content to their lived experiences (Hammond, 2015).

These concepts and practices are things that need to be taught with intentionality as well as having a long duration of time. Most teacher programs offer only one course on equity and Social Justice, if they offer any at all (Ayers, Quinn, & Stovall, 2009). Teacher programs need to add more of these courses so as to make a meaningful impact on teacher candidates. With well created courses based on the development of Social Justice and culturally responsive classroom cultures, more teachers will incorporate these practices into their own classrooms. When these practices are intentionally implemented,

students of color will be incorporated into the classroom culture and feel like a part of the learning community. These will be the first steps to helping close the Achievement Gap in Minnesota.

Conclusion

This chapter covered the present state of students of color in Minnesota schools. There is a huge disparity between graduation rates of students of color and their white classmates which puts Minnesota at the bottom of education for students of color in the United States. This chapter went into detail about different practices that can be implemented in science classrooms in order to best serve those students. There needs to be a change in how science is taught in secondary schools in Minnesota. There are far too many incidents of teachers using a textbook as the sole means of shallow learning. The use of Culturally Relevant and Disaggregate Pedagogy has shown to be a more effective way of teaching science to students. These pedagogical practices have shown to give students better understanding of scientific concepts because they have been tied into the lived experience of the students. The traditional mindset of the teacher being the gatekeeper of knowledge will need to change and refocus on being a guide for students on their collective journey of learning. This cultural shift of individual success to collective learning will allow students to learn from each other in a guided manner. The teacher must guide the students by igniting their curiosity, breaking down the content into accessible language that the students can grasp, and then introducing scientific vocabulary after the students have been given opportunities for processing the new content. The question that this capstone was investigating is: *how can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement*

Gap? When Disaggregate and Culturally Responsive Pedagogies are brought together into science lessons, a culture of Social Justice is created.

These practices are important due to the fact that they form a classroom culture that is based on multiculturalism, collectivism, and holding students to high expectations. When these practices are put into place, a learning partnership is created between the students and the teacher. The teacher is able to effectively guide the students to learning scientific concepts and increasing intellectual capacity and promoting ownership of their learning. This then turns the students into independent thinkers and learners while simultaneously trying to teach their classmates. When students teach the concepts to others in their own way, this causes the content to be incorporated into their long term memory that they are able to recall in the future. This feeds back into those students wanting to learn more and being more engaged with their learning. This, hopefully, will continue throughout their time in school leading up to graduating from high school after four years leading to the closing of the Achievement Gap.

The next chapter involves professional development for current teachers to participate in. The purpose of the professional development is for secondary science teachers to learn how to incorporate Culturally Responsive and Disaggregate Pedagogies into their classroom. It involves how to implement the four Phases of Disaggregate Pedagogy and how to mirror that with the four parts of the Culturally Responsive Pedagogy.

CHAPTER THREE

Introduction

The question that this capstone is attempting to answer is: *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* This capstone is investigating Disaggregate and Culturally Responsive Pedagogies, and how they can be used in the science classroom to create a Social Justice environment in order to help students of color feel more included in science. This is so that other teachers can implement these pedagogies to help close the Achievement Gap in Minnesota.

This project involved the creation of a professional development series that is designed to help secondary science teachers in Minnesota create a Social Justice environment within their classrooms by implementing the Culturally Responsive and Disaggregate Pedagogies into their daily lessons. This could be a huge benefit to all science teachers as well as the students of color that are in their classrooms. The pedagogies that were reviewed have proven to increase intellectual capacity in students, promote independent learning, as well as making meaningful connections of the content to the lived experiences of students (Brown, 2019; Hammond, 2015). This promotes student engagement in school and ultimately help teachers hold students to high expectations. This results in students graduating from high school on time. This has the potential to help close the Achievement Gap that students of color are currently facing in Minnesota.

This chapter covers the rationale for the decision to create a professional development, the description of what the professional development covers, the timeline

of the professional development and how the effectiveness of the professional development will be assessed. There is a summary of the chapter at the very end.

Rationale

The reason for this professional development to target secondary science teachers is to ensure that they are aware of these fairly new pedagogical practices, can have ample opportunity to learn about them, and can implement them into lesson plans starting the next class day. Science teaching has traditionally been taught in a way in which scientific processes and scientific vocabulary are taught simultaneously which has been known to create an increased cognitive load on students and has proven to alienate students, especially students of color (Brown 2019; Hammond 2015).

A misconception that educators have for Culturally Responsive Pedagogy is that they just need to dress up their lessons with cultural references but keep the lesson lecture-based with traditional tests to measure student learning (Lee, Menkart, & Okazawa-Rey, 2008). This misconception should be addressed and rectified. Culturally Responsive Pedagogy offers so much for students from different backgrounds including increased brain capacity and the development of them becoming independent learners. It is a type of teaching that is responsive to the culture of the students in the classroom. It is not race-specific but is able to be used to ground the classroom content into the lives of the students (Hammond, 2015). This is the effect that Culturally Responsive teaching will have on students of color and other underserved student populations.

The heavy use of scientific jargon has proven to further alienate students because of language identity according to Bryan Brown (2019). His work on Disaggregate Pedagogy has shown the benefit of teaching scientific processes in everyday, accessible

language in order to include linguistically diverse students in the classroom discourse. Once the concepts have been introduced in this manner, the scientific vocabulary is then introduced and students are given the opportunity to use this scientific language in discourse activities with their classmates and with the guidance of the science teacher. Zaretta Hammond (2015) and her work in Culturally Responsive Pedagogy shows that teachers need to be *warm demanders* of all of their students. Using the culture of the students in the classroom and being able to make the connections of the content to the background and experiences of the students in the classroom will prove effective in increasing intellectual capacity (Hammond, 2015).

In order for teachers to be eligible for license renewal, a certain amount of Continuing Education Units (CEUs) are needed to be taken. These CEUs are earned mostly through professional developments that are offered by the district the teacher is contracted with. There are certain types of CEUs that need to be completed such as mental health awareness, suicide prevention, technology integratation etc. (Minnesota Professional Educator Licensing and Standards Board 2021). I would advocate for my professional development being required for science teachers to take. Having this professional development become a requirement for recertification would prove to be beneficial because all of the secondary science teachers would have the opportunity to learn these pedagogical practices around the same time and, hopefully, implement them shortly after. This would hopefully lead to more and more current teachers buying into Culturally Responsive and Disaggregate Pedagogies. This would potentially lead to the closing of the Achievement Gap in Minnesota and also potentially lead to more diverse

representation in the field of Science, Engineering, and Technology. As well as more people of color wanting to enroll in teacher programs.

The Andragogy framework of Malcolm Knowles' helped with the creation of a lesson that best supports adult learners (1984). Andragogy is to adult learning as pedagogy is to child learning. There are best practices to help teach adult learners and Malcolm Knowles (1984) has written extensively how to do this. The basic theme of this work is that adult learners need to have a purpose for what they are learning and to have a say in what they are learning (see Appendix A)

Project Description

The location of this professional development will take place in the home district of the teachers that are participating. This can be a coordinated effort to potentially have multiple school districts offering this professional development at the same time. I am hesitant to suggest that this be offered during the Minnesota Educator Academy workshop weekend due to the fact that most of the educators go on vacation during that time instead of attending the workshops. I feel that having this professional development offered in the home district of teachers will offer the best turnout. This will be a six-part professional development series that takes place over the course of an academic year. Each session is one or two hours in length and the entire series is eight hours total. Each session meets monthly beginning with the first month of student contact time.

Overall, the professional development covers the Achievement Gap in Minnesota (dating back to the graduation class of 2012), the shift in mindset needed to best serve students of color in the science classroom, an overview of what social justice is, the Nature of Science, and how to implement the Culturally Responsive and Disaggregate

pedagogies into the daily lessons (see Appendix B). The presentation is interactive with the audience with the use of Pear Deck (https://www.peardeck.com/googleslides).

Pear Deck is an educational tool that is used with Google Slides or PowerPoint presentations. A slideshow is created and Pear Deck allows the creator to add interactive features that the audience is able to participate in using their personal devices. The interactive features can involve questions that are short answer, polled, multiple choice, true/false, etc. Pear Deck allows for the presenter to see learning happening in real time. It's a form of formative assessment that shows the understanding of the group as a whole. This is a tool that has been used effectively with both in-person and distance learning during my time as a teacher. Having the lesson be interactive proves to be more effective in terms of memory retention compared to the passive listening that is traditionally done at professional developments (Dominguez, n.d.). The science teachers will be able to join the Pear Deck presentation using personal devices such as laptops, tablets, and phones and be able to interact with specific sections of the slideshow. This will also help the audience members see the slides depending on how big the area is, how far the screen is from people, among other factors.

