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The Importance of Interdisciplinary Education

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The Importance of Interdisciplinary Education

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Abstract

This thesis work explores the concept of *Interdisciplinary Education* and how it can improve the educational experience for students while also creating citizens more capable of participating in a democratic society. In order to create more well-rounded citizens, schools should provide an interdisciplinary approach to education that centers the perspectives of the those who are traditionally excluded. Much of the education curriculum today is based on a system that favors the majority leaving out entire groups of students from minority populations. As a result, schooling overwhelmingly does not help oppressed students become critically conscious citizens who are equipped to participate in the democratic process of decolonizing education. Without well-rounded, critical thinking citizens, the path toward inclusivity and democracy are threatened. This proposed study focuses on an interdisciplinary curriculum that will serve as an example of how educators can work together to create a curriculum in which students would gain a more practical and holistic academic perspective. If successful, this proposed curriculum will provide educators with an approach to work across all academic subjects to connect ideas with real world experiences ultimately creating more well-rounded and critically conscious students. We cannot expect our students to decolonize and revolutionize the world unless we as educators give them a voice and the knowledge to do so.

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Chapter 1

Introduction and Positionality

One's positionality is not only formed by lived personal experiences but is shaped by the social constructs that make up those experiences (Dahl, 2015; Herr & Anderson, 2005). While everyone has their own personal viewpoints and opinions, those opinions are formed by experiencing life within social institutions. As one researches, it is important to understand positionality and how one's experiences have created certain perspectives throughout life. In this chapter, I will share my experiences of joining clubs, growing up with education focused parents, studying abroad and teaching during a global pandemic and how they have given me the opportunity to explore my own positionality. In the first section I will cover some experiences from my childhood. Joining a club for students with disabilities allowed me to see the advantages of a classroom with multiple disabilities. Parents with an education mindset opened to the door to the importance of higher education and becoming a life-long learner. In the later sections I will go over studying abroad in Spain at the age of sixteen and how it gave me my first taste of being an outsider in the classroom due to a lack of knowledge of the language and culture. Once in college I got the chance to study abroad in Australia which allowed me to study the lives of the indigenous peoples of Australia. Studying about marginalized groups of people opened my eyes to the importance of various viewpoints in curriculums in schools in order to give more than just the western viewpoint a voice. More recently, teaching during Covid-19 has made teachers around the globe rethink their classrooms and curriculums. More than ever in this virtual world, we must focus on the decolonial turn and give all students and educators the chance to have their voices heard in an attempt at liberating marginalized groups in education. Interdisciplinary

education is a way of bringing multiple disciplines together whether virtually or in person as opposed to having only one voice heard. My positionality has been shaped and created by my lived experiences over my lifetime leading me to the idea of an interdisciplinary approach to teaching as a way of focusing on decoloniality and bringing multiple viewpoints and personalities to my curriculum.

My Childhood in Perspective

Maldonado-Torres (2011) explains that decolonization is still happening in terms of knowledge and power from the western world. It is important that western culture norms and knowledge continue to be critiqued as being the sole viewpoint in the classroom. As a society, we must not allow the continued propagation of capitalism and racism and we must question what knowledge and whose knowledge continues to be taught and seen in classrooms. I agree that decolonization is still happening and needs to make its way to the curriculum and classrooms in public schools across the US. Questions about who is writing textbook material and what is getting published need to be raised in order to change the dialogue around what is being taught and discussed. In my experience, classrooms are a homogeneous environment with students of similar backgrounds and lacking diversity. As a student, I was not involved with students of different abilities until I joined the club Best Buddies[1], at fourteen, which opened my eyes to different needs and viewpoints in the classroom. Having the experience of helping students with schoolwork as well as socialization allowed me to see the diversity that is lacking across education as a whole. Maldonado-Torres (2011) makes a great point that decolonization is

[1] Best Buddies is a club at Unionville High School, Pennsylvania, United States, that provides activities for students with and without disabilities to come together and socialize and learn from each other. The club also organizes events for students to collaborate and work together in order to run an event or raise money for kids with special needs.

more than simply breaking away physically but should include breaking away in terms of knowledge and culture norms. There is a lack of decolonization in the classroom as seen by the lack of diversity in classrooms which are dominated by the western world's culture and norms which circulate capitalism and racism.

In my experience, decolonization in terms of knowledge in the classroom is still in its early stages and we must start giving students the opportunity to express their viewpoints as well as listen intently to those around them as part of the process of self-reflection and decolonization. Takacs (2003) explains the importance of giving students the chance to question who they are and why they know what they know. Once students have the ability to listen to each other they will gain a better understanding of the views of others and respect those differences as opposed to simply tolerating them. I agree with the decolonial position of Takacs (2003) in that students should be given the opportunity, and even challenged, to reflect on what they know and their positionality about various subjects as opposed to the teacher simply stating his/her opinions. Everyone brings different views to a conversation and it is important that students understand their views have a place in the discussion. I began to understand the importance of various view points after joining Best Buddies and seeing students with varying abilities bring different opinions and viewpoints to the classroom. Having the opportunity to bring my experiences and differences to a classroom consisting of solely students who are different from me allowed me to see my positionality for the first time. Takacs (2003) discusses the idea that everyone has a different story and will bring that background to the classroom. The challenge is to assist students in developing a decolonized view of not only the larger society, but of themselves as well. Students should be given the chance to share their experiences and create dialogue amongst

their peers, no matter their ability, instead of simply listening to the sole viewpoint of the educator or peers who may be just like them.

Giving students the chance to decolonize how they see their own positionality through the use of narrative, dialogue and various viewpoints is an important way for them to tell their own stories while listening to others. Positionality is the idea that identity can change over time based on historical and social changes happening around the person (Kezar & Lester, 2010). Connelly and Clandinin (1990) discuss the importance of narrative and storytelling in education curriculum in order to develop one's positionality. The authors argue that teachers and students must listen to each other's narratives as part of the curriculum in a school because humans are natural story tellers. I agree with the authors that humans are natural story tellers and it is important to carry that through classrooms and the curriculum in schools. If teachers and students use stories and begin to listen to each other it can enhance the learning environment in schools. After joining a club to help students of varying abilities, I found that learning about those students and how to help them came through listening to their stories and experiences as opposed to reading a textbook. Hearing other's stories helps to put ideas together in order to create your own thoughts as opposed to reading about them in a textbook. Connelly and Clandinin argue that narrative should be an important part of someone's educational experience as humans are natural storytellers. While trying to understand those with varying abilities and educational differences I found that storytelling and listening was the most beneficial way to begin to understand another way of life.

Impact of Social Institutions on my Educator Mindset

In my experience listening to others' narratives was a vital part of my education and therefore my positionality because people gain knowledge through experience and socialization.

Berger and Luckmann (1991) describe institutionalization and the idea that institutions are socially constructed throughout time based on knowledge acquired by different people through socialization. Humans gain knowledge based on the situations they encounter which then become their own personal reality. I agree with Berger and Luckmann that knowledge is acquired through socialization which is then passed down to future generations as truth. Growing up I lived in a house with educated parents who never questioned the idea of their children attending higher education institutions. While sitting at the dinner table each night the conversation would center around school work and my interests in order to further the discussion about college and continuing my education. Educational institutions were important in my house which through socialization became important to me as I grew up. The authors stress the idea that institutions are socially constructed and knowledge is passed down to future generations through socialization. As seen in my house growing up, education was an important institution that should be realized by everyone. I am now an educator as well as a lifelong student because of socialization from my parents about the importance of educational institutions.

My interpretation of my experience is that what we learn through socialization becomes our own personal reality but what we don't learn becomes limitations in our positionality which must be recognized when doing research. Herr and Anderson (2005) discuss the idea that while writing action research it is important to understand one's positionality and limitations within the research. According to the authors, an insider-outsider team approach to research is the best option to achieve equitable power relations. An insider-outsider team allows the researchers to understand their positionality either inside or outside the topic and collaborate with those in the opposite position on equal terms. I agree with the authors that positionality when looking at action research is important in understanding limitations. It is important to research and

understand new topics while also understanding where I come from in terms of the subject and what limitations and biases I might bring to my research. Only by focusing on my biases can I decolonize my thinking and thus acting/teaching. My parents stressed the importance of education and I was able to gain a love of learning growing up. Although I have enjoyed my educational experiences thus far it is important to understand that I have always been taught the importance of education which could have affected my opinions. Limitations while conducting action research are just as important to consider as the research itself. Creating a team of individuals both inside and outside the subject would have a profound impact on the legitimacy of the research. Knowing where I come from and my positionality on the importance of education allows me to decolonize and understand my views and how they affect my research.

