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CULTURALLY RESPONSIVE TEACHING IN SCIENCE CLASSROOMS

by

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A capstone submitted in partial fulfillment of the requirements for the
degree of Master of Arts in Teaching.

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CHAPTER ONE

Introduction

Research Question

A mother of one of my 7th grade science students recently texted me, absolutely panicked. She said, “What’s going to happen when she leaves 8th grade? I’m terrified. What if she can’t do it without all this support? Is she going to be okay?” She raises an important question: what are we doing to help students be successful in life beyond middle school? Will they have developed the cognitive skills to be self-directed learners? Are we creating enough opportunities for students to experience productive struggle?

Many educational scholars have dug into the question of how to develop independent learners. I am interested in approaching this dilemma with another lens: culturally responsive teaching. As a middle school science teacher, I will be focusing on the ways that science educators can bring culturally responsive teaching practices and mindsets into their classrooms. The end goal, however, is not to stop at cultural responsiveness. Instead, teachers need to be using culturally responsive teaching to support their students as they work to become independent, self-driven learners. The question that will be addressed in this research is: “How can science teachers use culturally responsive teaching to help their students develop into independent, self-directed learners?”

To understand the premise of this project, one must have a clear grasp on the concept of culturally responsive teaching. Gloria Ladson-Billings, one of the country’s most influential education scholars, defines culturally responsive teaching as “a pedagogy that empowers students intellectually, socially, emotionally, and politically by using

cultural referents to impart knowledge, skills, and attitudes. These culture references are not merely vehicles for bridging or explaining the dominant culture; they are aspects of the curriculum in their own right” (1994, pp. 18-19). This method has been touted as one of the most effective ways by which educators can support underachieving students. As a middle school science teacher, I notice the number of students who are highly dependent on teacher support. Whether because of a lack of confidence or a lack of skills, dependent students are often unable to know where to start when tackling complex problems. Culturally responsive teaching creates a learning environment in which students can take risks and persevere through authentic and high-rigor learning tasks, thus building their intellectual capacity and developing more independence in their learning (Hammond, 2015).

In this project, I will be focusing on four components of culturally responsive teaching. These four key areas were originally outlined by Zaretta Hammond, author of the book “Culturally Responsive Teaching and the Brain”. They include: increasing awareness, developing learning partnerships, supporting information processing, and building a community of learners (2015). I will be reviewing the existing research on Culturally Responsive Teaching in STEM spaces, and then will share recommendations on research-driven strategies for bringing CRT into the science classroom.

Rationale

I am a white woman that teaches primarily Black students in North Minneapolis. I work with incredibly brilliant, creative, kind, and driven students. However, over their lifetime and the generations of those who came before, my students have been negatively

impacted by an educational system entrenched in inequity. These inequities have caused a substantial opportunity gap between Black and brown students and their white peers.

For this gap in our country to be addressed, we need to approach it from a multitude of directions. We must work to actively dismantle the systems of oppression that maintain this gap. At the same time, teachers and schools must create educational experiences that help students overcome barriers. We can do that by recognizing students' natural cognitive resources and helping to build communities and experiences in which they can apply those gifts to become independent, self-driven learners.

For me, there is one aspect of our country's educational inequity that is particularly alarming. Many students of color, by no fault of their own, are remaining dependent learners. This is caused by daily systemic injustices in our classrooms and our schools. For students to become independent learners, they must have access to specific strategies for overcoming complex learning tasks *and* they must have enough confidence to continue persevering through the challenges. The opportunity gap is preventing students of color from having these experiences. Therefore, they are remaining dependent on adult support instead of being able to independently problem solve (Johnson, 2011).

In my current school, as well as many of those I've observed, there are few opportunities for students to engage in productive struggle. Too often, the learning tasks given to students are low-level and repetitive. Children may learn a set of steps or a specific fact, but they do not learn *how to learn*. Some teachers may say, "Okay, then I'll just make the assignment harder." This is not enough. We must increase the rigor and authenticity of tasks, but we must also build a community in which students feel free to

take risks and to periodically fail. This research aims to help science teachers find ways to achieve the balance. Our classrooms must be rigorous, authentic, safe, and responsive.

Context

I have spent six years teaching science at my school, which is part of a network of charter schools in North Minneapolis. Our schools are kindergarten through eighth grade, and serve primarily Black students. Nearly 100% of our students qualify for free and reduced lunches and many have jumped around between a number of schools prior to coming to our school. Students tend to enter our school well below grade level on the standardized tests and highly dependent on teacher support. Again, this is no fault of their own, but is a result of the inequities that exist within Minnesota and the country. Our goal is to prepare our students to be lifelong learners and active citizens, with the freedom to live choice-filled lives.

One quick story from my classroom shows the ways in which my idea of a “strong teacher” has shifted. One afternoon, I had a doctor’s appointment and had to leave school early. I alerted my supervisor, sent sub plans, filled out the PTO form, and went on my way. I figured that all would be well. The next morning, as I was prepping for the day, the principal stopped into my classroom to share a story from the previous afternoon.

According to her, the seventh period bell rang and a group of eighth graders headed to my science classroom. About 25 minutes into the period, one of the eighth graders knocked on the principal’s door: “Excuse me, Ms. Washington, we’re just wondering--what should we do next?” Ms. Washington, who was quite confused, asked the student to elaborate. Apparently, the class of twenty-seven eighth graders had filed

into science class, only to realize that the substitute had not shown up. There was a bit of confusion until the students decided, together, that they would still get to work on their daily class routine. Students had completed their “Do Now”, reviewed it together, and set up their notebooks for the day’s lesson. Finally, they reached the section during which we typically do our investigation, take notes, or complete our reading. Only then did they decide it was important to touch base with the principal.

After hearing this story from Ms. Washington, I could finally name an important shift in my teaching philosophy. One of the reasons that I began teaching is because I appreciate feeling needed. I wanted to be a teacher that showed up every day and kept the class engaged, motivated, answered all their questions, and basically--just did it all! However, my mindset has shifted. I don’t want students to need me. I don’t want students to depend on my lesson in order for them to learn. I don’t want students to work hard to please me. If students rely on these extrinsic forces, then the learning stops when they leave my classroom. Instead, I need to find ways to increase their independence. I need to create a learning environment in which students are the ones driving their own learning. Students should have the skills and the confidence to tackle problems independently.

I am no expert. I have not yet reached a point where 100% of my students are independent, self-directed learners. Recently, I was speaking with a coworker who supports our alumni once they’ve left our school and moved on to different area high schools. She shared some general feedback heard often from teachers and administrators of our alumni. Many of these educators explain that our students are really good at filling out worksheets and doing homework assignments that are due the next day. They work

hard when an adult sits with them, and ask questions right away when they don't understand.

However, they explained that many of our alumni struggle when it comes to bigger, more self-directed projects. They get flustered and agitated when they don't understand something, and sometimes have difficulty getting out of that negative space. I believe these tendencies are because of a lack of experience. In middle school, we were very supportive. We walked them through everything and were extraordinarily available when they needed help. Because of this, students may have developed a kind of "learned helplessness".

Since hearing this, I have spent a lot of time supporting and observing in our middle school classrooms. In these, as well as in my own, I have noticed trends that can account for some of our alumni's challenges. Some of these observations include: 1) Learning tasks are often very teacher-centered, including taking notes, working through example problems, or having a chapter of a book read aloud. 2) Students are receiving a lot of praise for completing low quality and/or very simple work. 3) Teachers are very accommodating, allowing students to reach out for support whenever it's needed.

Our teachers are well-intentioned. We want to do whatever it takes to support students. However, by overfunctioning and coming to students' rescue, are we actually enabling students? Are we subconsciously communicating low expectations and teaching students a "learned helplessness"?

This is a big motivating force for my research focus area. I want to help our school to become a place where students can become independent learners that have the skills and confidence to tackle anything!

Project Overview

During the 2020-2021 school year, our staff participated in a book study on Zaretta Hammond's book, "Culturally Responsive Teaching and the Brain". Deciding to take a risk, I signed on to co-facilitate this book study. Our team read the book chapter by chapter and met once a month to discuss. This experience was transformative. It pushed me to think critically about my own classroom. It encouraged me to analyze my own teaching and, in doing so, recognize the many ways in which I am exacerbating existing inequities.

Overall, staff were very pleased with the conversations coming out of the book study. On average, 95% of participants have said that the book study sessions have been impactful. However, in one of our surveys, a staff member explained, "I think if we had time to speak about what CRT looks like in our lessons/rooms it will have much more of a takeaway." I heard a similar sentiment during a science content meeting later on in the school year. We all appreciated the book study and the introduction to Hammond's framework. However, we were stuck on how to implement this in our science classes.

My hope for this project is to provide an extension of our book study, specifically for the science department at our school. Science is already an important part of our school's academic programming. As science teachers, we try to emphasize skills over content, so that students can be lifelong learners and problem solvers. We are on the right path. However, we have not yet been intentional about using culturally responsive strategies in our instruction. I believe that focusing on CRT in science instruction would make a big difference in students' experiences.

The development program will be structured around Zaretta Hammond’s “Ready for Rigor” framework, which will be discussed in depth during the second chapter. The goal of the PD series is that every teacher is able to analyze and adjust existing science lessons to make them more culturally responsive. It will be a cooperative learning experience. Teachers will work together to learn about what happens in students’ brains when they are learning, and then will use this knowledge to bring culturally responsive practices into their lessons. Eventually, the shift should help students on their path to becoming independent learners by increasing their problem solving skills and their confidence in their intellectual abilities.

Conclusion

In the next three chapters, we will be discussing the question, “How can science teachers use culturally responsive teaching to help their students develop into independent, self-directed learners?”

Chapter 2 will dive deeper into the existing research around culturally responsive teaching, inequities in science education, and how to implement CRT in science classrooms. We will hear from education leaders such as Gloria Ladson-Billings, Zaretta Hammond, A. Wade Boykins, and more. During this chapter, the hope is that you develop a strong understanding of the importance of building students’ independence, as well as how culturally responsive teaching practices can be used to accomplish that goal. Chapter 3 will share a more detailed description of the professional development opportunity, including how, when, and where it will take place. Finally, Chapter 4 will go into the big takeaways as well as considering the implications and limitations of the research.