Session one begins the series and provides an overview of what each session covers throughout the professional development as well as a timeline and resources. After this, there is an overview of the graduation rates of students of color in Minnesota and an overview of the Next Generation Science Standards as well as the Nature of Science. There is a homework assignment for the audience to read Zaretta Hammond's *Culturally Responsive Teaching and the Brain* as preparation for session two (see Appendix C). This session takes place during Teacher Workshop Week so that all science teachers can meet

and so that the series can finish in February. This allows for the teachers to have three full months to continue using the pedagogical practices in their lessons. The purpose of having the homework assignment is so that session two will have more meaningful discussions.

Session two goes in depth into the concepts of Culturally Responsive teaching and how they are beneficial to science instruction. There is also time for teachers to bring in their lesson plans and to tweak them to reflect the concepts from Culturally Responsive Teaching. This session is two hours in length to have time to cover the concepts, tweak or create lessons based on this pedagogical practice, and leave room for discussion. This session should take place in late September, one month after the first session.

Session three is an hour in length and half of the time is dedicated to teacher discussion and dialogue on how the lessons are going with the use of Culturally Responsive Pedagogy. The other half of the session is dedicated time for the teachers to continue creating or tweaking their upcoming lessons to reflect Culturally Responsive Pedagogy. There is a homework assignment for the teachers to read Bryan Brown's *Science in the City: Culturally Relevant STEM Education* for the next scheduled session (see Appendix D). The reason for this session is for the teachers to have dedicated time to tweak their lessons and to ask any questions that they have on Culturally Relevant Pedagogy. The purpose for having the homework assignment is to help have more meaningful conversations in session four.

Session four is two hours in length in order to cover the concepts that were discussed in *Science in the City: Culturally Relevant STEM Education* as well as dedicated time for discussion, reflection, and time for teachers to create or tweak lesson

plans to reflect the concepts of Disaggregate Pedagogy. The first hour encompasses the review of the concepts of Disaggregate pedagogy, discussion and reflection amongst the audience members of the session. The second hour focuses on integration of Disaggregate Pedagogy into upcoming lessons.

Session five is an hour in length and is dedicated to answering questions and promoting dialogue amongst the audience members. There is also dedicated time for lessons to be created or tweaked to integrate both Culturally Relevant Pedagogy and Disaggregate Pedagogy.

Session six is an hour in length and focuses on reviewing the Achievement Gap, Nature of Science, Culturally Responsive Pedagogy, Disaggregate Pedagogy. There is also time to field any final questions and facilitate dialogue amongst the audience members.

Timeline

The timeline to complete this project is a full calendar year starting at the beginning of a school year. There will be a survey sent out to science teachers about how they teach science with a Social Justice lens (see Appendix E). Time is needed to process the data that they submitted, which will inform what specifically needs to be covered in the professional development. A rubric will need to be created that is based on the professional development standards that the district has in place. There will need to be time dedicated to necessary research and documentation to create the slideshow presentation. A specific room that is large enough to accommodate participants will need to be located and reserved for the professional development to take place in. Time to

contact outside experts to come in and participate in the professional development and lead discussions will also need to be made.

This will all need to be done multiple times due to the fact that this is a six-part professional development series. There will be a session that takes place each month during the school year beginning in August, during teacher workshop week. The following sessions will take place towards the end of each month in September, October, November, January, and February. December will be skipped over due to Winter Break. Once the professional developments have been completed, there will be opportunities for the audience members to participate so that they can reinforce what they have learned from the presentation. These opportunities will be to create their own Critical Affinity Space with trusted colleagues that want to create a social justice classroom. These Critical Affinity Spaces are for teachers who are motivated to incorporate professional development into their teaching practices (Foster & Nocella 2020). This will promote accountability for teacher follow-through with the implementation of the pedagogical practices into their lessons.

There are built-in checkpoints in the series where teachers will be able to engage in dialogue to see what their experiences have been with implementation of the pedagogical practices. There are times dedicated to workshopping and creating or tweaking lesson plans and there are informal check-ins to see how things are going. During the slideshow portions of the sessions, there will also be certain interactive questions via PearDeck where teachers answer specific questions. The answers to these questions will be compiled and reviewed to make changes as needed. At the very end of the professional development series, there are questions that the teachers will answer to

gauge how effective the professional development was and to suggest changes to make the series more effective. The questions will be delivered to the teachers electronically via Google Forms (see Appendix F).

Assessment

The effectiveness of the project will take some time to be calculated. The whole Capstone Project is focused on increasing the graduation rates of students of color. It will take at least four years in order to collect the data to see if there is any change in graduation rates. In order to collect meaningful data from these pedagogical practices, the focus would need to be on the current class of 9th grade students and look at their graduation rates. This is so that four years of consistent pedagogical practices would help increase graduation rates for students of color. After the initial four years, the graduation rates for each subsequent year can be analyzed to see if there are any changes.

The data will be available on the Minnesota Department of Education's website and will have graduation rates by specific high schools, whole district level, and state level. When the data is collected, time will be needed to analyze the data and attempt to isolate other factors to graduation rates, such as moving to a different school or a different state. At first, the data that is collected will need to be from the high school that the science teachers are working at, unless there is a wholesale buy-in from the district and all secondary science teachers use the pedagogical practices. In that case, graduation rates for the local school district will be looked at. If success is seen, then there could be potential for other districts around the state to adopt the project. If substantial increases, of at least one percentage point, can be seen in graduation rates then the Capstone Project is a success.

The driving question of this Capstone was *how can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* The pedagogical practices that were discussed are well informed and backed by data to show their effectiveness at holding students of color to high expectations as well as making science content accessible to students while still maintaining high expectations and without sacrificing rigor. The professional development series is the answer to the Capstone question because of the duration and the intentional implementation of the pedagogical practices. The pedagogies are introduced separately and the teachers are given time to read each of them as well as dedicated time to implement them into their daily lessons. These pedagogical practices are able to be used immediately in their lessons. There are sessions that are dedicated to reflecting on how the lessons went and how they can be improved upon. Having all of the secondary science teachers in the district take this professional development at the same time will allow for greater collaboration and effective implementation.

Summary

This is a six part professional development focused on secondary science teachers in Minnesota. The professional development series was created in order to answer the question: *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* This is so that science teachers can implement Culturally Responsive and Disaggregate Pedagogies into their classrooms to best serve students of color in order to help close the Achievement Gap in Minnesota.

The presentation is an interactive slideshow that the audience members will actively participate in so that there is a greater chance of understanding from interactive

learning. There are exit questions that the audience members will fill out so that there can be a gauge of how the presentation went and how likely they will begin to implement the different pedagogical strategies. This presentation was based on the Andragogy framework for adult learners and will also provide future opportunities for teachers to participate in so that they will be able to reinforce what they have learned from the presentation.

In the next chapter, I discuss my personal trials and tribulations that I experienced during this Capstone Project as well as the most important resources that helped shape my project. There are insights on my self discovery as a learner, researcher, and writer as well as what I feel are the limitations and implications of this capstone project. I also attempt to lay out my future plans with this professional development, the results that will be collected, as well as benefits to the teaching profession.

CHAPTER FOUR

Introduction

This chapter is my reflection on this Capstone Project journey and my attempt to answer the driving question of *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* The sections cover what I learned on this journey, the most influential and important works, the implications and limitations of the professional development series, and what the possible next steps are — otherwise known as *where does it go from here?*

What I Learned

This has certainly been a wild ride for me. There were several inspirations for pursuing this topic for my Capstone. First was the unnecessary murder of George Floyd and the resulting Black Lives Matter protests in the Twin Cities. The second was learning about the underlying statistics for the graduation rates of black students in Minnesota. There were many events that occurred during my research which lead to many highs and lows for me personally. The raid on the Capitol Building on January 6th, 2021 and the continuing pandemic being a select few of these events. While working as a first year teacher, I had to shift from hybrid learning, to fully online learning, back to hybrid learning, and then to fully in-person. I still do not know what most of my students look like but that is very much a low-level concern when taking into context everything that has happened this year.