Not only should we consider limitations in our own positionality when considering research but one's narrative should also be highly regarded as part of the educational experience in the classroom. Dahl (2015) uses the stories of four Kenyan educators in order to explain the importance of narrative in education. The article explains that experiences from teachers' lives are just as important as teacher training and those experiences and narratives should be used as ongoing professional development. I agree that narrative and telling stories is a valuable tool for teaching in the classroom. Teachers are human beings whose lives continue to evolve and change just like the students therefore their stories are valuable experiences that can be learned from in order to improve teacher professionalism. The value of education that was given to me growing up included the idea of becoming a lifelong learner; being a student never ends. I would watch my parents come home from work exhausted but always find time to read and research topics of interest to them. With the concept of consistent learning it is important to use new knowledge acquired along the way as a tool for improving my ability to teach. Dahl (2015) describes four

Kenyan teachers on their path as educators to explain the importance of narrative being used in education. As a lifelong learner, I feel as though curriculum combined with a narrative of life experiences is a powerful combination for education.

Effects of Studying in Spain

In my opinion, narrative is an important addition to what is taught in classrooms because teachers are gatekeepers of knowledge for their students and their personal stories can help decolonize what is being taught from textbooks. Hung (2018) interviewed teachers in hopes of gaining an understanding of why teachers avoid discussing controversial topics in the classroom thereby failing to contribute to the decolonization of education. He concludes that teachers are gatekeepers of controversial knowledge and they choose the safe knowledge that will be presented to their students. Teachers each have their own personal practical knowledge they have acquired throughout their life that plays a crucial role in how that teacher will approach controversial topics when teaching. Although I have not encountered having to teach a controversial topic in the classroom, I agree with Hung (2018) that personal practical knowledge will differ from person to person and have an impact on the classroom environment. Teachers need to understand their personal practical knowledge and where it comes from in order to better understand their positionality in the classroom. One of the most important parts of my personal practical knowledge as an educator comes from when I arrived in Spain at a bus station to study abroad and a police officer walked away from me because he could not understand me when I asked for help. My first few weeks in Spain were difficult as I did not speak the language and was unable to communicate with my host family, peers or teachers effectively. In another instance, I was ignored in a restaurant because the waiter could not understand my Spanish accent and he looked to my host mom as if I was not there. For the first time in my life I felt like

an outsider which has given me the chance as an educator to understand how students may feel in my classroom when they arrive. Another example I saw in Spain of outsiders in a classroom was the Moroccan students that attended the school. As Quijano (2000) states, coloniality of power is the idea that those who colonize will maintain power over those they have colonized. While studying in Spain it was apparent that the white, rich students were expected to attend college while the Moroccan students would grow up and work on the farms which sometimes led them to not finish high school. The lack of expectation for students to attend college based on skin color and culture was a clear indication of coloniality of power at work. The Moroccan students were viewed as outsiders in the classroom as opposed to valid members of the class community. My time in Spain has solidified the idea that personal practical knowledge is acquired throughout life and each person will differ from the next. While studying abroad I had the opportunity to try something new and be the stranger in a classroom. This opportunity has become a part of my personal practical knowledge and has helped me to make my students feel comfortable in my classroom as their educator.

While my experiences in Spain helped me to better understand how my students may feel when entering a new classroom, it is important to continue to critically look at education in the hopes of connecting what is taught to my students' lives. I understand that my students may feel unwelcome based on previous grades, behavior or experiences and making them feel understood is my goal. Manfra (2009) discusses the differences between practical and critical action research and the implications each type of research has in education. Practical action research focuses on the individual classroom and practicality questions while critical action research focuses on social, cultural and political contexts of education. The author stresses the importance of a mix of both types of research with an emphasis on critical action research in order to improve

educational structures and create a more democratic society. I agree with Manfra (2009) that both practical and critical action research should be used as an educator. Before studying abroad in Spain, I may have approached teaching with the purpose of improving my teaching and my classroom practices throughout the years. After having lived in Spain and seeing how others live, I now have the goal of critical action research and connecting my teaching to the lives of my students. The idea of making connections to my students lives reminds me of the Moroccan students living in Spain and the differences they faced in the classroom. Not only were the students not expected to attend University but because of that expectation the teachers did not make meaningful connections with them in the classroom. Due to coloniality of power, Moroccan students were not engaged in the classroom like white students and lost the opportunity for a connection to the classroom and the curriculum. Manfra (2009) explains how critical action research can help change the structure of education and not just individual classroom issues. Having the opportunity to experience another culture and way of life has opened my eyes to critical action research and the idea that connecting socially, culturally and politically in the classroom will offer a better educational experience to all of my students.

My experiences have given me the opportunity to understand the importance of critical action research and connecting my curriculum to students' lives but I must also keep in mind the continuum of positionality that can change throughout my research. Positionality is constantly changing and my views as an insider or outsider of research can go back and forth. Herr and Anderson (2005) explain the importance of positionality and the continuum that occurs while conducting research. The researcher is not strictly an insider or an outsider but can slide along the continuum throughout the research process. The authors also stress the importance of positionality as a social construct that is formed through human interaction throughout time. I

agree with the authors that positionality is a social construct and it is important to understand one's positionality when conducting action research. I also agree that positionality lies on a continuum and can change throughout the research process depending on the situation at hand. It is extremely difficult to look at one's own environment from an outside lens. While studying abroad in Spain I was for the first time in my life an outsider to another culture. This experience gave me the chance to begin to understand positionality and what it means to be an insider or an outsider because for the first time I was an outsider. Although I was not able to understand how the Moroccan students felt in the classroom based on their skin color, I was able to understand the idea of coloniality of power and the importance of involving all students in the classroom discussion regardless of race. Herr and Anderson (2005) discuss the continuum of positionality and how one's positionality can continually change while conducting critical action research. After studying in Spain, having experienced being an outsider to another culture, I began to understand how positionality is socially constructed and will be constantly changing throughout my life including research.

Australia and my Global Perspective

Not only was living in Spain important because it gave me a chance to feel what it is like to be an outsider but it also gave me a chance to see things from multiple viewpoints from different regions of the world. Maldonado-Torres (2011) explains that decolonization was not solved by creating ethnic studies at universities. Such programs were just identifying, but not solving, the unmet social demands of the colonized and oppressed. The author also mentions the notion of shifting the geography of reason which explains that knowledge cannot be produced solely based on one viewpoint or one region of the world. When focusing on the decolonial turn it is imperative one looks at identity and epistemic positionality. I agree with the author that

when looking to decolonize education it is important that regions of the world and various viewpoints are not ignored. In order to better the education system it is important that curriculums focus on a decolonial turn and look at all ideas and philosophies from various languages and countries as opposed to only the western culture and norms. When studying in Australia at age twenty I took a class about the Indigenous peoples of Australia where we learned about their history but also looked at issues from their viewpoint. In one class, we took the day to walk around the city looking for carvings from the indigenous tribes and making impressions as to not ruin or destroy the carvings. As opposed to simply learning about the Indigenous tribes in Australia from a white man and a textbook, our professor gave us the opportunity to learn from what the indigenous tribes had made themselves from their point of view. Decolonization requires that western culture and norms are not so highly regarded and knowledge be produced from looking at multiple theories and philosophies from around the globe. Having the opportunity to study the indigenous tribes of Australia through carvings and personal experiences was much more profound and decolonized than using a textbook and a detached professor.

Not only was finding carvings and exploring Australia a more hands-on way of learning about indigenous peoples but hearing their stories through narrative also helped in gaining an understanding of the indigenous tribes and their ways of life. These testimonies offer a viable alternative to Western society therefore contributing to decolonization. Kramp (2004) explains the differences between paradigmatic knowing and narrative knowing in terms of conducting research. Paradigmatic knowing requires logical proof whereas narrative knowing allows the researcher to find meaning from the story for the one who experienced it. The author emphasizes the idea that narrative inquiry is about both the process of telling the story and the product of the story itself. I agree with Kramp (2004) that narrative knowing allows the researcher to be more

concerned with understanding rather than explanation and proof. Telling a story provides not only a plot but a point of view as well as emotion and experience. When completing the class in Australia regarding indigenous peoples, one of the most interesting and important parts of the lectures included guests from the indigenous tribes. Hearing first hand stories from people about their ancestors and ways of life was the most memorable and impactful part of the class. As opposed to simply hearing about the indigenous tribes from an oppressor viewpoint it gave me a broader understanding of their ways of life hearing from real people about real experiences. Narrative knowing can provide a more well-balanced approach to knowledge because stories can provide more than just fact and proof they can provide a plot with point of view and experience. Hearing from indigenous peoples about their ancestors and history in Australia was a more memorable and personal approach to learning about indigenous tribes than using a textbook created by non-indigenous peoples.