CHAPTER TWO

Literature Review

An Overview of Culturally Responsive Teaching

This project will be utilizing the theory of *culturally responsive teaching*, which has been referred to as many names over the years, including culturally relevant, culturally competent, culturally sustaining, and culturally appropriate. Geneva Gay is one of the most prolific and influential educational researchers when it comes to the theory of culturally responsive teaching. In her book published in 2000, Gay describes the theory as “using cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant and effective for them. It teaches *to and through* the strengths of these students. It is culturally *validating and affirming*” (Gay, 2000, p. 29).

For many years, educational scholars have been suggesting that culturally responsive teaching is a possible solution for addressing inequities within our nation’s classrooms. First, this section will provide an overview of culturally responsive teaching, including the ways it can be used to help students grow into “independent thinkers”. The second part of the section will go into the specific practice areas of culturally responsive teaching. In the next section, we will then be thinking about how these can be applied within the middle school science classroom. As we dive into the research, it is important to understand the ways that culturally responsive teaching can improve students’ performance and independence, regardless of their racial and/or cultural background.

The goal in this project is to equip science teachers with the skills they need to create rigorous and responsive science lessons. Teachers will move through a series of

professional development sessions. As a team of science teachers, we will first discover how students' brains learn and then will determine ways we can use culturally responsive teaching to help our students become more independent learners.

These questions are incredibly important as our country becomes increasingly diverse. We need our education system to provide equitable learning experiences for all children, as our country needs diverse perspectives in order to thrive in a growing world.

History of the Movement

In order to truly understand culturally responsive teaching and its implications on students' educational experience, one must look back at the history of multicultural education in our country. Deborah Harmon, an educational researcher at the University of Michigan, published an article in 2012 that traced this history. Harmon suggests that the movement for multicultural education emerged in the 1960s during the Civil Rights Movement. She explained that before the Civil Rights Movement, many people believed "that minority students' lack of achievement was due to dysfunctional families and cultural deprivation" (Harmon, 2012, pp. 16-17). However, activists emphasized a new theory about the gaps in achievement. These gaps, they explained, were caused by "the negative impact of devaluing minority groups' cultures and the conflicting expectations between school and the home" (p. 17). This was an important shift in the discussion around educational inequity. Instead of the emphasis being placed on deficits in students' personal or home lives, the focus turned toward what was actually happening in the education system. Later in her 2012 article, Deborah Harmon pointed out the following:

Civil Rights activists demanded educational institutions to cease their racist and oppressive practices and distorting their cultural heritage and cultural contributions to

society. They also demanded the establishment of ethnic studies courses and departments on college campuses so students could learn their true history. (p. 17)

Activists' fight for educational equity is often considered the beginning of our current-day movement for culturally responsive teaching.

Leaders in the Movement

Since the Civil Rights Movement, there has been a group of educational scholars focused on addressing the discrepancies in educational achievement. This group has poured years of research into determining the root causes of these inequities and proposing possible solutions. Together, they developed a theory of culturally responsive pedagogy and a series of books about the topic. James Banks, often referred to as “The Father of Multicultural Education” wrote the foreword to this series. In it, he refers to their theory of culturally responsive pedagogy, explaining, “This theory postulates that discontinuities between the school and low-income students and students of color is an important factor in their low academic achievement. The theory also postulates that the academic achievement of these students will increase if schools and teaching are changed so that they reflect and draw on their cultural and language strengths” (Gay, 2000, p. ix). These education scholars aim to improve schools to help them become more responsive to the strengths and needs of their students.

As we dive into the research of specific education scholars, it is important to recognize that culturally responsive teaching aims to help *all* students, not just low income students and students of color. In the same series foreword, James Banks explained, “An important goal of multicultural education is to improve race relations and to help all students acquire the knowledge, attitudes, and skills needed to participate in

cross-cultural interactions and in personal, social, and civic action that will help make our nation more democratic and just” (Gay, 2000, p. viii). When thinking about the theory of culturally responsive teaching, it is important to remember that this type of pedagogy and set of beliefs is as important for white students as it is for students of color.

Gloria Ladson-Billings. Gloria Ladson-Billings is one of the education scholars that contributed to the Multicultural Education Series. In her 1995 book, “The Dreamkeepers: Successful Teachers of African American Children”, Ladson-Billings first introduced the idea of culturally relevant teaching. She begins by describing the inequities that African Americans students face in our classrooms. One of these challenges, she explains, is the common belief that students of color are culturally deprived and disadvantaged. She explains,

The use of such terms contributed to a perception of African American students as deprived, deficient, and deviant. Because of this, many proposed educational interventions were designed to remove the students from their homes, communities and cultures in an effort to mitigate against their alleged damaging effects. Educational interventions...often were based on a view of African American children as deficient white children. (p. 8)

Later in the book, Ladson-Billings explains the aspects of culturally relevant teaching and highlights teachers who utilize these mindsets and pedagogy to educate their students. She defines it as the following:

Culturally relevant teaching is a pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes. These culture references are not merely vehicles for bridging or

explaining the dominant culture; they are aspects of the curriculum in their own right. (pp. 18-19)

In order to become a culturally relevant teacher, it is important that one is reflective about his/her beliefs and practices. It is not enough to simply apply responsive pedagogical strategies. It is equally important to recognize our own internalized conceptions of ourselves and others. An updated version of Ladson-Billings' book provides a table that compares beliefs held by culturally responsive teachers with those held by assimilationist teachers (Ladson-Billings, 2014, p. 38). One important difference is in the way that teachers view knowledge attainment. A culturally responsive teacher views teaching as "pulling knowledge out" of students, while an assimilationist teacher thinks of teaching as "putting knowledge into" students (p. 38). Additionally, an important differentiation between the two types of teachers is the way that they view community. A culturally relevant teacher is entrenched in the community and recognizes the importance of giving back. An assimilationist teacher, on the other hand, encourages students to use their achievement as a way to get out of their community and to escape to another.

Gloria Ladson-Billings continues to be one of the leading education scholars within the movement to bring culturally responsive teaching into classrooms. As we work to make our teaching equitable, we should keep in mind the mindsets and beliefs that Gloria Ladson-Billings has outlined throughout her career.

Geneva Gay. Geneva Gay is another one of the major contributors to the theory of culturally responsive teaching. Her work builds and expands upon the work of Ladson-Billings. Interestingly, Geneva Gay preferred a different term for the concept.

Instead of referring to it as “Culturally Relevant Teaching”, she used the label, “Culturally Responsive Teaching” (2000, p. 29). Today, the two are used interchangeably to refer to a very similar set of beliefs and practices.

However, Geneva Gay’s research did have a slightly different focus than that of Ladson-Billings. Ladson-Billings focused her attention on educators’ mindsets and beliefs. According to her, culturally relevant teachers must believe that every student is capable, and they must hold high expectations that communicate that belief (1994). Geneva Gay, on the other hand, focused on curriculum and instruction.

In her book published in 2000, Geneva Gay lists some of the characteristics of culturally responsive teaching:

- It acknowledges the legitimacy of the cultural heritages of different ethnic groups, both as legacies that affect students' dispositions, attitudes, and approaches to learning and as worthy content to be taught in the formal curriculum.
- It builds bridges of meaningfulness between home and school experiences as well as between academic abstractions and lived sociocultural realities.
- It uses a wide variety of instructional strategies that are connected to different learning styles.
- It teaches students to know and praise their own and each others' cultural heritages.
- It incorporates multicultural information, resources, and materials in all the subjects and skills routinely taught in schools. (p. 29)

When contrasting this list with the one from Ladson-Billings’ book, the differences are quite clear. While one focuses on mindsets and beliefs, the other focuses

on transforming curriculum and teaching practices. Both are crucial as we think about making our classrooms rigorous and equitable. For simplicity's sake, I will be using the term *Culturally Responsive Teaching* for the remainder of this paper.

Zaretta Hammond. More recent research by Zaretta Hammond takes a different approach, focusing on the connection between neuroscience and culturally responsive teaching. She emphasizes the ways that teachers can use brain-based learning concepts to support students on their path to becoming independent learners. In her book, *Culturally Responsive Teaching and the Brain*, Hammond explains,

While the achievement gap has created the epidemic of dependent learners, culturally responsive teaching (CRT) is one of our most powerful tools for helping students find their way out of the gap. A systematic approach to culturally responsive teaching is the perfect catalyst to stimulate the brain's neuroplasticity so that it grows new brain cells that help students think in more sophisticated ways. (2015, p. 15)

Throughout her research, Hammond emphasizes the differences between dependent and independent learners. Dependent learners are described as “not able to do complex, school-oriented learning tasks such as synthesizing and analyzing informational text without continuous support” (p. 13). Independent learners, on the other hand, have “increased brainpower and can accelerate their own learning, meaning they know how to learn new content and improve their weak skills on their own” (p. 15).

Dependence does not mean deficiency, and students' dependence is by no fault of their own. In fact, most students begin school as dependent learners. As educators, our job is to provide opportunities for productive struggle, during which students become

more and more independent. We also must create an environment in which students can develop positive mindsets about their abilities. Without these, students will continue to be dependent on adult support (Hammond, 2005).

Challenges Within Science Education

Now that we have gone into an overview of culturally responsive teaching, we must align on the reason it is needed in every science classroom. Two alarming data trends demonstrate the necessity of high quality, student centered, and equitable science education. Additionally, we must take a close look at the national standards in order to have a deeper understanding of the strengths and weaknesses of science education within our nation currently.

The Science Gap

A major *science gap* is forming between the United States and other wealthy countries. For a long time, the US has been considered to be the uncontested leader of science and technology across our planet. However, recent reports are showing that the global landscape is changing, and the United States is falling behind. A 2013 report by President Obama's office looked more closely at STEM education in order to formulate a strategic plan (Committee on STEM Education, 2013).