What I learned from this process is that I am still very much committed to helping close the Achievement Gap and am happy to have found two resources that will help me and other educators. I also learned that I need a lot more processing time in order to feel

that I am doing things correctly. I found that I am not the best writer when it comes to grammar and punctuation. I also feel like I need to mention that, during this time, I feel that I have some form of undiagnosed ADHD that might have contributed to the tardiness of deadlines and lack of comprehensive writing. There were many instances that I would have my Capstone question connected to the literature in my head but would have none of that written down. Needless to say, if I were diagnosed with ADHD, I would not be surprised.

Important Works

During my literature review, the three resources that I found the most helpful were the works of Zaretta Hammond, Bryan Brown, and Gloria Ladson-Billings. Gloria Ladson-Billings is one of the foremost authorities on teaching people how to work best with black students and her work on Culturally Relevant Pedagogy is a masterclass on how to best work with black students.. Zaretta Hammond's (2015) works on Culturally Responsive Teaching and the Brain gives tips and tricks on helping students learn citing research in psychology and neuroscience to back up their effectiveness. Not only this, but she also makes a twist on the phrase *high expectations* and uses the term *warm demander*. This term is used in reference to students who put in lackluster efforts into their classwork and how the teacher is able to create a positive environment and relationships with these students in order to push them to do their absolute best. This is done with the students' feelings being respected and appreciated. This is important for teachers to understand and believe in so that students can feel that they belong in the classroom and that the teacher is there to push them in the right direction.

The work of Bryan Brown (2019) was also incredibly important to my Capstone project. His book *Science in the City: Culturally Relevant STEM Education* introduced me to Disaggregate Pedagogy and how it is effective in teaching science to students of all cultural backgrounds. He talks about how students need to be included in the conversations in the classroom and that these conversations need to start with everyday language that the students know. Once the scientific processes are explained in everyday language, the students have a starting point for the rest of the lesson. Once they have engaged in this conversation, the scientific terms and vocabulary are introduced to the students and they are given ample time to engage in dialogue with the teacher and their peers. This has proven to be effective for learning new concepts and also for long-term memory retention.

Implications and Limitations

A possible implication of this capstone project is that the pedagogical practices could be implemented into district curriculums and could potentially be required to be used by all science teachers. I am sure that there would have to be a trial period and data collection in order for school boards to see the effectiveness of the pedagogical practices but the implication is there. I do have to mention that Zaretta Hammond's (2015) Culturally Responsive Teaching can be taught in any subject, not just science. This differs from Bryan Brown's (2019) Disaggregate Pedagogy, which is specifically written for science educators to use in their lessons.

There are two potential limitations to this project. One limitation is how it is viewed by other teachers. The effectiveness of this project is limited by the flexibility and willingness of the teachers attending this professional development to incorporate these

pedagogical strategies into their everyday teaching. In my personal experience, there are many teachers who are set in their ways and attend professional developments as a formality with no recourse in actually implementing what they have learned. The second potential limitation is the administration of school districts not wanting to use this professional development in fear of it being too political or politically-motivated and wanting to appear to be remaining politically "neutral." This is in the similar vein of viewing Black Lives Matter as a political organization as opposed to a human rights organization.

Where Does It Go From Here?

I have been asked "how are you going to use your capstone and what is your plan to get there?" This is an incredibly fabulous question and it all depends on the previously mentioned limitations that could rise up. I know that I plan on using the pedagogical practices that were researched for this capstone in my lessons. I hope to be able to create a Critical Affinity Space with other teachers and talk about the Achievement Gap and what we, as educators, can do to close it. I will talk about my professional development series and also offer it to them as a resource that they can use. The next step would then be to seek out guidance from the administrators and see what kind of traction can be made towards implementing the professional development within my district. To be quite honest, I have no idea if this is something that will be used in my future school district. My propensity for idealism makes me think that it will be used and accepted by other science teachers. Common sense dictates that if I get enough backing from my fellow educators, at both the middle and high school levels, then the capstone project would be used effectively and genuine change and results will happen.

The results of this capstone project will depend greatly on the majority of science teachers effectively using Culturally Responsive Pedagogy and Disaggregate Pedagogy. This implementation would need to happen at every grade level. The results will be the graduation rates of the students that are attending the local school district in which the professional development took place. If there is more than one high school, the results will be for the high school that the professional development takes place in. If and when this is done, the graduation rates of students of color would be recorded and researchers would be able to see trends year in and year out. The results would not be immediate and so patience and trust in the process are necessary qualities in order for the project to be successful and to produce reliable data. The results would need to be communicated to the Minnesota Department of Education and I would keep my own record of the results each year to compile data to back up my professional development as being legitimate.

Summary

During this Capstone journey, I had the driving question of *How can secondary science teachers bring Social Justice into the classroom in order to help close the Achievement Gap?* I found incredible works that really shaped my Capstone project in the form of Zaretta Hammond (2015) and Bryan Brown (2019). I feel that these two works specifically can be utilized with great effect to help improve inclusion and engagement of students of color in secondary science education. These two pedagogical practices are specifically created to hold students of color to high expectations while also changing the way that science has been traditionally taught in classrooms. During this Capstone Project, I also learned many different things about myself as a learner. I realized that I take a lot longer to process information and need more time to effectively write out

and explain my thought processes. This is something that I need to work on in order to be a much more effective teacher for my students.

I truly hope that this professional development series can be used effectively by science teachers. In order for anything to be effective, a majority of teachers must have buy-in and for that majority to continually engage in these pedagogical practices. I believe that most teachers will be able to buy into these practices because they still allow for individual creative freedom when it comes to lesson creation. There might be some limitations to this project but the potential benefits, I believe, vastly outweigh the limitations. If these pedagogical strategies are used effectively and consistently throughout all secondary grade levels, students of color will feel that they belong in the classroom and this would, theoretically, help to close the achievement gap.

The most important thing that I have learned, and something that teachers seem to forget, is that students are human beings that are trying to navigate their own world. There should be a more concerted effort to humanize this educational process and the world of school. The students are worth this endeavor.