What I learned in Australia about the treatment and experiences of indigenous peoples parallels that of indigenous peoples in the United States and other parts of the world. With similar experiences occurring across the globe it is important that curriculums in schools become epistemically diverse. Fregoso and De Lissovoy (2019) explain the importance of an epistemically diverse curriculum as opposed to a western epistemological based curriculum in schools. In order to implement such curricula, the authors propose using decolonial literary works as a way to replace western modes of reason. I agree with the authors that a curriculum dominated by western culture and norms does not allow students the opportunity to see other viewpoints beyond that of the privileged. An epistemically insurgent curriculum proposed by the authors would help to radically change education and give a larger voice to marginalized groups rarely represented in education curricula. In my experience in Australia it was evident that the

curriculum did not represent any viewpoint other than the white oppressor. On day one of my indigenous peoples class my professor made it very clear he would not be following the textbook and would be presenting the class with help from guest speakers and indigenous peoples themselves. Although I did not know it at the time, my professor of indigenous studies was the face of decolonization. Without an understanding of narrative inquiry, my perspective of my experiences in Australia would be epistemically different. Though the professor was able to teach in the way he wanted by bringing marginalized voices to the forefront, the curriculum in general would not have allowed for such freedom of narrative. Fregoso and De Lissovoy (2019) describe an epistemically insurgent curriculum which gives a voice to otherwise marginalized and oppressed groups. My experience highlights the idea that curricula around the globe fail to be epistemically diverse and show a clear lack of diversity.

Teaching during a Global Pandemic

In order to successfully implement an epistemically diverse curriculum, new ways of thinking and teaching about totality and exteriority must be considered. Totality includes the system that exists created by those with authority or control and the exteriority includes those on the outside of the totality. De Lissovoy and Fregoso (2019) explain Dussel's philosophy of liberation in which we must rethink the totality and therefore rethink what is being taught in schools to include ideas outside of the totality. The authors not only explain the importance of rethinking the totality but also that such liberation of the oppressed needs originality not imitation. New ideas and philosophies must be used in order to change the totality and we must not try to attempt to fold the oppressed or the exteriority into an already failing existing system; we need a new system all together. In my experience as an educator during a global pandemic, the totality of Covid-19 includes all of the rules and regulations now mandated because of the

rapidly spreading virus. As educators, we have been forced out of our classrooms into an entirely new virtual classroom we create ourselves. Due to the stressful situation, educators that are part of the exteriority are deciding not to be part of the Covid-19 totality of online teaching and are choosing to quit their jobs instead of teaching online. Although I will not be leaving the teaching profession, the impact of Covid-19 has been powerful and life changing. Just as Covid-19 serves as its own informal totality, the global pandemic has continued to remind me as an educator to question the totality of western culture in education and realize the importance of liberating the exteriority whether I am teaching online or in person. Fregoso and De Lissovoy (2019) describe the importance of rethinking totality and exteriority in education through Dussel's philosophy of liberation. With an entirely new totality in the works thanks to a global pandemic, educators now have a difficult responsibility to try to liberate through original means both in person and online.

As described by Dussel's philosophy of liberation, imitating what already exists will not properly liberate the oppressed within the education system and I believe interdisciplinary education could be a means by which to begin to liberate and decolonize. Cook-Sather and Shore (2007) describe interdisciplinarity and the importance of not only connecting disciplines but questioning the core of each discipline as well. In order to move away from the current educational structure in which each discipline remains separated, interdisciplinary education would promote the idea that the professor is not the sole authority and the professor and students continually learn from each other. The article asks the question of who has legitimate perspective into what constitutes knowledge which opens the door to the possibility of interdisciplinary education. I agree with the authors that interdisciplinary education could promote free and inventive thinking between professors and students allowing each to learn from each other. With the opportunity for every person in the classroom to have a voice, interdisciplinary education

could begin to break the structures of education and give a voice to marginalized groups. When a global pandemic hit this past year, every educator around the globe had to slow down and rethink their teaching strategies. I personally believe teaching in a virtual setting has illuminated the importance of interdisciplinary education. Without dialogue between all persons working and learning in a school setting, delivering a curriculum to students proved very difficult. In my experience, students have had to communicate more while learning online giving them more of a voice in the virtual classroom. I also feel as though more collaboration between educators in different subjects would help students learning from home. One example in particular was a collaboration between math and science educators including myself. The math teacher was looking for a way to teach water displacement. By collaborating with myself and some other educators, we were able to come up with examples using household items and various ideas from our own curriculums to help the math teacher execute the lesson. Teaching online has presented many new challenges to both new and veteran teachers but collaborating together to create a more interdisciplinary approach to teaching can help alleviate some of those challenges to teaching students at home. Interdisciplinary education combined with online learning can create an open forum for communication between students and educators potentially opening the door to decolonial liberation within education.

Moving Toward Interdisciplinary Education

Interdisciplinary education can be used as a tool to create a space for the oppressed to self-liberate by opening communication and bringing multiple viewpoints and ideas to each subject and curriculum. Tight, Devlin, and Davies (2010) describe modification interdisciplinarity in which educators of various subjects come together to learn from each other in order to not only connect disciplines but change them as needed before bringing them

together. Modification interdisciplinarity is described by the authors as a more extreme form of disciplinarity because of the idea that subjects need to not only connect but learn from each other and change in association with other disciplines. I agree with the authors that this form of disciplinarity is extreme and not yet common but I also agree that it is necessary in a truly liberating education. As an educator during a global pandemic this is more important than ever. Every single teacher around the globe is having to do something different with their classrooms and curriculum giving us unprecedented times in education. With the idea of modification interdisciplinarity we as educators would get the chance to bring our own positionality and knowledge to a discussion about not only our subject but other subjects as well. As one's positionality is a social construct, I find it to be important that many viewpoints and ideas are used in each discipline as opposed to separating knowledge into categories. We have created our own ideas and positionality through social experiences, highlighting the importance of interdisciplinary education and using such knowledge for the entire education world and not one subject. The authors describe the entire continuum of disciplinarity including modification disciplinarity which in my opinion is extreme but needed in education today. Not only should subjects collaborate with various positionalities but in a new virtual world, now is the time to consider such a change.

My personal experiences throughout my lifetime have led me to examine my own positionality and what that means for me as an educator to young minds. I not only grew up in an education focused family but I was given opportunities to travel and study in various places around the globe. Each time I traveled I was given a chance to learn a new culture and perspective on life through a different education system. As an educator, I now focus on continuing to be a life-long learner as well as embrace different ways of learning in my

classroom. Based on my experiences I acknowledge the importance of various viewpoints and opinions and the impact that can have on creating an epistemically diverse curriculum in my classroom. My testimony has led me to embrace the idea of an interdisciplinary educational approach which allows multiple disciplines and viewpoints to come together for a common goal. By bringing together multiple viewpoints there can be a focus on the decolonial turn in which more than just western voices in power are heard. Education is about more than simply telling future generations about ideas and facts; it is about challenging future generations to innovate and transform the world we live in, including everyone not just those in power. We cannot expect our students to decolonize and revolutionize the world unless we as educators give them a voice and the knowledge to do so.

Chapter 2

Thematic Concern, Conceptual Framework, and Definitions

THEMATIC CONCERN:

Education today tends not to be inclusive of marginalized voices. As a result, schooling overwhelmingly does not help oppressed students become critically conscious citizens who are equipped to participate in the democratic process of decolonizing education. Without well-rounded critical thinking citizens, the path toward inclusivity and democracy are threatened. In order to create a more well-rounded citizen, schools should provide an interdisciplinary approach to education that centers the perspectives of the traditionally excluded. This proposed study will focus on an interdisciplinary curriculum that will serve as an example of how educators can work together to create a curriculum in which students would gain a more practical and holistic academic perspective. If successful, this example curriculum will provide an opportunity for teachers to find connections between subjects and marginalized peoples and ideas ultimately creating more well-rounded and critically conscious students.

CONCEPTUAL FRAMEWORK:

1. What role does education play in creating critically conscious citizens in a democracy?
2. What is interdisciplinary education and what value does interdisciplinary education add to society in creating critically conscious citizens?
3. Why has interdisciplinary education not been widely used in education and what limitations exist within its framework?
4. Is interdisciplinary education an appropriate structure for education in the current climate of distance and virtual learning?

DEFINITIONS:

Constitutive

Banking Model	The Banking model of education was proposed by Freire (1970) and is the concept that students are empty vessels and school is meant for teachers to fill those vessels with information and send the students on their way. The banking model suggests that the teacher knows all of the information and the student has no knowledge to contribute to the classroom.
Critical consciousness	Critical consciousness is defined by El-Amin et. al. (2017) as "the ability to recognize and analyze systems of inequality and the commitment to take action against these systems" (p. 1).
Critical Thinking	Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. (Foundation for Critical Thinking, 1987)

Decolonization	Pressbooks (2020) defines decolonization as the process of deconstructing colonial ideologies of the superiority and privilege of Western thought and approaches and involves dismantling structures that perpetuate the status quo and addressing unbalanced power dynamics.
Epistemology	Merriam-Webster (2020) defines Epistemology as the study or a theory of the nature and grounds of knowledge especially with reference to its limits and validity.
Interdisciplinary education	A mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and or theories from two or more discipline or bodies of knowledge to advance fundamental understandings or to solve problems whose solutions are beyond the scope of a single discipline or area on research practice. (NAS, 2004)
Positionality	Positionality is the idea that identity can change over time based on historical and social changes happening around the person (Kezar & Lester, 2010).
Social Institution	Berger and Luckmann (1991) describe institutionalization and the idea that institutions are

	socially constructed throughout time based on knowledge acquired by different people through socialization.
Transformative Intellectuals	As explained by Giroux (1988), transformative intellectuals are those who make pedagogy more political and the political more pedagogical. Students must be treated as critical agents and critical reflection and action must be brought to the forefront of the classroom.