In this report, they shared statistics from a 2009 study of 33 countries. Students were tested on their ability to apply academic knowledge to real-life situations. The results showed that 12 of 33 countries scored higher than the US in science, and 17 countries scored higher in math (Committee on STEM Education, 2013, pp. vi - vii). Additionally, a 2020 report by the National Science Foundation indicated that other

wealthy nations' STEM fields are advancing quickly, while the United States remains relatively stable (State of US Science & Engineering, 2020).

This trend is having a major impact on STEM jobs. To continue to be a leader in our world, we need to “manufacture better and smarter products, improve health care, develop clear and more efficient domestic energy sources, preserve the environment, safeguard national security, and grow the economy” (Committee on STEM Education, 2013, p. vi). For these to happen, we need to have a large and well-trained STEM workforce. That is not happening. In fact, a report cited in Obama’s committee plan suggests that “there will be one million fewer STEM graduates over the next decade than U.S. industries need” (p. vi).

The Opportunity Gap

Another set of statistics are especially disturbing. There is an immense gap in the academic achievement between white students and students of color. A 2015 study by researchers Quinn and Cooc looked closely at the trends in achievement between different student groups. For this study, they used results from the 2011 National Assessment of Education Progress (NAEP). While there are serious issues with standardized testing, the results can help to elucidate some alarming trends in our educational system.

According to this study, there were very apparent gaps even by 3rd grade. Females scored 0.23 standard deviations (SD) lower than males; Black students scored 1.07 SD lower than white students, Hispanic students scored 0.85 SD lower, and Asian students scored 0.31 SD lower. They also looked at data from Grades 5 and 8, noticing

that the gaps did not change significantly as the students aged (Quinn and Cooc 2015, p. 339).

This gap has often been referred to as, “The Achievement Gap.” However, I prefer to use the term “Opportunity Gap.” Labeling it an achievement gap places the onus on the students and suggests that the gap is due to students’ intelligence and/or ability to perform on academic assessments. However, changing the label places the responsibility on the systems that have caused this gap. Students’ low performance on these standardized tests is not their fault. It is due to the radical differences in educational opportunities provided to students of color vs their white peers.

The Implications of These Gaps

Science is about identifying problems and coming up with possible solutions. Right now, our country is providing inadequate educational experiences to culturally and linguistically diverse populations. Because of this, diverse students are unable to reach the tables at which major problem-solving is happening and decisions are being made. Without the perspectives of diverse students, we are missing out on entire perspectives and thus limiting the number and types of solutions that we come up with.

The United States wants to return to being the leader of science and technology. For this to happen, we need every perspective at the table. We must begin by addressing the inequities that exist in our K-12 education system. The opportunity gap needs to be closed, and there need to be more direct paths through which culturally and linguistically diverse people can be part of these decision-making spaces.

In the next part of this section, we will analyze the strengths and weaknesses of the new set of standards recently adopted by many states: *Next Generation Science*

Standards. Understanding the gaps in our national science standards can help to provide rationale for bringing culturally responsive teaching into every science classroom.

Inequity in the National Standards

In 2012, the National Research Council published a new set of science standards, called the *Next Generation Science Standards* (NRC, 2012). The committee had many goals in creating this new framework for K-12 science education. These goals included:

All students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering and technology. (p. 1)

The Next Generation Science Standards are based on three major dimensions: (1) science and engineering practices; (2) crosscutting concepts that unify the study of science and engineering; (3) core ideas in four disciplinary areas. According to the committee, these dimensions are meant “to support students’ meaningful learning in science and engineering [and should be] integrated into standards, curriculum, instruction, and assessments” (p. 2).

Science educators and researchers believe that the new standards have many strengths. For example, the committee takes an important step in acknowledging the inequities that exist in our country. In Chapter 11 of the framework overview, they explain, “Today there are profound differences among specific demographic groups in

their educational achievements and patterns of science learning, as in other subject matter areas” (p. 279). They then push the discussion further by diving into some of the reasons for these differences, focusing specifically on two of the reasons: inequity across communities, and a lack of relevant and responsive content and pedagogy for diverse student populations (NRC, 2012)

Many researchers believe that acknowledgement is not enough. We must do more to address these issues. One of these critics is Alberto Rodriguez, who self-identifies as a “Latino science educator/researcher who is committed to making education more accessible, equitable, and successful for all students” (Rodriguez 2015, p. 1033). One of the problems with the standards, Rodriguez suggests, is that many teachers are resistant to the pedagogical changes that are happening as our classrooms become increasingly diverse. Highly effective teachers look different today than they once did. No matter whether teachers’ resistance is by choice or because of a lack of skill/understanding, our framework and standards must support this pedagogical shift, not contradict it (Rodriguez, 2015).

Rodriguez goes on to propose a way to counteract this resistance: adding a fourth dimension to the framework entitled, “Engagement, Equity, and Diversity Practices” (Rodriguez, 2015, p. 1042). He believes that doing this would elevate the importance of addressing inequity in our classrooms and shifting our perceptions and pedagogy to support all learners.

In his paper, Rodriguez provides examples of what could be included in the framework to support educators as they increase the engagement, equity, and diversity of their classrooms. Some of his examples are listed below:

- Students have choices for representing knowledge (i.e. presentations, posters, skits, video narratives, lab reports, and so on)
- Accommodations are made to make the science classroom accessible to parents/guardians/community leaders and elders (e.g. providing a translator, printing newsletters in more than one language; providing transportation; providing babysitting, and so on)
- Contributions of non-Western and/or female scientists are also highlighted (Rodriguez, 2015, p. 1043)

These are just a few examples. Imagine what could be possible if our country's educational system prioritized the issues of engagement, equity, and diversity in science classrooms. In order for us to provide a truly equitable education for all, the National Research Committee must pour the same amount of time and energy into these issues as they did into the other three dimensions of our country's new science standards.

Culturally Responsive Science Teaching

Science for All is a motto that has been used countless times in the last three decades as a type of clarion call for strengthening science education. In a 2012 article, Judson C. Laughter and Amelia D. Adams share an important question, "How can national associations make repeated calls of *Science for All* while scientists remain primarily male and White? We argue that one explanation for these racial and gender disparities is how science is taught in middle schools" (pp. 1107). If science continues to be taught using traditional teaching methods, our country will never reach the goal of *Science for All*. As our country becomes more and more racially, culturally, and linguistically diverse, it is important that teaching pedagogy shifts to be more inclusive

and equitable (Brown, 2017). Many scholars suggest that culturally responsive teaching is the way to do this. By incorporating culturally responsive teaching in science classrooms, teachers can engage students of all races and help students to develop sociopolitical consciousness and critical analysis skills (Laughter, 2012).

Culturally responsive teaching can be applied to science education in a number of ways, including the specific strategies that teachers use during instruction, as well as the content that they are teaching (Brown and Crippen, 2016) . First, we will focus on some ways that culturally responsive pedagogical practices can improve learning in science classrooms.

In a 2011 study, Carla C. Johnson worked with new science teachers as they tried to implement CRT in their classrooms. Johnson described the way that one of the teachers utilized collectivism to engage more students in his science class. For a while, Mr. Roberts had been using a more individualist approach to his teaching. At some point, he recognized the importance that collaboration and collectivism played in the cultural experiences of his class, which was made up of primarily Hispanic students. Johnson explained a shift that made an important difference in this science classroom:

Mr. Roberts challenged the students with a question of the day at the beginning of each class. Rather than giving students the answer, Roberts would take the time to explain the question and walk students through an active debate of each answer choice. When the question was open-ended, students would share their responses in a healthy discussion that included valuing opinions. Rather than having cooperative learning groups—Roberts had a cooperative classroom that could be best-described as a community of learners. (p. 178)

In this example, Mr. Roberts recognized his students' cultural experiences and strengths. He utilized their collectivist tendencies to invest his students in a bigger question. Regardless of the content being taught, Mr. Roberts' collectivist practice would support students' engagement and learning (Johnson, 2011).

While these pedagogical practices are important, it is just as important to deeply analyze the content of what we are teaching. If we continue to teach disparate facts and westernized funds of knowledge, then there is little chance that students will be equipped to break down the structures of inequity that exist in our society. A 2010 article by Boutte et al explains, "without centering issues of power, equity, and culture, efforts will remain superficial and will not likely address the intended long-term goals of reducing structural inequities in school and society (Boutte et al 2010, pp. 3). One of their examples clearly demonstrates the differences between these two approaches to culturally responsive teaching in science.

In this classroom, students were studying cell structures. Their goal was to better understand the role that different cellular structures had on the overall function of the cell. The teacher wanted to make the topic more interesting, so she encouraged students to use magazines and newspaper clippings to create a collage of objects that had similar functions to the organelles of a cell. This activity gave students a chance to showcase their creativity. It made science feel more accessible and fun. It also helped students remember important scientific vocabulary, increasing scores from the typical 60-85% to a 75-90% (Boutte et al 2010, pp. 6). This is an example of using culturally responsive teaching practices to improve student achievement.

However, many scholars believe that culturally responsive teaching must go a step further. Teaching science is not about *covering* a ton of facts and information. Teaching science is about creating opportunities for students to uncover multiple perspectives and explore topics with a critical consciousness. Butte et al suggested that the teacher could have brought diverse perspectives into her unit on cells, including the story of Dr. Ernest Just. Dr. Ernest Just was a Black scientist who did important work within cellular biology. His work had major contributions within the field. However, he dealt with countless experiences of racism and prejudice. Because of these experiences, Dr. Just left the United States to continue his studies in Europe (Butte et al, 2010). Imagine if students had a chance to discover Dr. Just's story and his contributions to the field. Imagine if they then had a discussion around the systems of inequity that caused him to leave the country. Adding these to the unit could benefit all students. Students of color leave feeling more seen and validated, and white students leave having greater understanding of their privilege and the challenges that others often face (Butte et al, 2010).

In her 1995 paper, Gloria Ladson-Billings explained that there is a false binary between connecting to students and academic success. In fact, culturally responsive teaching emphasizes both of these aspects of education. Science educators must recognize that students' cultures can become a vehicle for learning. When we tap into students' cultural backgrounds and emphasize the strengths that they already possess, students can then utilize these strengths to support their learning (Ladson-Billings, 1995).