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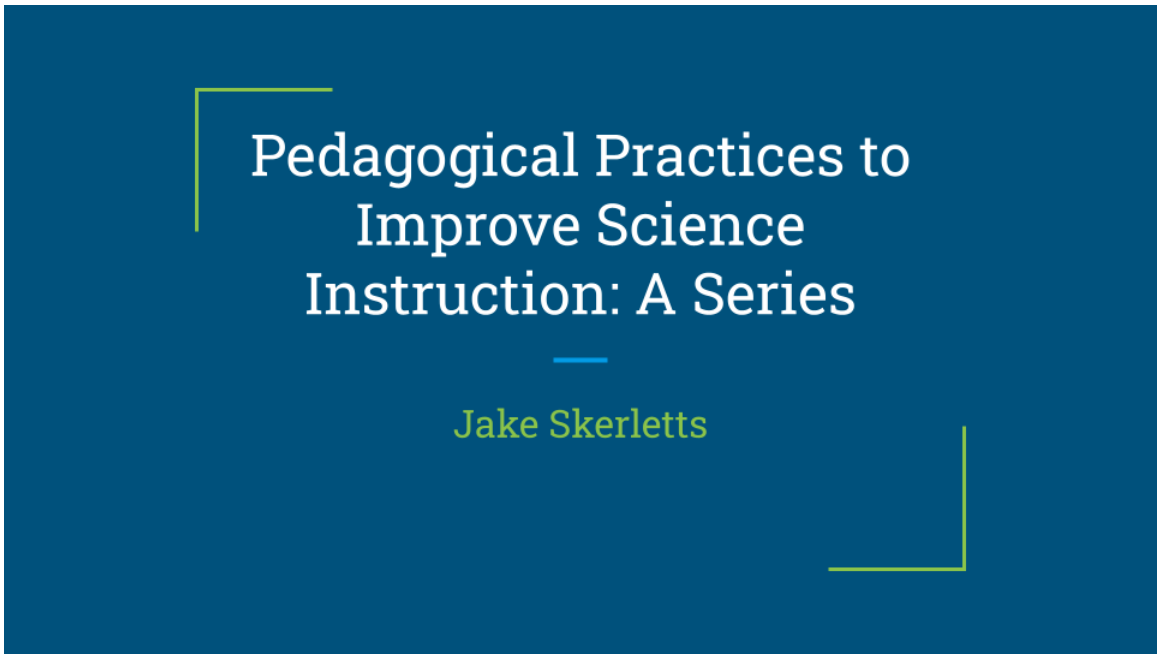
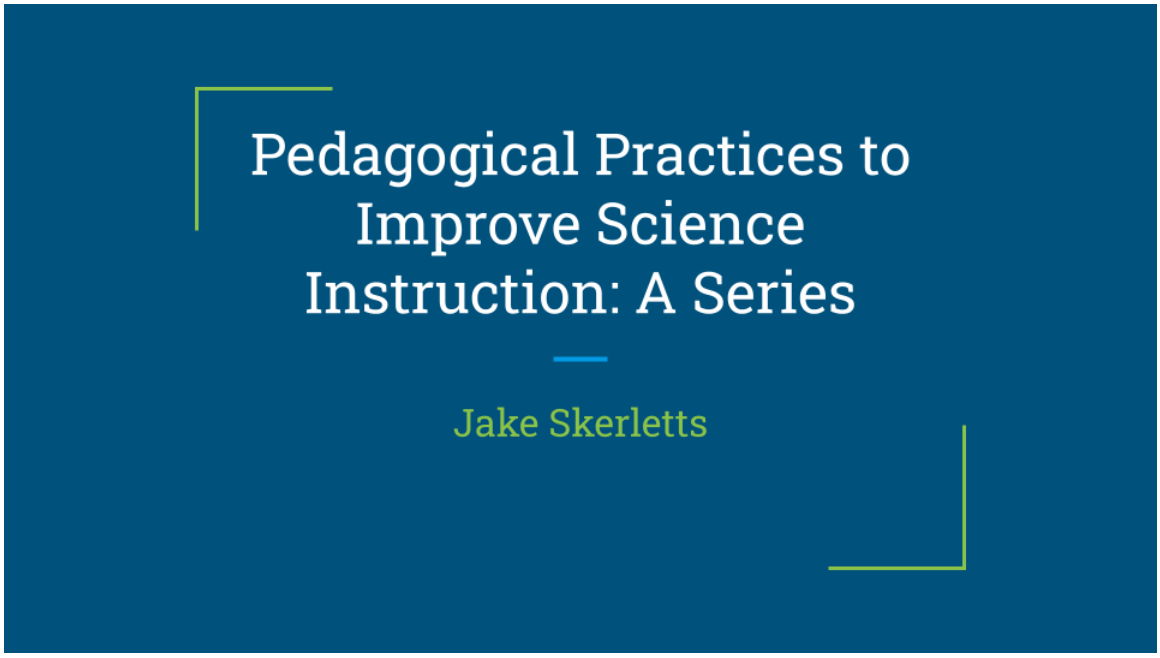
Appendix A

Malcolm Knowles' 4 Principles of Andragogy

Appendix B

Culturally Responsive Pedagogy and Disaggregate Pedagogy Professional Development





Ice breaker question:

If you could have one professional men's sports team in Minnesota be as good as the Lynx, which team would it be?

Students, write your response!

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Session I (one hour duration)

Jake Skerletts

What is the reason for this professional development?

In reality, it will benefit all students but we will focus on our students of color.

It's to best support our students of color

Outline of Series

Session 1: Intro to Achievement Gap and Nature of Science teaching

- Where Minnesota ranks in education for students of color
- What can science teachers do to help close the achievement gap

Session 2: Intro to Culturally Responsive Teaching and the Brain

- Warm demander
- Four phases of learning
- Time for reflection and lesson planning to integrate CRP

Outline continued

Session 3: Open forum for discussion and questions

- Time to bring in other lessons to tweak

Session 4: Introduction to Disaggregate Pedagogy

- Time to rework lessons to reflect Disaggregate Pedagogy

Session 5: Time for questions and discussion

- Time to rework lessons to fit both CRT and Disaggregate Pedagogy

Session 6: Review of Achievement Gap, Nature of Science, CRT, Disaggregate Pedagogy

- Final thoughts, questions, comments

What are you hoping to get out of this professional development series?

Students, write your response!

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If you could change one thing about science teaching, what would you change?

Students, write your response!

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What this Professional Development Is Not About

- Limiting teacher creativity when it comes to creating lessons
- Putting teachers down emotionally

Purpose of this Professional Development

- The purpose of this series is for science teachers to integrate two pedagogical practices into their lessons in order to help close the Achievement Gap here in Minnesota
- Learn about best practices in teaching students of color
- Learn about best practices for science teaching
- Uplift and empower you, as science teachers

What are some group norms we should have throughout this series?

Students, write your response!

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What is the Achievement Gap?

- The Achievement Gap is the term that is used to describe the disparity in graduation rates of students of color compared to those of white students
- This was first revealed in Minnesota during the 2011-2012 school year
- Each state has their own Achievement Gap

National Education Rankings by State (via WalletHub)

There are many factors that go into ranking states quality of education

Factors such as money spent on students, graduation rates, test scores, etc

These factors are applied to all states and are ranked based on "quality points"

Where do you think Minnesota ranks in overall education? (The lowest ranking is 50)

Students, write your response!

Answer: It ranks 12th overall! (McCann 2021)

Where do you think Minnesota ranks in graduation rates for students of color? (Lowest rank is 50)

Students, write your response!

Answer: It ranks either 49th or 50th depending on which group you are looking at (Severson 2019)

Student Group Data: Four-Year Graduation Rates

Student Demographic Group	2019 Graduation Rate (percent)	2020 Graduation Rate (percent)	Change from 2019 to 2020 (percentage points)
All Students	83.7	83.8	+0.1
American Indian/Alaskan Native Students	50.8	55.7	+4.9
Asian Students	87.6	89.1	+1.5
Black Students	69.9	69.2	-0.7
Hispanic Students	69.9	70.4	+0.5
White Students	88.7	89.0	+0.3
Two or More Races Students	72.3	73.5	+1.2
Students Receiving Special Education	63.0	65.0	+2.0
English Learners	67.2	66.2	-1.0
Students Eligible for Free/Reduced-Price Meals	71.0	71.6	+0.6

Looking at the data in this chart, what do you notice?

What can science teachers do?

Students, write your response!

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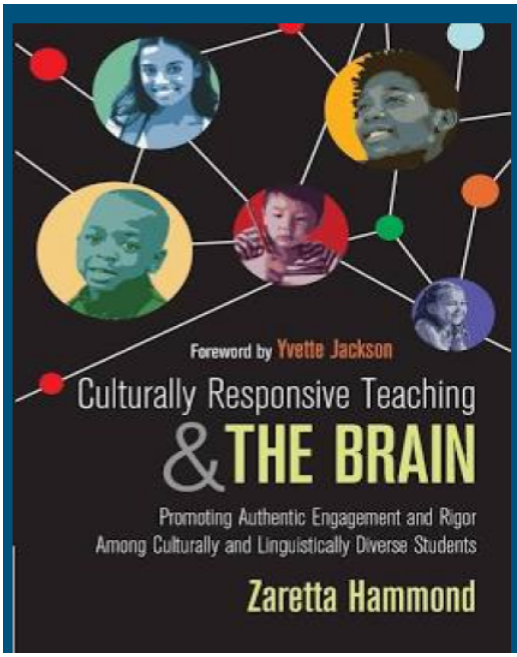
What is the first thing you think of when someone says "Nature of Science"?

Next Generation Science Standards



Culturally Responsive Teaching

Culturally Responsive Teaching and the Brain by Zaretta Hammond

- This is your homework assignment for the next session.
- Please read the book and use the double entry journal in order to record things that stood out to you and what your thoughts were when you read it.
- Also take notes on things that you felt were contradictory to your experience.
- The next session, we will go into the concepts described in the book and there will be room for discussion and also dedicated time to create or reshape any upcoming lessons to model Culturally Responsive Teaching.

End of Session I

Thank you for your time!

Session II (two hour duration)

Jake Skerletts

Culturally Responsive Teaching and the Brain

Review and implementation of concepts

What is filling your bucket today and what's draining it?

Students, draw anywhere on this slide!

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For your assignment you were asked to:

- Read through Culturally Responsive Teaching and the Brain and take notes on:
  - Concepts that were new to you
  - Things that you can easily use in your upcoming lessons
  - Things that you felt conflict with your experiences as a teacher

What was something that was new to you?

Students, write your response!