***Operative*:**
For the purpose of this paper,
the following definitions will apply:

Consumerist Society	A consumerist society can be defined as a society in which the main focus is to consume goods. The purchasing of material goods can equate to one's personal well-being and happiness.
Higher Order Thinking Skills	Higher order thinking skills are defined as skills that go beyond memorization or regurgitation and ask students to understand, analyze and evaluate information and concepts.

Chapter 3

The Narrative

What is Democracy?

Democracy is defined by the Merriam-Webster dictionary as, "a government in which the supreme power is vested in the people and exercised by them directly or indirectly through a system of representation usually involving periodically held free elections." In other words, democracy is a form of government in which people express their beliefs and opinions and those in the majority maintain power with the opportunity for those in the minority to become the majority at any time. As George Counts (1932) states the most genuine expression of democracy in the United States is "a sentiment with respect to the moral equality of men: it is an aspiration towards a society in which this sentiment will find complete fulfillment" (p. 286). Counts describes democracy in a way compatible with the project of decoloniality. That is, for Counts (1932), democracy is where all people have equal opportunity regardless of race, sect or occupation. Without the opportunity for the minority to speak up and voice their opinions a democracy would not be possible. Without decoloniality there can be no democracy. A democracy requires that marginalized groups have their own thoughts and opinions to most effectively struggle against colonialism as a collective as opposed to being told what to think by those who hold the power; meaning those with an advantage based on race, religion or occupation. Instead of being told what to learn and how to learn various information by an all-knowing teacher or curriculum, an education within a democracy should focus on the masses of people, not only those with special advantages based on race, occupation, or group.

In order to actively participate in a democracy and have one's own thoughts as a collective fighting against the domination of colonial education, critical consciousness must

flourish. Critical consciousness is defined by El-Amin et. al. (2017) as "the ability to recognize and analyze systems of inequality and the commitment to take action against these systems" (p. 1). Someone who is critically conscious is able to identify variations in equality and speak up about said inequalities. A critically conscious individual is one who is able to question the authority as well as understands their position within the democratic state. According to Freire (1970), citizens must become active members of society who "Learn to perceive social, political, and economic contradictions and to take action against the oppressive elements of reality" (p. 86). Without the ability to think critically and ask questions of those in power, the minority party can easily become the oppressed. The oppressed are those being told what to think and how to act by those in power, for example in an authoritarian state. The oppressed include those without privilege based on their race, gender, occupation or socioeconomic background. The oppressed specifically includes people of color and people with a lower socioeconomic background. For democracy to be successful the majority party, those who are privileged, must not become the oppressor due to a lack of knowledge within the minority party or those being oppressed. If the minority party, the oppressed, is not educated and cannot form their own opinions, the majority can easily take over and maintain power. In order to prevent the oppressor and the oppressed situation as stated above from Freire, education must be used to create critically conscious citizens able to ask questions of those in power in order to maintain democracy. As Spring (2008) states, "Critical thinking is necessary for the survival of a democratic society and a democratic society is necessary for the exercise of this form of critical thinking" (p. 51). A democracy cannot survive without critically conscious citizens and critically conscious citizens can be created through a democracy. In providing critical thinking in education, students would have an opportunity to learn about democracy as well as how to question authority and not

simply believe everything they are told as truth. In order to teach students how to be critically conscious, schools must use higher order thinking skills within their curriculum. It is imperative that students learn to ask questions and come to their own conclusions as opposed to simply being told the right and wrong answers. Chomsky (2003) quotes Bertrand Russell, "The goal of education is to give a sense of the value of things other than domination, to help create wise citizens of a free community" (p. 38). Russell emphasizes the importance of a free community in which domination by one group is not present. A decolonized democracy requires all citizens to be educated in critical thought in order to prevent one party from becoming the oppressor and therefore never giving the minority party, the oppressed, a voice.

Banking Model of Education

When I think back to my public-school education the first thing that comes to mind is desks that are in perfect rows with a teacher at the front of the room and silent students taking notes. I can think of the occasional colorful classroom, but the majority of my memories entail white walls and a class of students all facing the teacher standing at the front of the room. As mundane as that may sound that is the epitome of how Freire (1970) describes a banking model of education, a thoroughly colonial approach to teaching and learning. Marginalized students in particular come to school expected to suppress themselves to learn from their teachers in order to reiterate that information at a later date to get a score on how well they remembered what the teacher said. Students listen to lectures and occasionally participate in class discussion in order to learn information they may or may not be interested in to perform well on a test. The majority of a child's education should not consist of listening to one teacher and assuming everything that teacher says to be true. In order to engage in critical thought the idea that the teacher knows all of the relevant information needs to be ignored. As Freire (2005) states, "Educators need to know

what happens in the world of the children with whom they work" (p. 130). As stated in the Eighth letter of Freire's book, *Teachers as Cultural Workers*, two professors were walking home from a conference and spoke to children flying a kite about how the children knew the distance of the kite line without having a meter stick (2005). The children explained how they tied knots in the line about every two meters and they were able to calculate the height of the string. The children did not have a piece of paper in front of them nor were they writing anything down in terms of geometry or angles. The article states, "Nothing of what he knew had any value in school because what he knew he had learned through his experience" (Freire, 2005, p. 131). The idea that what the child knew about kite flying not being relevant in school is a prime example of a colonial model of education marked by a lack of relevance to the concrete world our education system has become. In a decolonized education children should be involved in their education and their education should be centered around their concrete world.

The colonial banking model of education described by Freire (1970) is a large part of public education today. The banking model is an approach to education in which the teacher simply gives the students information and the students take in that information in order to repeat the information on an assessment later on. The banking model implies that the teacher knows all of the information and the students have no knowledge to contribute to the classroom (Freire, 1970, p. 72). By using the banking model students are not being taught to think critically. Students are being taught that what the teacher or textbook says is a fact and no discussion needs to occur. With this approach of learning, the students are learning to memorize and repeat as opposed to thinking critically and abstractly about a subject. Educators should promote dialogue in their classrooms in order to allow students to challenge certain ideas and each other. As Freire (1970) mentions, we as educators cannot become the oppressors of colonial education nor can

we allow our marginalized students to uncritically remain the colonized or the oppressed and never question those in power.

Contributing to our understanding of colonial education Jean Anyon (1980) conducted a study about the different types of schools that exist based on the income, occupation and socioeconomic backgrounds of those living in specific communities. She studied four different types of schools including what she called, working class schools, middle-class schools, affluent professional schools and executive elite schools. Anyon (1980) determined that in each type of school, teachers taught in such a way to prepare students for specific jobs in society, "…fifth graders of different economic backgrounds are already being prepared to occupy particular rungs on the social ladder" (p. 1). In working class schools most parents had blue-collar jobs and students completed work in which they had "very little decision making or choice" (Anyon, 1980, p. 3). In executive elite schools, Anyon explains that most parents had executive positions and students completed work with the teacher in a "decision-making process" (1980, p. 11). As Anyon (1980) states, "the "hidden curriculum" of schoolwork is tacit preparation for relating to the process of production in a particular way" (p. 14). The type of school was determined by the economic background of the parents which in turn determined the type of education students received. Those with lower socioeconomic backgrounds were receiving an education which prepared them for working class jobs whereas those with higher socioeconomic backgrounds were receiving an education which prepared them for executive level jobs. As seen through Anyon's (1980) study there is a hidden curriculum in schools, which we can call a colonialist curriculum, that keeps the existence of the oppressor/oppressed relationship alive in society.

The colonial banking model of education described by Freire (1970) does not allow for students to become critically conscious citizens who are able to participate in a democracy. A

democracy should not consist of an oppressor and the oppressed, in this case the teacher and the students, because without critically conscious citizens able to question inequality, one group is able to gain power without opposition. The banking model does not allow students to begin to think critically in order to actively participate in a democracy. Another colonial aspect of the current education system is the focus on consumerism in schools.

Education and Consumerism

When beginning to look at education and consumerism it is imperative to look at the history of education and school choice in the United States. After the decolonial ruling of Brown vs. the Board of Education in 1954, schools were told that segregation was illegal. In response to that decision, court ruling politicians began writing new colonial laws, which in most cases quietly went against the new rule of desegregation. According to Luckett and Luckett Jr. (2015), Freedom of Choice, which was presented by Joe Patterson, was the perfect opportunity to maintain white power. Freedom of choice was said to be an initiative that allowed families the choice of where they wanted to enroll their children as an answer to desegregation and Brown vs. the Board of Education. Although the plan was put in place under the guise of desegregation and integration of black and white students, Luckett and Luckett Jr. (2015) explains, "Underlying Freedom of Choice, however, was the reality that few if any black parents were going to be the first to choose to send their children to a previously all-white school" (p. 195). As Luckett and Luckett Jr. (2015) describes, Freedom of Choice may have sounded good on paper but in reality, it was going to further segregate black and white students' due to the fact that with choice white parents would continue to enroll their students in schools with almost all white students and black parents would in turn not want to enroll their children in all white schools.