The Components of Culturally Responsive Teaching

It is important to find ways to make culturally responsive teaching feel more accessible to teachers. One study (Underwood, 2018) looked at teachers' mindsets around CRT, and shared an enlightening quote from a science educator, Dr. Jackson. This educator explained her thinking:

CRP [culturally relevant pedagogy] is a whole lot of work and I think you have to be confident in the science and your pedagogy and your notions of what tools you have... to be able to do culturally relevant teaching... [long pause]. I know I'm not there. I'm not saying it wouldn't be worth it, but I think it's a very different type of training for teachers and teacher educators to think through that, it's an additional piece and...I know it would take me time to sort of wrap my head around that. (p. 57)

This teacher seems to suggest a lack of training and preparedness as the reason for not implementing CRT. This is just one of the many barriers that prevent teachers from using the practice in their classrooms. Another educator from this study shared that she stopped talking about race after being reprimanded by her institution (pp. 57-58). One other suggested that she would be better able to bring CRT into her class only if that class was specifically focused on diversity (p. 57).

As shown, there are many things stopping science educators from bringing culturally responsive practices into their classrooms. To account for these imagined barriers, Zaretta Hammond has broken down the practice into smaller, more manageable components. She calls it the "Ready for Rigor" framework (Hammond, 2005, p. 17). As a middle school science teacher with an extensive background in neuroscience, I believe

this framework is a fabulous tool for helping educators push for student independence.

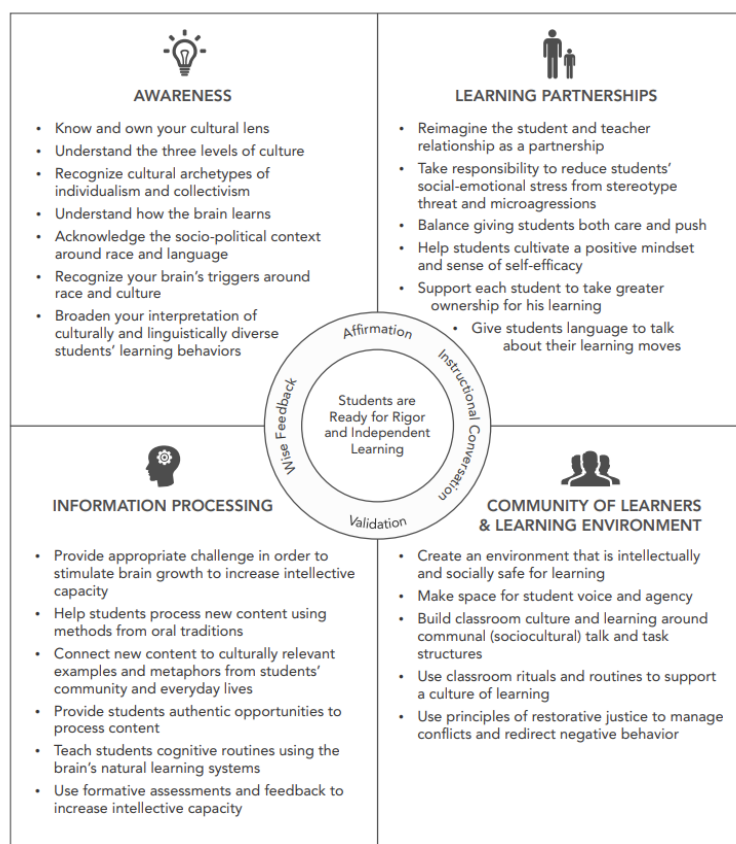
The framework breaks culturally responsive teaching down into four key areas:

awareness, learning partnerships, information processing, and community of learners and learning environment (see Figure I on page 30).

Though these components provide the structure for CRT implementation, this project will utilize research from many different sources in order to explain how they can be brought specifically to science classrooms. The next sections will detail each of these components and give specific examples of how education scholars recommend bringing it into science classrooms.

Figure I

Ready for Rigor: A Framework for Culturally Responsive Teaching



Note. From *Culturally Responsive Teaching and the Brain: Promoting authentic engagement and rigor among culturally and linguistically diverse students* by Z. Hammond and Y. Jackson, 2015, p. 17.

First Component - Building Awareness

The first component of culturally responsive teaching is awareness. Culturally responsive teaching is not just a set of instructional practices. It is an awareness and a mindset. According to Hammond, teachers must have two types of awareness: an awareness of the sociopolitical conditions causing inequity, as well as an awareness of one's own beliefs regarding culture and equity (Hammond, 2015). This awareness must be developed through intentional practices and, once built, will provide a foundation on which the other components can be grown.

Education scholars have dedicated years of research to finding the best way to support teachers in developing greater awareness. This section will suggest two such practices. These practices can help teachers better understand their own culture and the ways that students' cultural experiences and identities impact their learning. Though these practices can help, they will not cause a teacher to "arrive" at awareness. Awareness is something that must be continuously developed over the course of one's career and life (Hammond, 2015).

Strategy 1 - Project Implicit. The first practice was suggested by an education consultant with edutopia.org. Nikki Williams Rucker has been an educator for 15+ years and focuses specifically on increasing students' academic achievement through culturally responsive teaching. In a 2019 article entitled "Getting Started with Culturally Responsive Teaching", Williams Rucker suggests that one must begin the process by

doing an internal audit by “truly digging deep inside of ourselves and recognizing and naming those things we don’t want to look at or talk about” (Williams Rucker, 2019, para. 4).

Williams Rucker suggested one interesting way that teachers can begin to unpack these biases. In 1998, researchers at Harvard University developed “Project Implicit” as a way to help educate the public about their hidden biases (Harvard, 2011). Project Implicit uses systematic online experiments in order to test a person’s subconscious stereotypes. As science teachers, there is no better way to begin analyzing one’s biases than through a science experiment! Williams Rucker explained the importance of this, stating: “these unintentional, unconscious attitudes impact how we relate to our students and their parents, how we choose curriculum, assess learning, and plan lessons” (2019, para. 4). To counteract these effects, one must be first able to recognize the biases that exist within ourselves.

Strategy 2 - Brain Rules. All teachers should understand how a students’ brain processes the information they’re being taught. In her book, *Culturally Responsive Teaching and the Brain*, Zaretta Hammond shares six principles that make it easier to understand “how the brain uses culture to interpret threats and opportunities” (p. 46). One of these rules is “All new information must be coupled with existing funds of knowledge in order to be learned” (p. 48). Teachers need to do the work to learn more about students’ backgrounds and identities. Learning more will then help us to be better able to couple the content knowledge with relevant concepts from their day to day lives.

A 2011 study analyzed how a three-year professional development in culturally responsive teaching impacted two middle school science classrooms. According to their

findings, the training “enabled participants to transform their practice to focus on culturally relevant science pedagogy resulting in a more effective instructional environment for their Hispanic students” (Johnson, 2011, p. 170). There were a few common trends that came up often in interviews with the two teachers. Teachers often commented on the benefits of integrating students’ cultural identities into the science instruction. One example was shared in an interview with a first year science teacher, Ms. Fields. Throughout her interviews, Ms. Fields emphasized the importance of building relationships with students. Learning more about students actually strengthened her instruction. For example, when Ms. Fields taught about simple machines, she brought in a tortilla press as an anchoring phenomena; students analyzed the tortilla press to determine which simple machines it incorporated (Johnson, 2011). Ms. Fields explained her rationale:

I mean, any culture makes the student different, so every new student you have that comes from a different culture is obviously going to have a different way that they approach things. Especially as you take language as a barrier, they are going to have different needs. (p. 186)

Rather than ignoring students’ racial, cultural, and linguistic diversity, science teachers can utilize these differences in order to strengthen the connections occurring within students’ brains.

Second Component - Learning Partnerships

Another important component of culturally responsive teaching is developing strong learning partnerships. One must carefully examine the quality of their interactions

with students. It is not enough to focus exclusively on curriculum. Hammond explains this balance:

Use emotional connection to create a partnership that has the teacher and student coming together as a team to tackle a specific learning challenge...Because there's trust, the teacher can provide a degree of "push" or challenge without having the student experience an "amygdala hijack" and either withdraw or become defensive. (Hammond, 2015, p. 75)

For dependent learners to become independent, they need to feel safe to take risks and they need to believe that taking risks and pushing oneself will actually lead to a deeper understanding.

First, we need to focus on how to build trusting relationships with students. In her book, Geneva Gay goes deeply into what she calls *The Power of Caring*. She explains, "Teachers who really care about students honor their humanity, hold them in high esteem, expect high performance from them, and use strategies to fulfill their expectations" (2000, p. 46). When students feel cared for as both people and as learners, they are more likely to rise to the occasion. Long after leaving high school, one man looked back on a teacher from eleventh grade, stating:

She was hard on you, and you couldn't run no game on her. She knew everybody, and she didn't make you feel stupid even if you didn't know the answers. That's why I made sure I got her homework done even when I wouldn't do it for anybody else. (Gay, 2000, p. 49)

It is clear that when teachers invest in their students in an authentic and positive way, it pushes students to bring the best version of themselves to their learning.

Strategy 1 - Video Analysis. One way to develop deeper learning partnerships with students is to deeply analyze what is already happening in the classroom. Geneva Gay suggests that video recordings can help teachers can do a quantitative and qualitative analysis of their interactions with students. As we watch ourselves teach and interact with scholars, we can keep track of different data points.

Teachers might simply count the number of times they have any kind of verbal or nonverbal contact with students from different ethnic and gender groups during the course of a lesson. These contacts could include how many questions asked of whom; praise, prompts, or guidance given; and discipline imposed. (Gay, 2000, p. 74)

Teachers can then use this data to reflect on their practices and to plan for ways to improve. Just like in other aspects of teaching, developing trusting relationships with students takes time and creativity. This is one of many strategies that teachers can use to strengthen these partnerships.