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What was something that you can easily use in your upcoming lessons?

Students, write your response!

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What was something that you felt conflicts with your experience?

Students, write your response!

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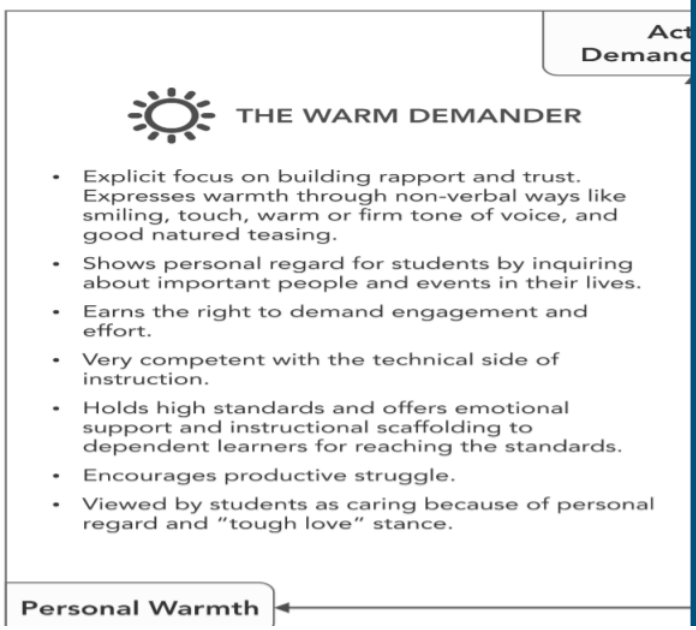
With your table mates, discuss what concepts intrigued you the most.

Review of Key Concepts for CRP



Warm Demander

Building Intellectual Capacity

Ignite: Cue the Brain to Pay Attention

- Gets the brain's attention
- Can be done in different ways (find a way that you feel comfortable with)
  - Call and response
  - Music
  - Powerful images in a slideshow (quotes, pictures, videos etc)
  - Structured talking activities

- Lasts about 5-10 minutes and is meant to gain attention and signal to students that learning is about to happen

Chunk: Feed the Brain Bite-Sized Pieces of Information

This is presenting information to the students in small, digestible pieces.

Keep the big picture in mind when presenting concepts so the students are able to piece it all together and make connections with their funds of knowledge

This is to not overwhelm the students with too much information

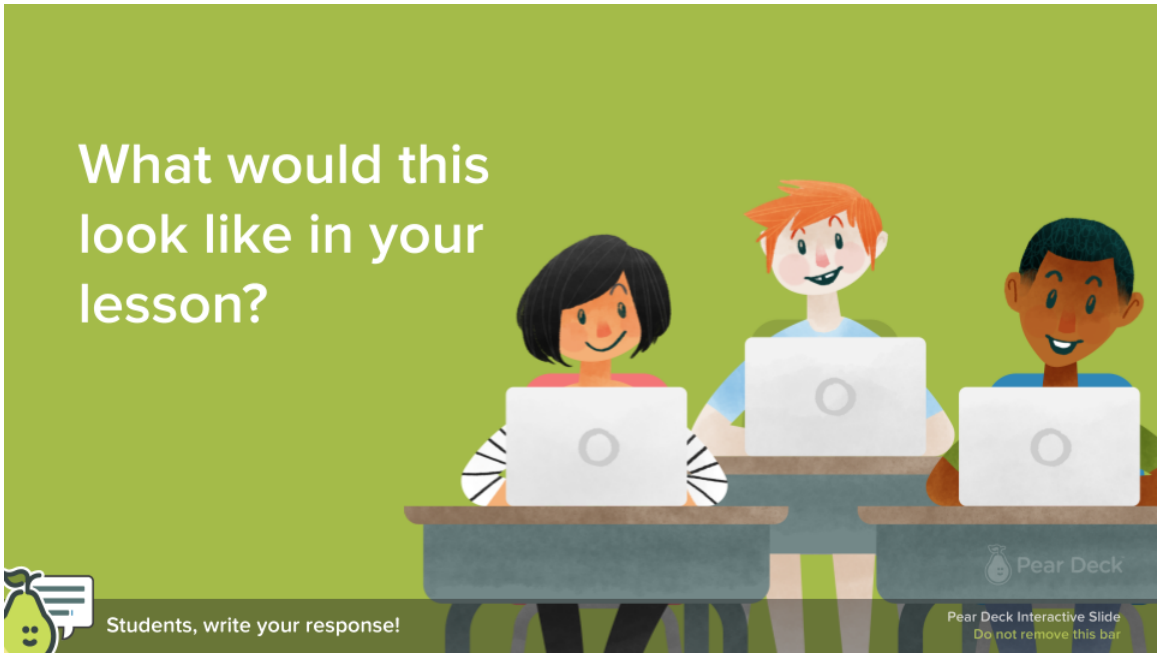
Chew: Help the Brain Process the Content

- The brain takes in information for 12-20 minutes
- After this time, it takes 5-10 minutes to process the information it just took in
- When teachers understand this processing time, there can be intentional activities for students to participate in to gain a better and deeper understanding of the content.

Review: To Strengthen Neural Pathways

- Reviewing with intention and regular intervals and intensity will help develop long term retention
- This can be done with any type of review game that you can think of.
- Another way is to have a long term project that incorporates the content that you introduce.

This is just the outline for you to use. You have creative freedom when implementing it.



Time for Lesson Creating/Reworking

- The next hour is dedicated time for you to take what you learned from Culturally Responsive Teaching and to implement the concepts into your lessons.
- Use your colleagues and use me to bounce ideas around to implement these concepts into your lessons

What questions do you have before we wrap up the session?

Think about a lesson where you did something new that you've never done before. How did it go? Looking back, what would you have done differently?

Parting Words

End of Session II

Thank you for your time!

Session III (one hour duration)

Jake Skerletts

Today's Agenda

Discussion and Dedicated Work Time

- This session will be an hour long
- Half of the time will be spent discussing how the lessons went
- Other half will be spent integrating Culturally Responsive Pedagogy into your future lessons

Stress Check

0 1 2 3 4 5 6 7 8 9 10

I'm in a good space and can focus

Something is bothering me, but I can still focus

I can't manage my emotions or behaviors right now

Students, drag the icon!


How did your lessons go?
Students, write your response!
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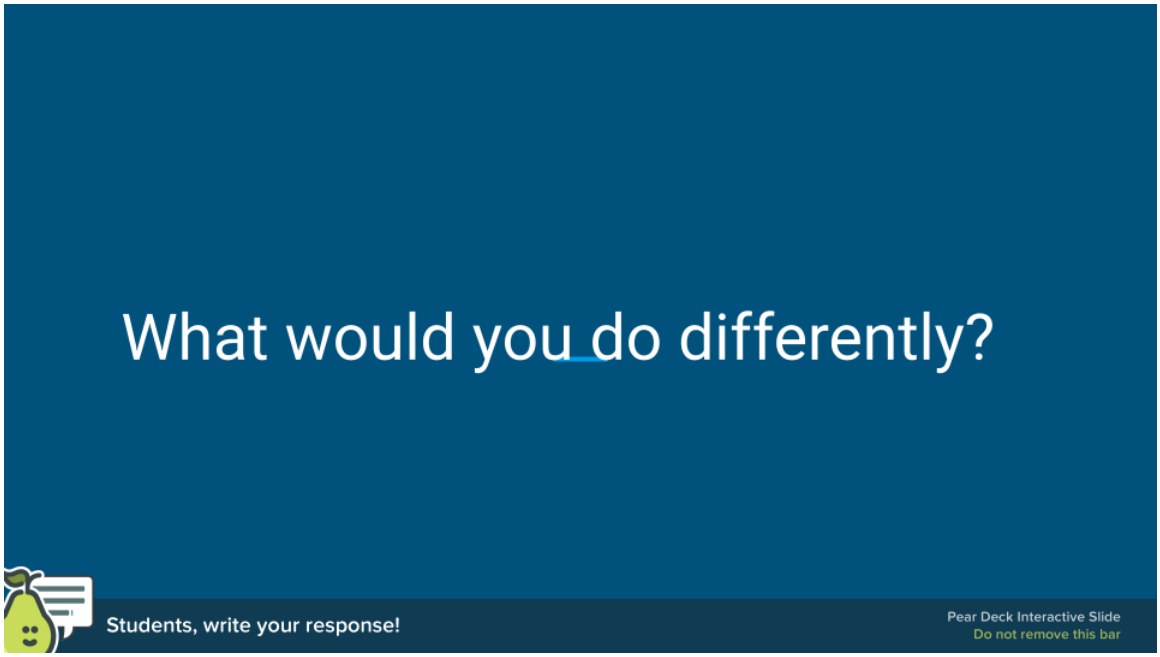
What would you do differently?
Students, write your response!
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What were your roses, thorns, and buds of the lessons? (Once you finished answering turn to your table partners and discuss your experiences)

Students, write your response!