As I drove to work one morning I decided to turn on the podcast "Nice White Parents" (2020) that I had seen while scrolling through podcasts a few days earlier. I had no idea what to expect but as a white person with white parents working in a predominantly white school district I thought the podcast would be beneficial for me to listen and learn from. As I was listening to the podcast the host, Joffe-Walt, began to talk about shopping for schools in the New York City public school system for her child and I had an aha moment. The host described going to various schools in her neighborhood in order to find the perfect school for her child to attend. Unlike the suburbs where I am located, the cities offer various options to parents for schooling, whereas my address determines the public-school I would attend. Principals would walk parents around the school showing them classrooms, amenities and telling them about all the special programs offered throughout the year, essentially *selling* the school to those parents. Finding the appropriate school for their children has become a shopping experience for many white parents in the public schools of New York City, and likely many cities around the country. Underneath the guise of fancy programs and amenities within the schools, white parents were trying to find out if the school had mostly white students enrolled or had many children of color enrolled. My question while listening to the host describe her experiences was "why are, mostly white, people shopping for schools like they are shopping for shiny new toys?" (2020). As I begin to think about the answer I am brought back to the idea that freedom of choice was never implemented as a way of desegregating public schools but quite frankly the opposite. White parents, with a colonial mindset, continue to look for schools with mostly white students which continues to maintain segregation and power structures in public schools.

As Spring (2008) states, "Education is now a form of consumerism" (p. 183). As opposed to showing students all of the options in front of them and letting them think critically about their

choices, schools are falling victim to big corporations and government and telling their students what the best choice may be. One of the biggest examples of the promotion of consumerism in public schools in the United States is when home economics class became family and consumer science class. In 1993 when the name changed, schools were not only marketing specific items to students but teaching students about consumerism (Spring, 2008, p. 186). Home economics taught students, mostly girls, how to perform tasks in the home such as cooking and sewing. In family and consumer science, students were now being taught what to buy at the store as opposed to how to make things at home. Home economics is just one example of consumerism being taught in schools, but overall education was being used to create citizens who would "merge into a consumer society" (Parsons & Frick, 2013, p. 17). As Monchinski and Ollman (2000) states, "Education is there primarily to provide the ruling capitalist class with people who have the skills, knowledge and behavioral attitudes that will help the capitalists make a profit and make the conditions and relations in which they make their profits secure" (p. 1). As Ollman (2000) states, education was an avenue for the ruling class, or the privileged, to promote consumerism in students which in turn assured them profit from what those kids would buy and eventually influence where those kids might want to work or spend time. Parsons and Frick (2013) explain,

> The prize for those not intelligent in the ways school measures intelligence is that, instead of a vision of efficacious leadership, they gain a vision of a "good job." This good job is clearly tied to wages and the promise that, to the extent to which they "apply themselves" at work, they can gain the promise of consumer goods and a comfortable life, all of which is wrapped around the extent to which they embrace the goals of materialism and consumerism. (p.17)

Schools have become a place for some students to learn how to do a "good job" in order to receive instant gratification. If schools continue to sort students into those who will become consumers and those who will rule the consumerist society, the idea of the oppressor and the

oppressed will continue to be perpetuated. As opposed to being a place of consumerist ideals, schools should promote decolonial critical thinking and discussion about products and the concrete world as opposed to sorting students into specific roles in a consumerist society.

Consumerism has taken over public schools over the past few decades. Kids are being told what to buy through advertisements from specific toothpaste, to soda varieties, to grocery store items. Students are also being sorted into varying groups based on their future roles in a consumerist society. One of the biggest pit falls of promoting consumerism in schools is the inability to promote critical thinking and decoloniality at the same time. By telling kids and parents what to buy and where to buy it, companies are promoting goods for their own profit while simultaneously preventing kids from forming their own educated opinions. By allowing students the opportunity for instant gratification, schools are simply producing passive consumers unable to actively engage in a democracy. Without properly teaching students how to come to their own conclusions based on critical thought, schools are prioritizing consumerism as opposed to the importance of actively participating in a democracy. A democracy requires citizens to form their own opinions and identify inequalities in the system based on critical thought as opposed to blindly following those in power. Not only are schools overrun with consumerism, but they also promote an authoritarian colonial education in which those companies, as well as teachers and educators, hold the knowledge and what they say is fact.

An Authoritarian Education

The first time I was given a voice in my education was graduate school. I was sitting in class on day one and the professor gave us the chance to let him know what *we* wanted to learn throughout the semester. At first, I was shocked and confused but that quickly turned to excitement that I had a say in what I was going to learn. The class may have had an overall topic

but for the first time the professor allowed us, the students, to guide the sub-topics and readings for the class. Why did I have to wait until graduate school to get a voice in the classroom? Up until that point I had always been handed a syllabus and everything was planned out from day one until the final exam at the end of the semester. Public education in the United States is largely based on an authoritarian model in which the administration tells the teachers what to teach and the teachers tell the students what to learn. Instead of students having a voice in the classroom, public education has consistently focused on those at the top of the system and what they want the students to learn. This top down approach to education does not leave any room for students to participate in their own education, unlike the opportunity I received in graduate school. Students should be given the opportunity to contribute to the curriculum for a class and have their voice heard as opposed to constantly being lectured to. As explained by Giroux (1988), "Transformative intellectuals take seriously the need to give students an active voice in their learning experience" (p. 127). In order to create critically conscious citizens able to participate in the democratic process of decoloniality, citizens must be given a voice in their own education as students. An authoritarian approach to education in which students do not participate in their own education is a way of keeping the colonialist elite in power. Those at the top of the system, those in power, can tell everyone what they want them to learn instead of allowing them to think for themselves. The less voices that are heard, the less opposition those in power will face. The less opposition they face, the longer they will get to stay in power.

Freire (1970) also describes the importance of educators and students working together as a collective as opposed to using an authoritarian approach, "The teacher presents the material to the students for their consideration and re-considers her earlier considerations as the students express their own. The role of the problem-posing educator is to create; together with the

students" (p. 81). The educator must have a basis of material for the class but once collaborating with students the educator must be willing to re-consider his or her original ideas. The educator or administrators should not be the sole deciders of what students will learn in school; students should have a voice in what they will learn too. Not only does this reciprocal approach to education get rid of the idea that the teacher is the sole holder of knowledge, but it promotes dialogue and equality between educators and students. Dialogue and equality between educators and students will lead to the destruction of the oppressor and the oppressed situation in the classroom.

The authoritarian educational model is not only detrimental at the secondary level but is harmful for students entering the workforce. Students who have learned to fall into line and never question the teacher and simply absorb information, will do just that in the workforce and defer to the boss. This approach leaves no room for critical thinking which leads to innovation and all businesses today are seeking innovation. From corporations to self-employed, innovation is necessary to stay competitive and survive in this fast paced world! There are always problems to be solved and new ideas to explore. The ultimate goal of education should not be to produce people as goods but to produce free human beings (Chomsky, 2003). Students should be actively participating in their education and allowed the opportunity to challenge and debate the information presented so they become critical thinkers with the ability to challenge the status quo and become active in decolonizing education to create a democratic society.

Engaging Students

Public schools in the United States should move away from the colonial banking model of education, promoting consumerism and encouraging an authoritarian pedagogical approach. Schools should be engaging students in their education in order to create critically conscious

citizens able to participate in a decolonized democracy. As Freire (1970) states, "To be human is to engage in relationships with others and with the world" (p. 3). Students should be engaging with their classmates, the teacher and the curriculum in order to fully benefit from their education. Through engagement students will learn to think critically making them more well-rounded citizens able to participate in a democracy.

While thinking about how public schools in the United States are failing to teach students how to be critically conscious citizens I can't help but wonder, where do the people who are critically conscious get those skills? We do not have a world full of followers who cannot think for themselves. Those who experience oppression, bigotry, racism, and exploitation tend to know how they are treated. However, being conscious of an oppressive system is one thing. Organizing to transform it is something entirely different. We have plenty of critically conscious citizens in the world; the problem is that not everyone is learning to collectively struggle against systems of oppression through the one universal system we have of public education. Two things come to mind for how people who have not experienced the most devastating forms of oppression become critically conscious if public school is failing to do so. School systems such as the International Baccalaureate (IB) program as well as parents actively involved in their child's learning and education. The IB program, for example, is organized in such a way that students must think critically about each subject and learn to bring ideas together from various disciplines. One of the main topics in the program is the theory of knowledge where students must think about *ways of knowing* not simply memorizing information. If a program such as IB and/or parents who are actively helping their children are able to produce critically conscious citizens, then public education should be doing something similar to compliment and encourage thinking, instead of creating an educational gap with the banking approach.