Second, we need to help students see the value in taking academic risks. We can do this by supporting students' academic mindsets. A 2012 article from the University of Chicago Consortium on Chicago School Research outlined what is meant by academic mindset. According to this article, academic mindsets consist of four core beliefs: "I belong in this academic community, my ability and competence grow with my effort, I can succeed at this, and this work has value for me" (Farrington et. al, 2012, p. 9).

Teachers must be intentional about helping students develop these mindsets.

Strategy 2 - Teaching about the Brain. Science teachers are uniquely qualified to help students develop an academic mindset. We can do this by teaching students about

what is actually happening in their brain while they are learning and growing. A 2017 article in Science Scope publication shared a strategy that science teachers can use in their classrooms:

Teachers can help students develop growth mindsets by explicitly teaching about the brain and how it changes during learning. *Neuroplasticity* is the brain's ability to form and reform new neural connections in response to experiences and changes in the environment. Students become more interested in learning when they find out they can get smarter by rewiring their brains through study and practice. (Robinson, 2017, p. 18)

It is important that teachers recognize the value of developing relationships with students. However, these relationships are not the end goal. Teachers should be utilizing relationships to build students' confidence and abilities so that eventually, the student can become independent, self-driven thinkers.

Third Component - Information Processing

Focusing on these first two components creates positive conditions for students' learning. However, strong awareness and partnerships are not the end goal. These are built *so that* students' learning can improve. This is where Hammond's third component, Information Processing, comes into play. Teachers should be constantly asking themselves whether students are being appropriately challenged and whether they are using culturally responsive strategies throughout the learning process (Hammond, 2015, p. 122).

Interestingly, information processing is the component of culturally responsive teaching that is often overlooked. For example, Zaretta Hammond shared a conversation

with a math teacher who said, “Teaching equations is pretty straightforward. How do you do that without making up some gimmick?” (Hammond, 2015, p. 138). This demonstrates one of the many misconceptions about culturally responsive teaching. People often believe that culturally responsive teaching just means including multicultural content. For example, they think that if you watch a documentary about racism, you are a culturally responsive teacher. They believe that if you use a rap to teach about cell organelles, then you’re a culturally responsive teacher. However, in both of these, students are still passive spectators. For these to be effective, they need to include authentic ways through which students can participate in the learning process. Students can only become independent learners if they are given opportunities to build their cognitive skills and their independence (Hammond, 2015, p. 122).

Learning is not limited to the classroom. Children are constantly learning as they experience the world. Our cultural experiences and traditions determine the ways that we take in, process, and remember knowledge. This causes shifts in our brain’s neural pathways. As Zaretta Hammond explains, “culturally and linguistically diverse students come to school with well-developed neural pathways for actively processing information under the right conditions” (2015, p. 127). The key of this component of culturally responsive teaching is to tap into those culturally specific learning techniques so that students can more effectively process information.

Strategy 1 - Ignite, Chunk, Chew, Review. Students must actively process information in order for their brain power to increase. One can do this by implementing an “ignite, chunk, chew, review” format within lessons. These four strategies were originally introduced by Zaretta Hammond as a way to lead students through the brain’s

stages of active processing (2015, p. 128). Within each of these steps, teachers can pull from countless culturally responsive techniques. The next paragraphs will go through the goal of each strategy (ignite, chunk, chew, review) as well as a couple techniques that could be used for each.

The goal of the **ignite** stage is to spark students' attention. This is an essential part of the learning process, as our minds can't internalize something when we have not been paying attention. There are countless culturally responsive ways to activate students' brains prior to learning. To name just a few, Zaretta Hammond recommends call and response, music, provocations, and talk (p. 130).

During the **chunk** stage, teachers need to make sure that the learning is bite-sized. Especially in science classes, teachers believe that they must fit a ton of information into the class period. However, students' brains can only hold a certain amount of information. We must determine the most essential information and present that in chunks so students can then actively process that information (Hammond, 2015).

The **chew** stage is vital for students to be able to use the information they have learned. When our brains reach their mental capacity, they tend to cycle down. They need a quick moment to chew on the information before being able to take in any more information. In one example, Hammond recommended that a teacher inserted "chew time" after 15-20 minutes of instruction. During this 5-7 minutes of "chew time", students processed what they had just learned. Again, there are countless culturally responsive techniques that can be used to help students chew what they've learned: thinking routines, "story-ifying" the content, spoken word, infographics, metaphors, and much, much more (Hammond, pp. 130-136).

The final stage, **review**, aims to strengthen the new neural pathways. One of the issues with science classrooms is the pace at which we “move on” to new content. If students learn something new but only practice it once or twice, it is likely to fade away. However, when we practice a skill or apply our knowledge to another concept, it strengthens pathways and the likelihood of us being able to use that content to become independent learners. This is another area in which culturally responsive techniques can be brought in. Zaretta Hammond recommends a few examples of techniques that teachers can use: students can create a game to review the content, they can work on long term projects in which skills are repeatedly brought up, or they continuously gather evidence to help them solve a real-world problem (Hammond, 2015, pp. 137-138).

When teachers approach lessons with a structure of “Ignite, Chunk, Chew, Review”, it encourages them to lead students through active processing. Additionally, it creates many opportunities for teachers to use culturally responsive learning techniques in order to activate students’ existing neural pathways (Hammond, 2015).

Strategy 2 - Presenting Real World Problems. Another way that science teachers can build students’ intellectual capacity is by anchoring their units in real-world problems. Problem-based learning is a fairly widely studied strategy for improving students’ science achievement and retention. It is defined as “an educational instruction method that fosters learning and the development of 21st century competencies and skills through problem solving and the integration and application of knowledge in real-world settings” (Merritt et al. 2017, p. 2).

At the start of the unit, propose a problem or a mystery that students need to solve. Structure the unit as a gradual gathering of evidence that students could use to

formulate an answer for the question. Anchoring the unit in a bigger, real-world problem pushes students to apply the cognitive routines that Hammond (2015) suggested. They will be looking for patterns, trying to understand how concepts fit together, recognizing whose points of view are present and absent, and more. One study looked into the benefits of problem-based learning, explaining that PBL has positive effects on a number of areas, including, “academic achievement, knowledge retention, conceptual development, and attitudes toward learning” (Merritt et al, 2017, p. 9). Problem-based learning offers an effective way by which teachers can push students to become more independent and self-directed learners.

Fourth Component - Community of Learners

Classroom learning environment has been shown to have an important influence on students’ academic achievement (den Brok et al, 2010, Yerdelen, 2019). A classroom’s learning environment is much more than the physical space, though. It includes the multiple dimensions that go into ensuring that the classroom is physically, socially, and intellectually safe for every student (Church et al., 2001; Gutierrez, 2008). As aspiring culturally responsive teachers, we must be intentional about creating a community of learners and an environment in which these learners can take risks.

A safe, calm, and productive classroom helps to reassure students that they are safe. Hammond points out the neuroscience behind this:

When our neuroceptive mechanisms confirm that our surroundings are physically, socially, and intellectually safe, we go into a state of relaxed alertness and are primed for learning. However, when our senses read the environmental cues as

threatening because of a cultural mismatch or subtle microaggressions, the brain goes on alert and triggers stress-producing defensive strategies. (2015, p. 144)

We want all dependent learners to take risks and to push themselves toward independence. Dependent learners tend to stop when things become challenging. However, if teachers create an environment in which failure is celebrated as a part of learning, that dependent learner may continue with the task even as the going gets tough.

In 2006, a study gathered data from eighth grade science students in a variety of California schools. The study used a questionnaire called the *What Is Happening In this Class (WIHIC) Questionnaire* to measure students' perceptions of their classroom environments. It included questions that focus on a number of different aspects of classroom culture including: "student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, and equity" (den Brok, 2006, p. 7). Interestingly, this questionnaire is meant to measure classroom environment, but asks many more questions about the interactions between students and teachers. This further suggests that while the aesthetics of a classroom can be important, the community is a much more important factor in students' perceptions.

Three important data points emerged from den Brok et al's 2006 study. First, there was a statistically significant difference between girls and boys in terms of their perception of the classroom environment. The second trend focused on classrooms that had students of many different ethnic and cultural backgrounds. When there were more ethnic groups in the classroom, students' had a more positive perception of group cohesiveness. Finally, the class size had a significant impact on students' perceptions of

their learning environment. According to the study, students preferred classes that were neither too big nor too small (den Brok et al, 2006). The authors shared this reflection:

This means that schools should create classes that are medium in size and that contain students from as many different countries and backgrounds as possible. Although many parents and students--and even teachers--may be inclined to favor classes containing many students that are alike in terms of background, such classes seem less fruitful in terms of creating an optimal learning environment from the perspective of the students. (Den Brok et al, 2006, pp. 21-22)

Strategy 1 - Collecting Data. Reflection is an important part of teaching. One article from the National Science Teachers Association suggests that teachers use the *What Is Happening In this Class Questionnaire* as a resource for reflecting on and improving their own classroom environment! The author explains the benefits of this survey: “A learning environment survey can help you create a holistic picture of your science classroom because as teachers know, all students’ learning is affected by both cognitive and affective (emotional) strengths and weaknesses” (Martin-Dunlop, 2006, p. 1).

The survey can be found online, and can be assigned to students as a way to evaluate how things are going in class. Students appreciate feeling valued. The teacher can explain to his/her students that the survey will help make class more enjoyable and will help to make the teacher more effective (Martin-Dunlop, 2006). Once students have taken the survey, it’s important to deeply analyze the results in order to come up with action steps. Using a survey like this can help a teacher uncover their hidden strengths

and weaknesses. We can then leverage those strengths and improve those weaknesses in order to make the community more welcoming and productive for all.

Strategy 2 - Cultural Values. Zaretta Hammond shared a strategy for creating a welcoming classroom for students. Though a classroom's physical environment is not the sole factor at play in creating a strong community, it is still important. Hammond points out, "In many collectivist cultures, beauty and harmony are important values that extend to the environment...Think carefully about what visuals are displayed on the walls. They send a nonverbal message about what and who is valued in the classroom" (Hammond, 2015, p. 144). As teachers begin to set up the classroom, remember that it is not *your* classroom, but it is *the students'* classroom. We must be meaningful and intentional about what we are putting on the walls in order to make sure that it aligns with the students' values. Hammond goes on to suggest, "Think about the cultural values of your students and translate those values into concrete objects and symbols that you can display or integrate into the classroom" (p. 145). These values don't have to stop at physical objects and symbols; try to incorporate the values into multiple times and spaces within the classroom.