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Time dedicated to lesson plan creation/reworking

What questions do you have before we wrap up the session?

Homework assignment: Read *Science in the City: Culturally Relevant STEM Education* by Bryan Brown

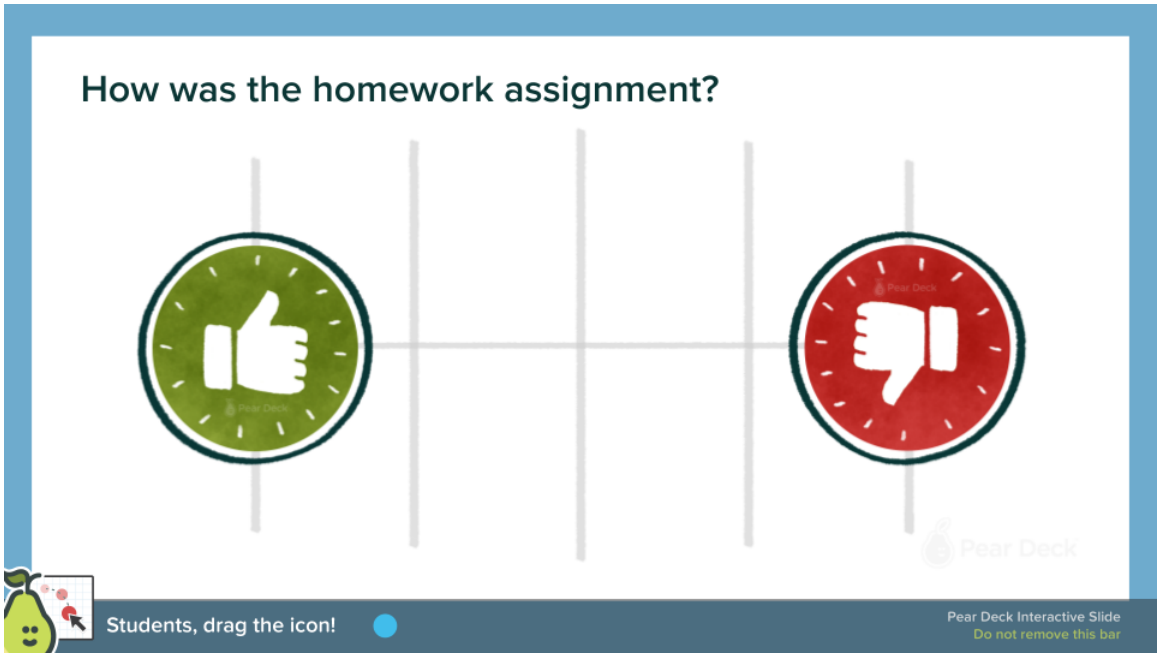
During your reading, takes notes on things that stand out to you or intrigue you or things that you don't like

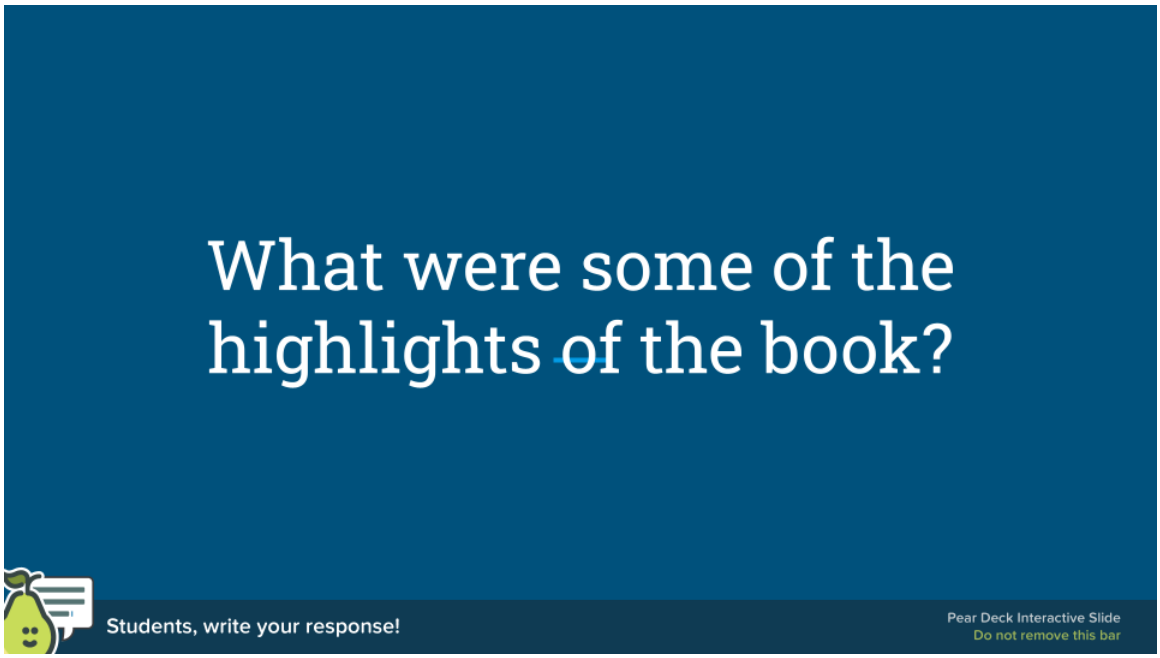
End of Session III

Jake Skerletts

Session IV (two hour duration)

Jake Skerletts




What were some of the highlights of the book?
Students, write your response!
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What questions do you have about the reading?
Students, write your response!
Pear Deck Interactive Slide
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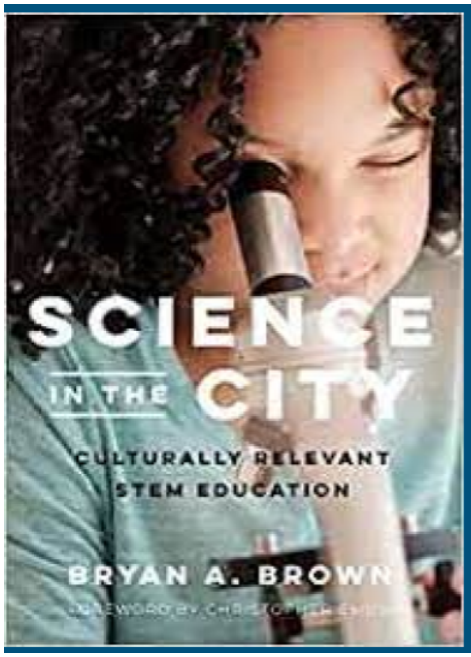


Review of Science in the City

Generative Formative Assessment

Creates an opportunity for the students to explain an idea

Needs to accomplish three things:

1. Used as an exercise to help students improve their understanding
2. Give students a chance to explain the answers
3. Give students a chance to practice using scientific language

Disaggregate Pedagogy

Phase One: Pre-Assessment

Can be verbal or written pre-assessment.

Allows two things for the teacher:

1. understand what aspects of the content students are clear about.
2. What language resources the students bring
   a. Can be used by the teacher to make connections using the language resources they have

Phase Two: Everyday Content Instruction

Offers the big idea of the instruction using everyday, accessible language

This is so that the concepts as clear as possible before introducing the academic science language

Phase Three: Explicit Language Instruction

These are the activities that the teachers has the students participate in so that they are introduced to the specific science terminology.

This allows for students replace the language that they used from the pre-assessment with the scientific language that they are learning.

There should be statements that this language mastery is a part of their learning

Phase Four: Scaffolding Opportunities For Discourse

This is to help build the scientific fluency of the students.

They need to be given ample opportunities to explain their learning using the scientific language that is being taught.