In order to combat the problems facing public education today, an interdisciplinary approach, for example the IB program, could be used in schools to allow students to participate in their education as opposed to being told what is important. Giving students a voice in their education allows them to become critically conscious individuals who are then able to participate in the process of decolonizing democracy. Such participation could help uproot the system of the oppressor and the oppressed and would allow a democracy to be present with critically conscious citizens.

What is Interdisciplinary Education?

Public education in the United States is failing to create critically conscious citizens who believe they have the ability to act collectively to decolonize education and in the process, decolonize democracy. According to Seneca, ancient philosopher, education should create citizens with minds of their own, not minds of those in power. Rhoten et. al (2006) explains, "Seneca held that education should produce citizens who could call their minds their own through study of the subjects and methods best suited for enlightened decision-making" (p. 1). If education provides students the opportunity to think for themselves, in return education will have created citizens capable of actively participating in a democracy, if one actually existed. In order to give students an opportunity to learn how to think critically and solve multi-dimensional global problems, interdisciplinary education should be implemented in public schools in the United States. Interdisciplinary is defined broadly by Rhoten et. al. (2006) as, "the interaction of two or more different disciplines, subsuming the ideas of cross-disciplinary, multi-disciplinary, and transdisciplinary" (p. 2). Interdisciplinary education as described above would bring together two disciplines to allow for students to learn various topics from multiple disciplinary perspectives. In order to refine the idea of interdisciplinary education further another definition is

necessary. A National Academies of Science (NAS, 2004) Committee on Facilitating Interdisciplinarity defined interdisciplinary research as,

> A mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and or theories from two or more discipline or bodies of knowledge to advance fundamental understandings or to solve problems whose solutions are beyond the scope of a single discipline or area on research practice. (p. 1)

The key addition in the definition of interdisciplinary education from the National Academy of Science includes the idea of integration of two disciplines. Interdisciplinary education should not only include two disciplines working together but should include two disciplines with integrated knowledge and perspectives. As opposed to looking at a specific topic through two different lenses, an interdisciplinary approach would combine two different lenses to then examine a topic or idea. When combining different groups or disciplines and allowing them to work together, more complex problems can be solved. Many real-world problems go beyond the scope of one discipline making it hard for an education focused on specialization to tackle such problems. Derry et. al. (2005) explains the importance of interdisciplinary education in a global world,

> Because these groups have members with different skills and perspectives, they have the potential to tackle broad issues, select problems that go beyond the confines of any one discipline, answer complex questions, frame problems with greater accuracy and breadth of understanding, combine resources and capitalize on differing skills in pursuing solutions to problems, and develop innovative solutions to problems. (p. 52)

With an increasingly global society, the importance of interdisciplinary education as decoloniality is growing exponentially. As the world's problems become more complex and public education in the United States becomes more specialized, the gap will get wider between problems and solutions.

In order to successfully implement an interdisciplinary approach to education in public schools in the United States, schools must begin to shift their focus from specialization of disciplines to a teamwork mentality. Bassoff (1983) presents four attitudes essential to

interdisciplinarity which include, flexibility, trust in others, acceptance of a common goal, and a willingness to share and take responsibility. The four attitudes listed above are vital for both students and educators when implementing an interdisciplinary approach to education. Although some of the essential attitudes may already be present in public schools, they are not widely accepted across disciplines within public schools. Educators must be flexible and trusting of others outside of the discipline they work in. Educators across the United States work together every day in order to offer an outstanding education to their students; the key difference in interdisciplinary education would be the willingness and ability to work together across disciplines. Along with Bassoff's four attitudes, Pracilio (2010) describes the three C's that are essential for an interdisciplinary team; cooperate, coordinate and communicate. In order for an interdisciplinary education to be successful, Pracilio (2010) suggests the importance of cooperation, coordination and communication across disciplines throughout a school or community. Educators across various disciplines must be able to work together and communicate in order to reach a common goal.

Interdisciplinary education in Chemistry: an example

Interdisciplinary education has been defined as integrating multiple disciplines in order to resolve complex global problems that require theory and concepts from varying perspectives. As a chemistry teacher in a public school in the United States, I will use chemistry as an example for using an interdisciplinary approach in education. When speaking of a chemistry curriculum, Jaffe (1938) explains:

> We must not fail to maintain a balance between the necessary factual material and the stimulating elements relating to the lives and accomplishments of the men and women who have given us a chemistry which can help the pupil to a clearer understanding of life and to a more healthful and complete one. (p. 385)

In order to maintain a balance in the education community, Jaffe states that subjects, chemistry in this particular case, must not be solely based on factual information and must be interdisciplinary in nature to include more historical or relevant to the times information about the subject. As opposed to simply presenting students with information regarding scientists and what they discovered, Jaffe explains the importance of teaching students about the lives of those scientists in order to provide a more well-rounded depiction of the subject as a whole. It is just as important to understand the scientists' lives when they discovered a particular theory as theory itself. Jaffe (1938) was discussing interdisciplinary education in terms of the history of chemistry when he suggested the biographical method of teaching the subject. He suggests teaching, "The scientist's duty to humanity…", "… the perseverance, tireless effort, and hard work…", "…the inner satisfaction…", "Physical courage…", "The imaginative and aesthetic power…" and "…social mindedness…" (Jaffe, 1938, p. 387). Not one of the six ideas listed by Jaffe centers around the discovery or findings of the scientists alone. All of the suggestions focus on the scientist as a human being and how and why they discovered what they did. This biographical method of teaching chemistry is purely interdisciplinary and teaches subject material through various lenses such as science, history, philosophy, religion or politics. Such an approach is conducive to centering the voices of the marginalized thereby disrupting colonial education. Although many schools only use a chemistry curriculum based on the scientists' discoveries as well as scientific theories, an interdisciplinary approach to a chemistry curriculum would allow for varying perspectives to be taught.

As stated earlier, the current public education system in the United States is centered around the banking model in which students are simply given various pieces of information and asked to memorize and repeat at a later date. Jaffe's (1938) idea of integrating knowledge about

the scientists and the time period they lived in when they made their discoveries to a chemistry curriculum would not be possible with the current public education system. Jaffe's model of interdisciplinary education in chemistry would require more than just memorization from the students but would require them to integrate various subjects into learning about the scientists who contributed to the field of chemistry. This focus can bring in a discussion of the role of chemistry in advancing the science of war, capitalism, consumerism to further develop critical consciousness and decolonize education.

International Baccalaureate as an Option

Based on the history of classes being taught at the secondary level and the challenges to interdisciplinary education it seems as though it would be nearly impossible to uproot the entire education system in the United States or worldwide. However, there is always the possibility of systemic change. What is more, some countries, including parts of the US, have successfully implemented an interdisciplinary education at the secondary level through the International Baccalaureate (IB) program. The IB diploma program is two years long and allows students to take multiple classes including one core class in particular called the Theory of Knowledge (Nugent, 2002, p. 34). As explained by Nugent, "A key element of the Diploma pro-gramme (DP) curricula is an interdisciplinary course on the philosophy of learning entitled the theory of knowledge" (2002, p. 34). The curriculum is centered around the interdisciplinary class that focuses on the process of learning as opposed to finding specific answers. As described by Cole (2015) the Theory of Knowledge course is,

> [A] course about critical thinking and inquiring into the process of knowing, rather than about learning a specific body of knowledge. It plays a special role in the DP by providing an opportunity for students to reflect on the nature of knowledge, to make connections between areas of knowledge and to become aware of their own perspectives and those of the various groups whose knowledge they share. (p. 59)

At the end of the two years students take exams in which their scores can translate to college credit. The program as a whole is based on an interdisciplinary approach to learning that will help students navigate a global and multi-faceted world. The theory of knowledge class is meant to give students the space and platform to ask open ended questions about the world. In doing so students are learning to think deeply about and question the acquisition of knowledge as opposed to finding answers to close ended questions. Nugent (2002) states, "The goal of this course is for students to develop a coherent approach to viewing the world while unifying and moving beyond the academic subjects to an appreciation of international perspectives" (pp. 34-35). With the entire program designed specifically around an Interdisciplinary class, the program provides students with the opportunity to learn how to learn as opposed to what to learn.

When looking at the IB diploma program versus the current public education system in the United States, the differences are clear. Corporate, consumerist public education policy in the United States, despite widespread opposition by teachers, has mandated the colonial idea that regurgitation and memorization are at the core of education whereas the IB program focuses on the integration of knowledge between subjects in order to gain a better understanding of the topic being discussed. The IB diploma program also differs from the current public education system in that it gives students the chance to focus on the learning process as opposed to focusing on getting a correct answer. When asking students to focus on the method as opposed to the answer they will gain the ability to think through various problems instead of memorizing an answer they were told is correct. For all students, including the poorest and most marginalized students, to be included in decolonial, interdisciplinary approaches, corporate public education policy needs to be defeated and control of public schools should be centered in oppressed communities.