Conclusion

Chapter Two provided a review of the literature that supports the question, "How can science teachers use culturally responsive teaching to help students become independent, self-driven learners?" Culturally responsive teaching has been widely studied by education scholars, including Gloria Ladson-Billings, Geneva Gay, and Zaretta Hammond. These educators, along with many others, believe that culturally responsive teaching (CRT) is a powerful tool for pushing students' learning to the next

level. Chapter three first provided an overview of culturally responsive teaching and the importance of CRT in our education system. However, much of the research surrounding this practice focuses on history, civics, and language arts classrooms; in this chapter, though, we dove into culturally responsive *science* teaching. There are alarming issues arising in our science classrooms. The inequities between students of color and their white peers are alarming, and the United States is quickly falling behind other countries in terms of science achievement. In this chapter, we emphasized the need for culturally responsive teaching in science classrooms.

Finally, the last sections of the chapter focused on Zaretta Hammond's "Ready for Rigor Framework" (Hammond, 2015). Culturally responsive teaching was broken down into these four components in order to be more accessible for teachers who are just starting out on their journey toward culturally responsive teaching. In each section, multiple strategies are shared, with the hope being that readers walk away with a clearer idea of what it could look like to bring culturally responsive teaching into their classrooms.

This research has been conducted so as to help build a professional development opportunity for middle school science teachers. In this professional development, teachers will be focusing on the "Information Processing" component of Zaretta Hammond's Ready for Rigor framework. Though all four components are important, this one gives an opening for science teachers to begin bringing CRT pedagogical practices into their teaching. The specifics of this professional development opportunity will be described in detail within Chapter Three. I will also introduce the audience and the

setting for this project so that readers have a clearer idea of how, when, and where the professional development will be implemented.

CHAPTER THREE

Project Description

Overview

The purpose of Chapter Three is to describe the plan for a professional development program that addresses the question, “How can science teachers use culturally responsive teaching to help their students develop into independent, self-directed learners?” In this series of professional development sessions, teachers will analyze and adjust existing science lesson plans so as to incorporate more culturally responsive teaching techniques. Weaving culturally responsive teaching into our lessons themselves will help students develop strong academic skills and mindsets. With these, students can become independent learners able to tackle any challenges presented to them.

Chapter Two revealed alarming statistics about the inequities of our nation’s science education system. These inequities are limiting what is possible within our country, and must be addressed immediately. In Chapter Three, we will be outlining one way that science teachers can begin to address these inequities. First, this chapter will share some background information about our big question. Then, we will dive into the purpose of and objectives for this professional development series. Finally, we will describe the context for this professional development project.

Vision and Objectives

Educational scholars have recently been looking at Culturally Responsive Teaching as a possible way to address the opportunity gaps facing students of color. In her 2015 book, Zaretta Hammond explained,

Culturally responsive teaching (CRT) is one of our most powerful tools for helping students find their way out of the gap. A systematic approach to culturally responsive teaching is the perfect catalyst to stimulate the brain's neuroplasticity so that it grows new brain cells that help students think in more sophisticated ways. (p. 15)

The literature review revealed four components of culturally responsive teaching, all of which are vital in developing a culturally responsive classroom. The components are outlined below:

- Awareness - teachers must dedicate time and energy to developing an awareness of their cultural background and biases. They also must work to educate themselves on the cultural identities of their students as well as the sociopolitical context in which education is entrenched.
- Learning Partnerships - teachers must work to build strong learning partnerships with their students. These partnerships are anchored in trust and aim to create a balance of both care and push. When students have a strong relationship with their teachers, they feel safe to take risks in their learning which then helps them to become more and more independent.
- Information Processing - teachers must facilitate high quality, rigorous, and authentic learning tasks. Challenging students stimulates their brain growth and increases their intellectual capacity. Teachers can implement culturally responsive teaching practices to help students access and interact with the content.
- Community of Learners and Learning Environment - teachers must create an environment that is safe for students, both intellectually and socially. The

environment includes both the physical space and the culture of the classroom.

Students' voices and experiences should be at the center of everything in order to develop a culture of belonging and learning.

Though all four components are vital to student success, this professional development opportunity will be focusing on one in particular: information processing. The aim of the PD sessions is for teachers to find ways to incorporate culturally responsive teaching strategies into their classrooms. Culturally responsive teaching should not exist separately from the learning happening in the classroom. Academics and culturally responsive teaching should be interwoven; it is in these classrooms that students feel the greatest sense of belonging as well as the greatest academic success.

This professional development program will be specifically aimed at helping science teachers and paraprofessionals that support in science classrooms. I have chosen to focus on science because of challenges I've experienced during the last eight years of teaching science. During this time, I have struggled to incorporate culturally responsive teaching into my lessons. Upon speaking with other teachers, it is clear that this is a common gap. Together, we decided that this is something we wanted to focus on in the upcoming years of teaching.

There are five major objectives of this professional development series. They include, but are not limited to:

- Science teachers will review the components of culturally responsive teaching and create an argument for why information processing is such an important part of culturally responsive teaching.

- Science teachers will outline Zaretta Hammond’s “Ignite, Chunk, Chew, Review” approach to culturally responsive information processing.
- Science teachers will collaborate to bring culturally responsive teaching strategies (Ignite, Chunk, Chew, Review) into a shared lesson plan.
- Science teachers will use culturally responsive teaching strategies (Ignite, Chunk, Chew, Review) to analyze and rework one of their own upcoming lessons.
- Science teachers will practice the delivery of their culturally responsive science lesson and will incorporate peer feedback.

These are big goals. To achieve them, it’s important that we are intentional about the way in which the development is being delivered. The following section will go into a few important conceptual frameworks that will come into play while I plan this professional development series.

Effective Teacher Professional Development

According to a group of educational scholars from the Learning Policy Institute, professional development is considered effective if it “results in changes in teacher practices and improvements in student learning outcomes” (Hammond et al, 2017, p. v). In this literature review, researchers wanted to identify the features of effective PD. To do that, the group identified 35 rigorous studies in which professional development had a positive impact on teaching practices and student outcomes. Then, they looked for features that were shared by the effective professional developments. They found that the most impactful professional development had the following characteristics: focused on content, incorporated active learning, supported collaboration, used models of effective

practice, provided coaching and expert support, offered feedback and reflection, and was of sustained duration (Hammond et al, 2017, p. vi).

I especially love the idea of having a collaborative approach to professional development, as I believe it can be transformational within the school as a whole. In the Learning Policy Institute's review, they emphasized this, explaining:

When whole grade levels, departments, or schools are involved, they provide a broader base of understanding and support at the school level. Teachers create a collective force for improved instruction and serve as support groups for each other's work on their practice. Collective work in trusting environments provides a basis for inquiry and reflection into teachers' own practices, allowing teachers to take risks, solve problems, and attend to dilemmas in their practice. (p. 10)

Just like in classroom teaching, professional developments are much more effective when participants can uncover the information themselves and then work through it with their peers. It is not as effective when the participant passively receives information, as it reduces the amount of interaction that the person has with the content itself. With this in mind, I plan to be an active participant in this process. I will of course share objectives, outline the session, and keep the group on task; but I will also be actively participating in each session. Especially in such a small school, it takes an "all hands on deck" approach to make substantial change. I want to be a part of the team that makes that change, not the one that directs it.

Finally, as a way to "practice what we preach", each professional development session will be planned intentionally with "Ignite, Chunk, Chew, Review" in mind. This has two major purposes. First, the sessions themselves will act as models for teachers

who are new to this concept. Participants will be the students and will have a chance to see what it feels like to learn in this way. Second, we have discussed that this is simply a more effective way of teaching. Too often, development sessions include far too much content, without giving any opportunity for participants to actually work with the material. However, in these sessions, because of the intentionality of “Ignite, Chunk, Chew, Review”, there will be plenty of “chew time” for teachers to work deeply with the content as well as with each other.

As I plan this professional development series, my goal is to incorporate many of the features of effective PD, as outlined by the Learning Policy Institute. I will exclusively offer this PD to science teachers, so as to be as content focused as possible. I will be an active participant rather than a leader, so as to create an environment of collaboration and trust. I will include opportunities for practice and feedback, so as to encourage risk taking and problem solving. I will offer sessions over multiple days, so as to keep culturally responsive teaching at the forefront of participants’ minds.

In addition to being effective for adult learning, the approaches outlined above are very much connected to the research of Geneva Gay, Gloria Ladson-Billings, and Zaretta Hammond. Clearly, the principles of culturally responsive teaching are not only applicable to students of color. These strategies are just good teaching--regardless of the audience.

Evaluating for Effectiveness

There are a number of ways to determine the effectiveness of teacher professional development. This is crucial, as it does not make sense to continue with professional development unless it has shown to have a positive impact on teacher practices and

student outcomes. Three strategies will be used to evaluate the effectiveness of this professional development series.

First, we will analyze students' performance on standardized tests. If students are receiving an education that is more culturally responsive, one would expect their academics to improve. With a culturally responsive teacher, students gain confidence, independence, and problem solving skills. We will look at students' growth and performance on the NWEA science test; we will compare their gains to previous years as well as to the growth of students whose teachers did not participate in the PD series.

Secondly, I will observe within each participating teacher's classroom once after the series has been completed. During this observation, I will look for the components of "Ignite, Chunk, Chew, Review" and, more specifically, culturally responsive teaching strategies being used within each of these. An effective professional development should impact participants' teaching practices. If the development was internalized, we should see the following: 1) culturally responsive strategy used to *ignite* students' interest; 2) teacher delivery of an appropriately sized *chunk* of content; 3) a majority of time being spent with students actively *chewing* on the content; 4) a culturally responsive *review* activity in which students reflect on and extend their learning.