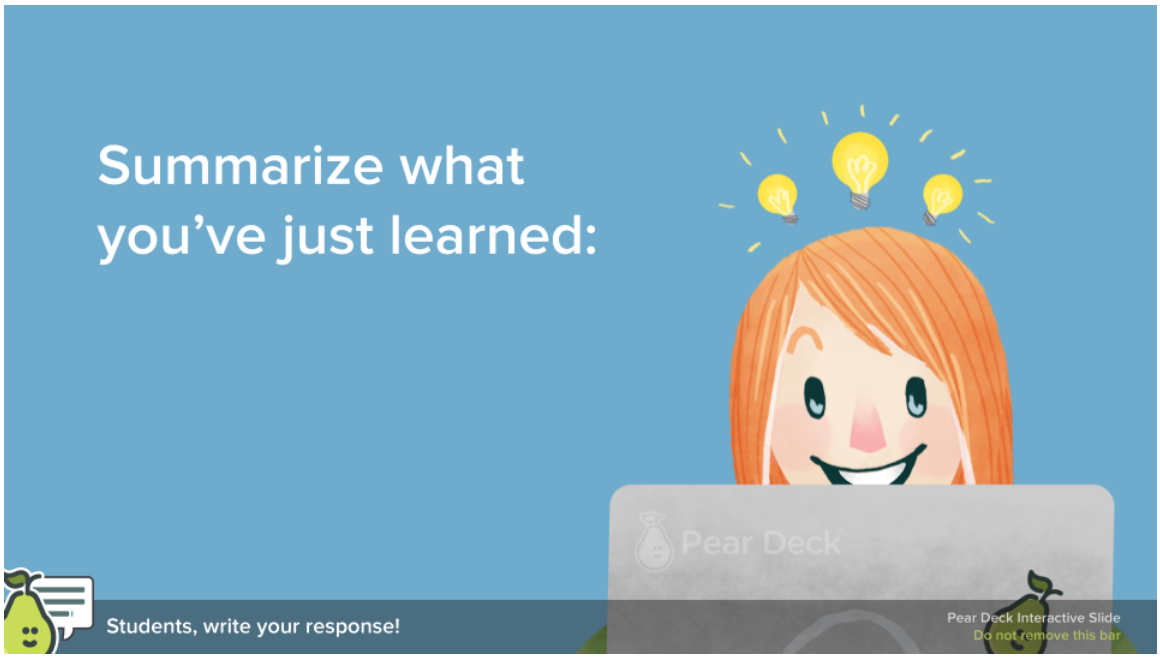
This can be done using open ended questions for the students to answer using the language that they were taught.

Discussion

What were some concepts that were new to you?

What was your overall feeling about Disaggregate Pedagogy?

What are some similarities and differences between Disaggregate Pedagogy and Culturally Responsive Pedagogy?


Summarize what you've just learned:
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Students, write your response!
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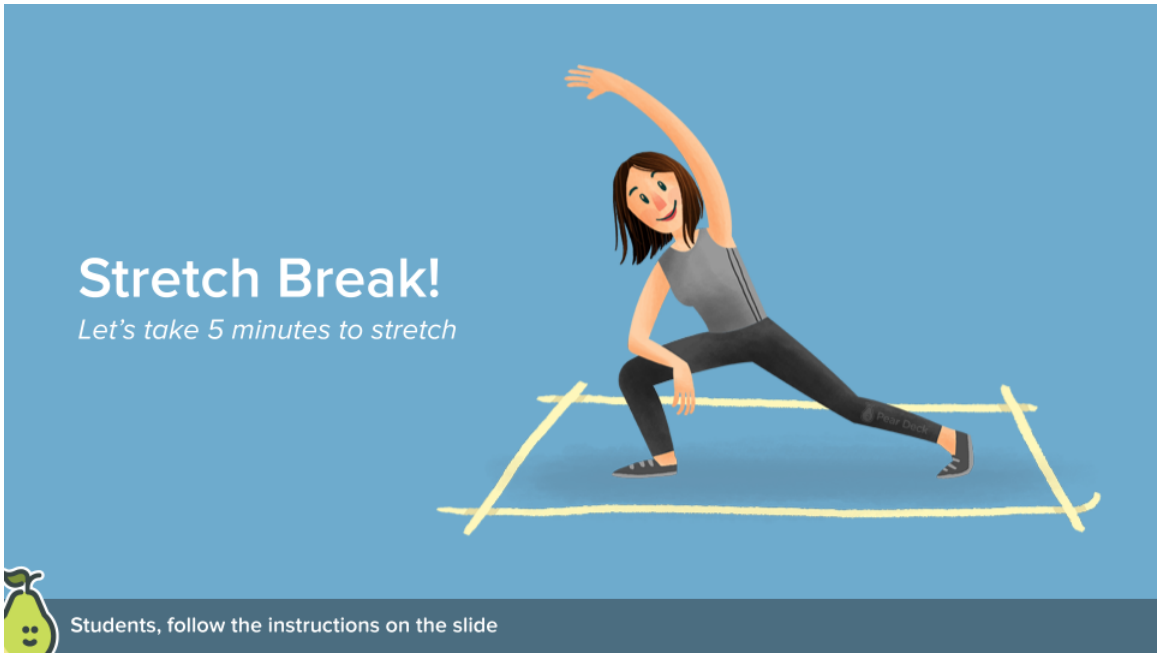
Stretch Break!
Let's take 5 minutes to stretch
Students, follow the instructions on the slide

Dedicated Time to Lesson Creation/Reworking

We will be spending the rest of the time to create/reworking upcoming lessons to reflect Disaggregate Pedagogy.

Work with your PLC to see what you can do.

Disaggregate Pedagogy is a guideline for you but the way that you go through the four phases is up to you and your creativity.

For next session, please bring any upcoming lessons and materials you need to create those lessons.

What questions do you have before we wrap up the session?

End of Session IV

Thank you for your time!

Session V (one hour duration)

Jake Skerletts

Today's Agenda

- We will have dedicated time for discussion on how your lessons went using Disaggregate Pedagogy
- We will also have dedicated time for you to rework any upcoming lesson


How did your lessons go when using Disaggregate Pedagogy?
Students, write your response!
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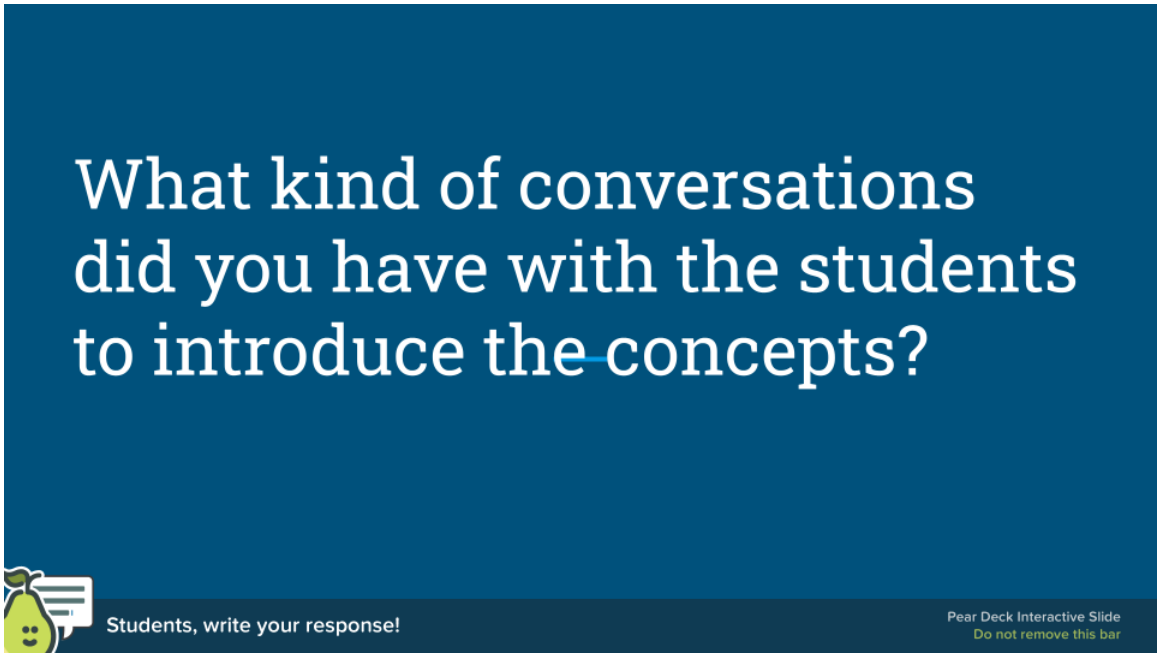
What kind of conversations did you have with the students to introduce the concepts?
Students, write your response!
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Did the students seem to show a better understanding of the concepts?