What is the value of Interdisciplinary Education?

Interdisciplinary education requires educators from multiple disciplines to work together towards a common goal or solution. When educators begin to work together across disciplines, there is an added value to the public education system that cannot be seen without interdisciplinary education. When multiple disciplines come together, different perspectives are brought to the table. Klaassen (2018) states, "the opportunity for learning is at the boundary of disciplinary, cultural and social groups" and between those lies, "a third space in which the meeting of different perspectives triggers co-construction of learning" (p. 843). As opposed to simply memorizing different concepts and theories, an interdisciplinary approach would elicit learning from varying perspectives allowing for more complex ideas and solutions to be the result. Pracilio (2010) describes the value of interdisciplinary education specifically in healthcare, "All team members bring unique skills and experience to their work" (p. 1). The value of interdisciplinary education in healthcare can be translated to the public education system as well. When multiple people work together they bring specific content knowledge as well as varying perspectives to a conversation about a common problem. Rhoten et. al. (2006) explains that people from varying corners of academia argue that, "many of today's pressing questions in areas such as the environment, health, technology, global security, and urban culture demand the cross-fertilization of disciplinary skills, theories, methods and ideas" (p. 1). If today's global and complex real-world problems require multi-disciplinary concepts, why is public education in the United States becoming more specialized? Interdisciplinary education would allow different concepts and theories to work together to decolonize education and solve global problems and would add value to the public education system in the United States.

Why is Interdisciplinary Education not the norm?

Current public education policy in the United States fosters a limiting and rigid curriculum and instruction. All students are to complete twelve grades, one each year, as well as specific subjects within each year. When students reach the high school level they may choose from a small variety of electives to fill a few spaces in their schedule that are not taken up by the mandatory credits. The amount of credits needed to graduate public school in the United States originated in the late nineteenth century with Carnegie units and have remained for over a century (Outhouse, 2012). Having a required number of credits to graduate high school and move onto higher education has limited the opportunity for an interdisciplinary educational system. Strict graduation requirements have limited the opportunity and administratively it would also be challenging to implement such a program. As Paula Viterbo (2007) figured out when implementing her History of Science course, barriers such as faculty with limited knowledge, and students with narrow disciplines, make an interdisciplinary education difficult to execute. Although many obstacles may exist for implementing an interdisciplinary approach to education, the International Baccalaureate (IB) program has worked to overcome those hurdles. The IB program has served as an example of a functional and practical way to implement an interdisciplinary education at the secondary level. However, many public schools in the United States have yet to adopt and carry out the program. Unfortunately, the IB program is expensive, takes two years and requires a lot of training for the educators. Interdisciplinary decolonial education supports critical thinking and problem solving which are fundamental skills for all well-rounded citizens to possess. College requirements and administrative barriers have militated against the implementation of an interdisciplinary education at the secondary level for over a

century. The IB program is a successful interdisciplinary option for students in high school but does come its own trials and tribulations.

In the late nineteenth century, it became evident that high schools around the nation were teaching different content at varying rates. Students completing a high school education in different towns and states were not receiving the same instruction from school to school. Due to the lack of standardization across high schools, the National Education Association created the Committee of Ten (CoT) which was comprised of representatives mostly from higher education with the goal of standardization (Sheppard & Robbins, 2005, p. 563). The task of the committee was to create a standardized curriculum for American high schools in order to regulate education for those looking to go on to higher education. With no standardization before this time, it was difficult for colleges to understand what knowledge their students had acquired before entering College/University. In 1896, after the CoT created a list of their recommendations, the Committee on College Entrance Requirements (CCER) was created in order to create a plan for implementation of the findings of the CoT (Sheppard & Robbins, 2005, p. 563). The CCER put together a plan in which those seeking entrance to college would need to complete 16 units of study in varying subjects before graduating high school. Those units came to be known as Carnegie Units and are now widely known as graduation credits. All public schools in the United States have certain requirements for graduation ranging from 13-24 credits or standards based on proficiency goals (Education Commission of the States, 2019).

Interdisciplinary education centers on learning through various subjects in order to gain a better understanding of the material. As opposed to teaching each subject as a separate entity, an interdisciplinary curriculum allows for the collaboration between subjects in order to teach material through various lenses. This type of education requires cross subject communication as

well as a curriculum that offers critical thinking and problem-solving opportunities for its students across subjects. In order to successfully implement an interdisciplinary education into secondary public schools, officials would need to take a closer look at graduation credits that require classes to be completed as separate entities. Due to the implementation of Carnegie Units in the late nineteenth century, schools have taught subjects as separate entities in order to appease Colleges and Universities. An interdisciplinary based education would require the removal or change of these credits to include classes that are cross curricular.

Not only are specific college requirements a barrier to offering an interdisciplinary education, but the administrative complications certainly militate against the idea as well such as who would teach each class and how to fit an interdisciplinary class into a schedule favoring specialization. An interdisciplinary education in which subjects are taught through multiple lenses and offer material from different subject angles allows students the critical thinking and problem-solving development they need from their education to succeed in the global world in which they live. Although an interdisciplinary education makes sense based on today's global world, it would be hard to implement based on various logistical issues such as student and teacher scheduling.

According to Viterbo (2007), offering a history of science class at the college level was vital to offering an interdisciplinary educational opportunity to her students. The challenges Viterbo faced at the college level are not unique to higher education. The same challenges would be faced when introducing a class such as history of Science to a secondary education system. One of the main challenges Viterbo (2007) explains is the idea of who would teach the class. Based on the name, it could be either a history teacher or a science teacher; or would it be better co-taught? If educators are not receiving an interdisciplinary education themselves, teaching such

classes may be a challenge. Along those lines, without proper training many educators may be averse to offering a class not solely in their discipline. Educators may perceive an interdisciplinary education as a threat to what they believe their subject has to offer. Lastly, another major obstacle to successfully running this course is the material that is to be used. If you have students focusing on a science major they may be more in tune with journal articles and scientific papers whereas students taking the course with a history focus may be more in tune with historical journals and primary sources. Some material may be too complex or too simple based on the background each student brings to the course (Viterbo, 2007). Managing those differences could be logistically challenging for the educator trying to teach the course. In order to combat these challenges and allow for classes to be taught that overlap subject matter and are interdisciplinary, the public education system in the United States would need to be redesigned starting with the younger grades.

Although an interdisciplinary education intends to provide a more well-rounded approach to teaching students various subjects, one of the other major challenges is the lack of interdisciplinary education for educators. Viterbo (2007) discusses her experience in facilitating an interdisciplinary education, "This was a 4-year, interdisciplinary program, which combined approaches from ethics, law, history, literature, sociology, and anthropology, to offer students a comprehensive, humanistic view of the medical profession" (p. 9). Viterbo describes the 4-year program she completed in order to learn how to properly teach in an interdisciplinary format. When looking at Viterbo's situation, it is easy to see that not every educator can or will complete a 4-year program on interdisciplinary education alone and the long training process proves to be a large obstacle in providing an interdisciplinary education to students at the secondary level. If

teachers are taking classes as separate entities and focusing on one subject, asking them to teach an interdisciplinary class without specific training would be a daunting task.

If teachers are not being taught to teach in an interdisciplinary, decolonial manner, they will continue to teach as they were taught, resulting in more specialization within subjects. In today's teacher education programs, the history of any particular subject is not required or may not even be offered as an option. Jaffe (1938) states:

> Above all, the teacher of chemistry should be so immersed in the history of chemistry, so alive to the cultural value of the science, and so alert to the many vital consequences of the impact of the advance of science upon a changing society that he will unconsciously carry over to his class the same enthusiasm for a science which has within its content and method great potential survival value for the human race. (p. 389)

In order to gain such an enthusiasm about a subject in which one will teach, it is important that teachers are offered interdisciplinary classes such as the history of science in their own teacher preparation. Interdisciplinary education allows students and teachers to look beyond just the factual information and gain insight to the whole picture of what life was like when certain discoveries were made. By limiting students to specific classes each year and requiring classes as separate entities will not lead to an interdisciplinary education that allows for critical thinking and problem-solving skills to be developed within our students.

Not only would educators require more training in order to successfully facilitate an interdisciplinary education curriculum, but educators need to be on board with the idea in general. Viterbo (2007) states, "…interdisciplinary ventures continue to be perceived by many academics as a threat to their disciplinary feuds, a climate that makes interdisciplinarity unattractive to untenured faculty" (p. 14). With very little interdisciplinarity in the current secondary education system, educators today have relied on education being taught as separate entities and one must choose a specific path. With that in mind, educators who have focused on

one subject take pride in that subject and may not want to offer an interdisciplinary based course that would stray from their specialty. After completing many years of education in order to become an educator in a specific discipline, an interdisciplinary education approach may be perceived as a threat to one's specific discipline (Viterbo, 2007). As long as educators continue to be a trained in a non-interdisciplinary curriculum and become well versed in one subject, it may be difficult to convince educators that a multi-faceted approach, with less focus on their specific subject, is a good idea.