Thirdly, the effectiveness of this PD will be evaluated through a teacher-facing survey. This survey will ask teachers to reflect on their professional development experience. In addition, it will ask teachers to reread each of the series' objectives and then evaluate whether or not they were accomplished. This will give me anecdotal evidence on teachers' experiences during the series, and will allow me to make changes prior to offering it to others in the future.

One of my big goals is to eventually create a professional development series for each of the four components of Zaretta Hammond's Ready for Rigor framework. I believe that these assessments could be used for each of the four series. I could analyze the effectiveness of this first series and use the knowledge to inform the other three series.

Now that we have gone into the objectives, framework, and evaluation process, the next section will dive into more specifics. It will provide a larger outline of the professional development series and will focus on each individual session's purpose. As you read, keep in mind the intentionality with which the content will be delivered and worked with.

Professional Development Outline

This series of professional developments will be split up into five sessions. The sessions will lead teachers through the process of analyzing and improving their existing lessons. The goal is that every teacher leaves the sessions feeling confident in their ability to improve an existing lesson to make it more culturally responsive.

The sessions will take place during our extended summer PD, which begins three weeks before the students return. This extended time gives teachers an opportunity to collaborate with others and align on goals for the year. This specific development will happen over the course of one week. Science teachers will meet for one hour each day for one week. It is important that there is not a huge amount of time between sessions, as the sessions will very much build upon each other. It is also important that this happens before the school year begins, as we are learning a valuable skill that could be hugely impactful throughout the year.

During the first two PD sessions, teachers will learn important background information. They will dig deeper into culturally responsive information processing as well as Zaretta Hammond's four steps: Ignite, Chunk, Chew, and Review. They will also spend time brainstorming specific strategies that teachers could use in each section of their lesson.

In the later sessions, teachers will be applying this knowledge. In the third session, all teachers will be provided the same lesson. They will be focused on the question of how the lesson could be improved to incorporate more culturally responsive teaching strategies. Focusing on the same lesson will allow for greater discussion and collaboration.

In the final two sessions, participants will become more independent. They will choose an upcoming lesson to revise and improve. Then, they will have the majority of the session to work on their specific lesson. Because this series will be done in-person rather than virtually, teachers will be surrounded by others working through the same process. There will be intentional times for teachers to pause and discuss so that they can still gain knowledge and experience from others.

Finally, the last session is a chance to practice! Practicing the delivery of a lesson is sometimes awkward for adults. However, it is incredibly important, especially when working on a new skill. Teachers will choose a section of their lesson and will practice delivering it. The other adults will act as students. This helps in two ways: first, it gives the teacher a chance to work through a new skill; second, it helps the "students" to understand what it feels like to learn in this new way. We will conclude by sharing

feedback so that teachers know what to continue doing and what to do differently next time.

Single Session Structure

I am designing each session intentionally with the “Ignite, Chunk, Chew, Review” structure in mind. As Zaretta Hammond emphasized, these steps help encourage active processing. Incorporating these steps into lessons is just good teaching, regardless of the learners’ ages. It will help participants remember the content and be able to apply it to their own experiences. Additionally, the sessions will be structured in this way so that it serves as a model for teachers. They will have a chance to experience an ignite, chunk, chew, review lesson firsthand. The presentation slides will have an icon in the top right corner. Though it is never explicitly named, these icons will indicate which part of the lesson it is. I hope that participants notice the icons and ask about their meaning. If someone points out the icons, it can be a great opportunity to initiate a discussion about how this type of lesson feels as a participant.

Additionally, there are a number of culturally responsive strategies that will be utilized in the sessions themselves. For example, in the ignite section of session #3, participants will be working together to create a motion and statement to represent each of the four steps of ICCR. This activity has a number of benefits, especially for people who have an active, collaborative background. Movement and collaboration will help to spark their attention and get them invested in the learning. Additionally, it utilizes neural pathways that are already well-established! This will help them remember the knowledge and apply it in the future.

Context for the Professional Development Program

Setting

This professional development will take place within a network of small public charter schools in North Minneapolis. It will specifically focus on science classrooms within the two middle schools, which serve students in 5th through 8th grade. The schools are part of a much larger network of schools, which exist in 32 regions across the United States. They are free, open-enrollment public charter schools that are located in primarily low-income communities and communities, with a focus on college and career readiness.

The network of schools is well-known, and is often celebrated for improving outcomes for students who have been traditionally underserved. On average, there is a higher percentage of students graduating from high school and from college, and students generally score higher on standardized tests than their peers of a similar background. Additionally, the schools have been celebrated for having a higher percentage of people of color in teaching and leadership roles than the country as a whole.

However, there are also well-known challenges associated with the schools. There is a high rate of teacher turnover, which then results in a younger and less experienced teacher population. Additionally, there are relatively high levels of student attrition. The reasons for this are highly disputed.

The two schools at which the PD will occur are part of this larger network. They are both located in North Minneapolis. The two schools have been outlined below.

School A has approximately 200 students in grades five through eight. It has been open since 2008. Approximately 95% of the student body is African American, with a

small group of students who identify as Latinx, Hmong, White, and Native. The staff is made up of approximately 20 teachers and paraprofessionals, approximately 60% of whom identify as people of color. There are two teachers that teach science specifically, one teaches 5th and 6th grade and the other teaches 7th and 8th grades. Both of these teachers are white, under the age of 40, and have been teaching for less than five years. In addition, there are two paraprofessional support staff who work exclusively in science classes with the science teachers. These two individuals have been in education for approximately two and ten years and are both African American.

School B opened in 2019 and is not yet fully grown. The school currently serves 4th through 7th grades, and has approximately 75 students. The student body is more diverse than school A, with approximately 80% of students identifying as African American, and 20% identifying as Latinx, Native, White, or Hmong. The school staff is made up of 12 individuals, approximately 40% of whom identify as people of color. Similar to School A, there are two teachers that teach science specifically. I am a white woman who has been teaching for eight years, and I teach the 6th and 7th graders. My colleague, a Black woman, has been teaching for four years, and teaches the 4th and 5th graders. Both of us are under the age of 40. In addition, there are two paraprofessional support staff who work with us in the science classrooms. One is a ~30 year old Black female, and the other is a ~40 year old Black male.

Science Classrooms

Science is an important part of students' academic experiences at these schools. It is considered one of the core contents, along with English language arts and math. Middle school students have science class every day for 60 minutes. The class size is capped at

28 students, but typical class sizes are closer to 25 students. There is usually just one adult in the science classroom. However, in the inclusion classes, there is typically a paraprofessional who is supporting students with individual education plans (IEPs).

In 2017, our school switched from a teacher-created curriculum to one that is widely used across our network of schools. Since then, science teachers have been focusing on implementing this new phenomena-based curriculum called *Amplify Science*. *Amplify Science* is structured around the Next Generation Science Standards. On its website, Amplify Science is described as the following:

A highly engaging, phenomena-based program for grades K–8 that integrates the latest practices in science teaching and learning, as well as interactive digital tools and hands-on activities, to teach students how to think, read, write, and argue like real scientists and engineers. (Amplify Curriculum, 2021)

This curriculum begins each unit with a big question that is supposed to spark students' natural curiosity and invest them in the content. There are definite strengths. It utilizes a skills-based approach rather than focusing on facts, knowledge, and information. In doing this, it helps paint a more accurate picture of what science looks like in the real world. It also helps students gain real life skills in literacy, critical thinking, and scientific argumentation.

One gap in *Amplify Science* curriculum is the lack of emphasis on culturally responsive practices and content. A goal of this professional development is to determine ways that middle school science teachers can bring culturally responsive practices into the implementation of the *Amplify Science* curriculum.

The strategies learned in this professional development series should be widely transferable. Though we will be focused on analyzing and improving our Amplify Science lessons, I believe that the same skills can be applied to almost any curriculum, whether standardized or teacher created.

Conclusion

This chapter has outlined the specifics of the culturally responsive teaching in science development opportunity. You have learned more about the context for the development project, including an outline of who will be involved and in what type of school this project will be taking place. We have also shared more specifics of what each session's objective and outline will be so that readers have a clearer idea of the project and its purpose.

Chapter Four will be the concluding chapter for this project. The chapter will share some highlights of what was learned about culturally responsive teaching in science classrooms. It will also go into some of the implications and limitations of the project. This project was developed in the midst of a global pandemic. The chapter will acknowledge how the covid-19 pandemic impacted the project. During a year that looked so different from the typical school year, how much more or less important is culturally responsive teaching? Additionally, how much more or less difficult is it to implement CRT during distance learning? The chapter will conclude the project by providing reflections, topics for future research, and overall areas of growth.

CHAPTER FOUR

Conclusion

Overview

Throughout this project, I have been attempting to answer the question, “*How can science teachers use culturally responsive teaching to help their students develop into independent, self-directed learners?*” At the start, my plan was to create a professional development series that addressed all four components of Zaretta Hammond’s “Ready for Rigor Framework”, including awareness, learning partnerships, information processing, and community of learners. However, in the end, I decided to create a professional development series that addresses one specific component of culturally responsive teaching: Information Processing. The new goal of the series was for teachers to be able to analyze the lesson plans as they currently exist in order to identify opportunities for more culturally responsive strategies. In doing this, we will increase the authenticity and depth of the learning experience *and* increase student engagement.

In this chapter, I will begin with a discussion of what I have learned over the course of this project. I will then go into the implications and limitations of this project, including how results can be shared with the larger education community. Finally, I will conclude with how the project can be extended in order to have an even greater impact on students across my school and the nation.

Major Learnings

I originally became interested in this topic because of a book study I helped to facilitate within my school community. The whole team read Zaretta Hammond’s book, *Culturally Responsive Teaching and the Brain*, and then we discussed the implications of

each chapter. Throughout this process, I realized that most people agreed with the idea of culturally responsive teaching. As a team, we could “talk the talk”. We knew how vital it is to be aware of sociopolitical context; we could recognize the benefits of having strong learning partnerships; we recognized the importance of providing deep, authentic learning opportunities; we believed in the power of a strong learning community. The biggest challenge was the *how*. Discussions constantly returned to the question of how we could actually pull it off. Teachers needed help finding ways to implement these learnings within their classrooms.