Students, write your response!

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What was a rose, thorn, and a bud from your previous lessons?

Students, write your response!

Pear Deck Interactive Slide
Do not remove this bar

Now we will spend the rest of the session creating or reworking the lessons that you brought.

What questions do you have before we wrap up the session?

End of Session V

Thank for your time!

Session VI (one hour duration)

Jake Skerletts

Stress Check

0 1 2 3 4 5 6 7 8 9 10

I'm in a good space and can focus

Something is bothering me, but I can still focus

I can't manage my emotions or behaviors right now

Students, drag the icon!

Pear Deck Interactive Slide
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What is filling your bucket today and what's draining it?

Students, draw anywhere on this slide!

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Final session!

- We will have a review of the concepts of Culturally Responsive Pedagogy and Disaggregate Pedagogy
- We will also revisit the purpose of this professional development series
- Time for discussion and your experiences of implementing these pedagogical practices

What is the Achievement Gap?

- The Achievement Gap is the term that is used to describe the disparity in graduation rates of students of color compared to those of white students
- This was first revealed in Minnesota during the 2011-2012 school year
- Each state has their own Achievement Gap

Revisit of the Achievement Gap

Minnesota is ranked at the bottom, in the nation, for the graduation rates for students of color.

The graduation rates from 2019-2020 had some marked improvement in certain groups but we need to do even better in the years to come

We, as educators, need to do what we can so that these students are able to feel seen, included, and wanted in the classroom.

When classroom lessons have meaningful ties to the culture and personal lives of the students, they feel more invested in their learning.

Revisit of the Nature of Science

The more modern way of looking at science, known as the Nature of Science, is more invested in learning science as a process rather than a body of knowledge.

The components of science give students the opportunity to engage in science and apply it to phenomenon that happen in their everyday lives.

With the guidance of the teacher, the content vocabulary can be introduced to the students in layman's terms so that they can begin to develop more of their scientific knowledge.

These scientific concepts can then be seen as being integrated with other fields of study or hobbies or general interests

Revisit of Culturally Responsive Pedagogy

It is a practice that can be used by any teacher in any licensure area

It has four steps in order to help build intellectual capacity in students

1. Ignite
2. Chunk
3. Chew
4. Review

Revisit of Disaggregate Pedagogy

This pedagogical practice was created specifically to be used by science teachers

It introduces concepts to students using every language that is accessible to them

The students then are introduced to the scientific vocabulary that is associated with the content that is being taught.

They are then given ample opportunities to use this new scientific language to help build better and deeper understanding of the content.

Remember answering these questions?

What are you hoping to get out of this professional development series?

If you could change one thing about science teaching, what would you change?

Did you get what you were looking for?

Students, write your response!

Were you able to change something about science teaching over the course of this series?

Students, write your response!

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Final Message

End of Session VI

Thank you for your time!

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Appendix C

Culturally Responsive Teaching and the Brain by Zaretta Hammond

You can find a synopsis of the book by clicking on the following link:

https://crtandthebrain.com/about/

Appendix D

Science in the City: Culturally Relevant STEM Education by Bryan A. Brown

You can find the synopsis of the book by clicking on the following link:

https://www.hepg.org/hep-home/books/science-in-the-city

Appendix E

Using Social Justice in the Classroom Survey

Using Social Justice in Daily Lessons

Please answer this form as truthfully as possible. Thank you for your time!

jskerletts01@hamline.edu (not shared) Switch account

* Required

What do you know about Social Justice? *

Your answer

Do you use Social Justice in your lessons? *

- Yes
- No
- Maybe

Do you think Social Justice can be used in science teaching?

Your answer

Would you attend a Professional Development that would help you implement Social Justice into your lessons? *

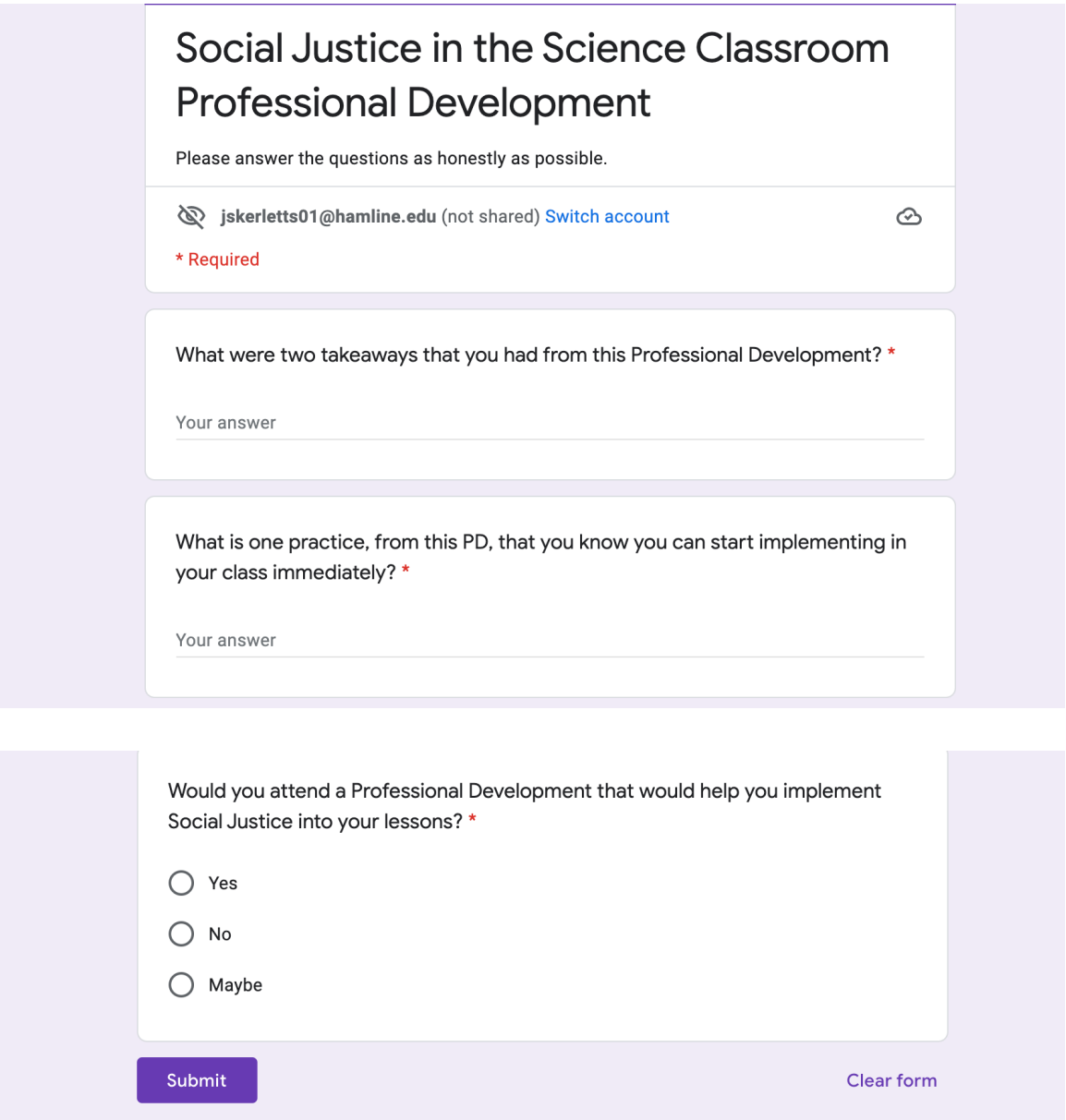
- Yes
- No
- Maybe

Submit

Clear form

Appendix F

End of Professional Development Exit Survey



Social Justice in the Science Classroom Professional Development

Please answer the questions as honestly as possible.

jskerletts01@hamline.edu (not shared) Switch account

* Required

What were two takeaways that you had from this Professional Development? *

Your answer

What is one practice, from this PD, that you know you can start implementing in your class immediately? *

Your answer

Would you attend a Professional Development that would help you implement Social Justice into your lessons? *

- Yes
- No
- Maybe

Submit

Clear form