As I began my project, I was still confident that each PD session would cover a different component of culturally responsive teaching. First, we’d review the concept of that component and why it is so important. Then, we’d brainstorm specific ways that we could bring it into our classrooms. However, this plan was flipped upside down during a meeting with my content expert. As I outlined my plans, I could see my content expert becoming more and more overwhelmed. After a little while, she interrupted me and said, “So what is the big concept and skill you want teachers to leave this PD series with?” I said, “Culturally responsive teaching, of course!” She poked and prodded at this until I finally recognized that this was much too expansive. In trying to cover so much, I would almost guarantee that teachers wouldn’t be able to extend and apply their knowledge. She pushed me to focus on one component. By focusing on one, I could then make sure that every participant walks away feeling confident and comfortable, ready to implement it immediately!

Upon greater reflection, I realized that this shift made so much sense. Trying to cover lots of content is actually antithesis to the real point of culturally responsive

teaching! One of the most important concepts within culturally responsive teaching is providing an opportunity for learners to become independent. Instructors should aim for students to be able to take the information and skills they have learned and then apply it to their own experiences. By simply covering a little bit of each component, learners would gain knowledge, but would not have strategies for how to utilize these skills in an independent manner.

Culturally Responsive Teaching vs. Multicultural Teaching

One of my biggest takeaways from this project is the difference between culturally responsive teaching and multicultural teaching. For a long time, I believed that culturally responsive teaching was when a teacher brought up multicultural content within their lessons. For example, a couple of years ago, I decided to have a unit all about water pollution and environmental racism. Doing this would make me a culturally responsive teacher, of course. I found articles and videos that we could look at together. We did an activity where we made observations about different samples of water. In one particular lesson, we read an article about the water disaster in Flint, Michigan. We learned about what went wrong to cause the water to contain dangerous levels of lead. After taking notes, students wrote a paragraph that showed their understanding of the concept. I thought the lesson was pretty great! After all, we were learning about how institutional racism impacts water quality. To me, that seemed like culturally responsive teaching. I was wrong.

Culturally responsive teaching is much more than just teaching content. Our goal is not for students to remember dates, people, concepts, and events. Hammond explains, “Our ultimate goal as culturally responsive teachers is to help dependent learners learn

how to learn. We want them to have the ability to size up any task, map out a strategy for completing it, and then execute the plan. That's what independent learners do"

(Hammond, 2015, p. 122). When I really thought about this on a metacognitive level, I realized that this was one of my biggest challenges as a teacher. I try to teach content, rather than teaching students how to independently tackle challenging tasks. This actually connects directly to the shift that I made in my plan for professional development. Again, I was trying to teach information, rather than trying to teach skills.

Ignite, Chunk, Chew, Review

One of my other big takeaways is the idea of "Ignite, Chunk, Chew, Review" as a way to revise and improve our existing lesson plans. This strategy gives teachers a way to systematically incorporate culturally responsive strategies. Additionally, it is very intentional about the neuroscience behind learning. Zaretta Hammond explained the concept beautifully:

Culturally and linguistically diverse families still use [traditionally cultural learning methods] to teach children life skills and to pass along important cultural knowledge from generation to generation. At home and in their communities, traditional learning methods still work. Consequently, culturally and linguistically diverse students come to school with well-developed neural pathways for actively processing information under the right conditions. (Hammond, 2015, p. 127)

After reading this chapter of Zaretta Hammond's book, I was excited! As a neuroscience major in college, I learned all about neural pathways and how our brains take in new skills and information. This strategy is a unique opportunity to bring together my two passions--culturally responsive teaching and the neuroscience of learning!

Limitations

One of the biggest limitations in my research is the size of my school community. We have one science teacher for 5th and 6th graders and one science teacher for 7th and 8th grade. Our partner school has the same structure--just two science teachers. This means the only teacher who teaches the same units is not even in the same building as I am. Unfortunately, this limits the amount of collaboration that is possible.

In my ideal world, there would be four or five teachers all teaching the same units. In that scenario, we would be able to truly collaborate to share ideas and practices. We would dive into the nitty gritty details of the unit. After a lesson, we could look at student work together and have deep discussions about the effectiveness. Together, we could decide on the strategies that are working best and those that aren't effective. When we come up with a really awesome way to invest kids and deepen the authenticity of learning, we could call the other teacher to share the idea! I believe that this level of collaboration is really impactful.

Right now, our science collaboration time is helpful but not transformative. When the science teachers meet together, we have enough similarities to be able to share some best practices. However, there's a limit on what's possible when you aren't teaching the same units and age groups.

I have an idea for how to address this challenge. My school is a network of charter schools that also exist in other locations across the country. Most of these schools teach the same curricula and have similar schedules/overall structures. Could we take advantage of this network to establish cohorts of teachers who are teaching the same content to the same age groups? These cohorts could meet twice a month to plan together,

internalize units, look closely at student work, practice delivering lessons, and share overall experiences. It would be a built in support network! It would be even more impactful if all teachers shared the “Ignite, Chunk, Chew, Review”. That way, we could work together to revise lessons and share best practices with others.

Benefits to the Education Community

This professional development series has the potential to make a transformational difference in the quality of science education. Right now, our country is falling behind in overall science achievement. Additionally, there continues to be an alarming opportunity gap between students of color and their white peers. This needs to be addressed. As noted within Chapter Two, many education scholars have suggested that culturally responsive teaching is a possible solution for addressing inequities in our nation’s classrooms. I believe that this series provides a structured opportunity for teachers to implement culturally responsive teaching strategies in their classrooms. This will then help to improve students’ independence and their ability to tackle problems of any type.

I would like for this PD series to be utilized widely within my school community and within our larger network of schools. It is helpful for us, of course, but we are a small community. It becomes much more transformational when provided to many different schools across our city and our country.

In my school, each content teacher has a specific curriculum that they are supposed to use. The curricula are widely used and research-based. By providing a curriculum, the school hopes that teachers can focus on internalization rather than planning. They believe that teachers should not have to reinvent the wheel every unit.

There are enough teachers out there, we should be able to use a curriculum and instead focus on delivery.

However, one of the limitations of this is the lack of authentic culturally responsive strategies in the lessons. By design, the curricula are designed to be successful in any classroom, with any students. This means that lessons do not bring in specific strategies and connections specific to the cultural backgrounds of the students themselves. When I identified this limitation, I realized that every teacher in our school would benefit from the “Ignite, Chunk, Chew, Review” strategy. What if we all used ignite, chunk, chew, review as a structure to help us revise our lessons?! Though I focused on science teachers in my professional development, I actually believe that this PD series would be successful in every content area.

I believe that this professional development series is highly transferable. It is general enough that it could be implemented within almost any content area and grade level. However, for collaboration to be as authentic as possible, it should be offered to relatively homogenous groups (in terms of content area and age group). We should not be offering the PD to a group of teachers of many different content areas. I believe that too much of the time would be spent giving context for the lesson, and not enough time diving into the actual teaching strategies. However, I do believe that it could be implemented within a team of teachers teaching any specific subject.

I plan to share the PD series in two ways. First, I will share the series and its outcomes with the Director of Academic Systems in our region. She oversees the content teams in our four schools, and can encourage each team to implement the professional development. This would mean that Ignite, Chunk, Chew, Review would be implemented

widely across our schools. Additionally, this woman often meets with folks in similar roles in other regions. If this PD series is effective, I would also hope that it is shared with schools in other areas. Seeing as we are one of 270 schools across the country, it could make a huge, transformational impact on millions of students of many different backgrounds.

Future Directions

At this point in the process, I have not yet implemented the professional development series within our science content team. I have completed the background research, outline of the PD, slides for implementation, and materials for assessment. However, we will participate in this series during week three of summer PD, which is the week before students return to school. As discussed in Chapter Three, I will evaluate the effectiveness of the PD in three ways: student growth on the MAP NWEA science test, informal classroom observations, and a teacher-facing survey. I will use the results of these assessments to determine the next steps.

If the PD is shown to be ineffective, I will dive deeply into the results in order to figure out what went wrong. I will rework the professional development to account for these challenges, and will adjust my plans prior to follow up sessions throughout the school year. I believe strongly that science teachers need to adjust the ways information and skills are being delivered. I do not think our school has yet found a way to make our science classes culturally responsive. Therefore, I will try different strategies during content team meetings and work harder to make sure our classrooms are supporting students on their journey to becoming independent learners.

If the PD is shown to be effective, then I can continue this journey with the other three components of Zaretta Hammond's *Ready for Rigor* framework, including Awareness, Learning Partnerships, and Community of Learners. I believe that each of these four components is vital to students becoming independent learners. Therefore, each deserves a series of professional development. I believe that the structure used for this one could be reworked for each of the four components of CRT. Having an opportunity to dive into the four components as a science team would make a transformational difference in the quality of students' experiences within our school and our larger network of schools.

Summary

In this project, I began the challenging process of answering the question: *How can science teachers use culturally responsive teaching to help their students develop into independent, self-directed learners?* Our staff had previously participated in a book study of Zaretta Hammond's book, *Culturally Responsive Teaching and the Brain*. Though it was incredibly impactful, staff continued to get stuck on the question of "how". The goal of this project was to create a professional development in which science teachers could collaborate to find concrete ways to bring CRT into their classrooms. The series focuses specifically on Ignite, Chunk, Chew, Review as a way to incorporate culturally responsive teaching strategies into our existing lesson plans. The goal of this concluding chapter was to reflect on the project and its implications and limitations.

Students need classrooms in which they feel seen and successful. They need teachers who are responsive to their cultural backgrounds and experiences. These spaces empower students to take risks and teach students the skills they need to independently

tackle challenging tasks. This is what will help our country's academic inequities to dissolve. However, culturally responsive classrooms do not just appear. It takes effort. I hope this professional development series is the beginning of the journey toward helping students become confident, independent learners able to tackle any challenge they confront.

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