Gaining the trust of educators and providing them with the proper training and education to teach classes through an interdisciplinary approach may be a difficult task but the students taking the class come with their own obstacles. As explained by Viterbo (2007) regarding her history of science class,

> Given the content and methodological variety of these courses, there was always the danger that they might become overly complex or, in my effort to attain synthetic explanations, too simplistic. At times, my students criticized the superficial, incomplete treatment of some of the subjects in the syllabus. (p. 11)

Viterbo (2007) describes the dilemma of offering a class to both science and humanities students based on the backgrounds they bring to the class. Science majors, "resented the lack of detail" while humanities majors "regretted the absence of real life complexity" (p. 11). In order to appease both groups of students, Viterbo (2007) felt that she would need to simplify the topics in order to be applicable to everything that it made the class too simple. Not only do students bring different backgrounds with them at the college level but students in high school also follow varying paths based on their likes and abilities. If one is "good" at math and science they may take more classes and electives around math and science as opposed to a student that is "good" at English who may take more classes focusing on the humanities. Unfortunately, in the current education system, specification happens at the high school level whether it is acknowledged or

not. Given the varying backgrounds students gain throughout education, an interdisciplinary educational approach can be difficult to implement due to the complexity of how to cater to each type of student without making the class too simple or too complex.

An interdisciplinary education would allow students to look at the material they are learning through a multi-faceted and more well-rounded lens of the world. Throughout history there have been some barriers to the successful implementation of an interdisciplinary education with logistics being one of them. Logistically it is difficult to offer a class taught by educators who themselves have not been taught to teach an interdisciplinary class. Not only would it require more training for educators, it would take some convincing of educators that an interdisciplinary approach would not be a threat to their subject but would be beneficial overall. Lastly, without an overhaul of the entire K-12 education system, students will always be entering high school and college with varying levels of background in each subject. The differences in understanding can lead to an interdisciplinary based class becoming overly simplified in order to appease everyone. Paula Viterbo (2007) learned first-hand that logistically, offering a history of science class, was difficult to do. She had to do training, figure out which departments would teach and offer the class, and how to successfully present the material to students with varying degrees and specifications. As stated above, an interdisciplinary education may require some changes to the K-12 public education system in order to be effective but it has successfully been done in other places around the world.

Although the IB program has been successful in over 105 countries around the world and over 40 states in the US have high schools with the IB program, the question is why more high schools have not adopted the program (Nugent, 2002, p. 33). One of the main barriers to the implementation of the IB program is the cost. Nugent (2002) states, “In addition to application

fees and final exam costs, each member school pays an annual membership fee of $7,300, which covers curricular development and updates every five years" (p. 35). With some schools around the US low on funds and some having to take away extracurricular programs, the cost of the IB program does not allow schools to consider the idea. Part of decolonizing education involves revealing and challenging that the fact that a big part of why the cost is an issue in the US is because nearly 60% of the federal budget is dedicated to the military and less than 5% goes to education. Not only is cost a challenge to the facilitation of the program but staff training and curriculum development requires extra time and dedication from educators (Nugent, 2002, p. 35). With educators in some parts of the US already receiving low wages, asking them to put in time and energy outside of the school day for a program that is foreign to them may not be perceived as a great investment. Again, demanding more funding for education and educators is a necessary part of decolonizing education.

Many students outside of the U.S participate in the IB program in order for their credits to transfer and give them the opportunity to attend College or University in the US. Nugent (2002) explains,

> The International Baccalaureate (IB) was developed to meet the educational needs of geographically mobile students who required academic credentials accepted worldwide, such as children of diplomats, students living abroad, native students returning from abroad, and children likely to travel extensively abroad. (p. 33)

The program was developed for families and students who travel as way to standardize curriculum for those wishing to pursue higher education in various countries. On the contrary, students going to high school in the US do not need to partake in the IB program to be considered for higher education.

In order for schools to provide an interdisciplinary education through the IB program they must pay a hefty fee each year on top of costs that students and families accrue through

exam and material costs. Not only is the program expensive, educators in the US are not trained to teach in the program and would need to invest time and energy into training and understanding the curriculum in order to successfully implement it. Lastly, unfortunately, with students being considered for higher education within the current K-12 public-school system, there is no incentive for high schools to offer this program to its secondary students. The IB program is a perfect way to offer an interdisciplinary education at the secondary level but with the current program "working" why would corporate school reformers want to change anything at their own cost? The push for change must therefore come from marginalized communities and educators.

Interdisciplinary education should be used in secondary schools in order to promote critical thinking and problem-solving skills in young adults. Throughout history multiple laws and procedures have militated against the implementation of interdisciplinary education in secondary schools. When the Committee on College Entrance Requirements met in the late 1800s, the new system for gaining access to higher education completely changed how high schools functioned. With the introduction of Carnegie units and graduation requirements, there was no longer room for interdisciplinary education. Certain classes needed to be taken in order to move on to the next level and none of those requirements included joint classes or an interdisciplinary curriculum. As long as colleges and universities require specific boxes to be checked, there will always be a barrier to the implementation of interdisciplinary education at the secondary level. Along with Carnegie units, the logistical and administrative aspects of interdisciplinary education make it difficult for schools to achieve. With a curriculum relying on multiple disciplines it is challenging to find educators with multidisciplinary backgrounds. Not only is it hard to find qualified educators, it is difficult to write a curriculum for students with narrowed interests who may only understand well the material for one subject. Although there

are multiple obstacles to using an interdisciplinary curriculum, the IB program has sought to challenge the status quo. The IB program successfully uses an interdisciplinary approach as well as a class called Theory of Knowledge in order to promote higher order thinking and problem-solving skills in students. The program demonstrates the ability to successfully use an interdisciplinary approach but unfortunately most secondary schools in the United States still have not bought into the program due to the associated expenses and aforementioned challenges. Interdisciplinary education ought to be used in secondary schools to decolonize education and to promote critical thinking.

Technology & Interdisciplinary Education

While providing students the opportunity to look at problems from multiple angles to better prepare them for the global problems present in the world today is important, technology is a key component to how well that will work. Technology has been widely used for decades and with the exponential growth each year it will not be leaving the education world anytime soon; if ever. Although technology has been widely used and accepted in education for over a decade, it is important to remember that technology itself is not a solution. When discussing technology as a silver bullet Selwyn (2017) explains, "Moreover, it is important to remind ourselves that these inequalities are complex *social* problems. As such, it is highly unlikely that there will be any neat technical solutions to the problems that beset contemporary education systems" (p. 103). Inequalities in education have been present since before the introduction of technology and it would be naïve to assume that a new tool such as technology would solve such problems. Technology is a tool that can be used in education, but to think technology is *the* solution to any problems is incorrect. As Audrey Watters (2015) states, "The rich and fascinating past of education is forgotten and erased in an attempt to tell a story about the future of education that

emphasizes products, not processes…" (p. 1). As technology has started to enter the world of education, the products themselves have been highlighted as opposed to the processes they can bring to the classroom. With too much focus on the product itself, education thinks of technology as a solution rather than a helpful tool.

One example of technology being introduced into education as a solution rather than a tool is Massive Open Online Courses (MOOCs). Selwyn (2017) explains, "Thus, while MOOCs might be effective in increasing levels of participation in education, they do not seem to be widening participation to those social groups who previously were not involved" (p. 106). MOOCs are a great example of the use of technology within education that did not solve previous problems. Many believed MOOCs would provide education to those who previously did not have access to education. As stated above, research shows that 80% of MOOCs participates are from wealthy families with previous access to education (Selwyn, 2016, p. 37). It seems as though those who introduced MOOCs did not have appropriate visions for their programs and they unfortunately fell short. When thinking about MOOCs as a way to bring people to higher education from social groups that do not normally have means to participate, it is important to think about more than access. Allowing students to log on from anywhere does not solve problems such as lack of Wi-Fi, lack of family support, and lack of background knowledge needed to be successful. There is much more to education than simply logging on and MOOCs are a prime example of an initiative without proper goals that ultimately failed in their goal to bring education to a broader group of students.

Another example of a technology initiative that seems to have lacked appropriate aims for education is One Laptop Per Child (OLPC). OLPC was an initiative that provided laptops to children in countries that lacked technology for the purposes of furthering their education by

providing access to technology. OLPC would provide cheap laptops to students in varying countries in order to better their education. Unfortunately, OLPC was not successful due to a lack of facilitators looking at the bigger picture. Cuban (2013) explains the outcome that there was, "No evidence that the program increased learning in Math or Language" (p. 1). Simply supplying computers to remote villages around the world was not the solution to provide a better education. Although the students had technology and an increase in accessibility, there may have been a lack of Wi-Fi, a lack of knowledge on how to use the computer and by the time the computers reached the final destination they were already outdated. Providing laptops to children in developing countries will not simply improve their education. The computers cannot teach, they can only help someone teach. The students and families also need to be trained on how to use the computers to the best of their ability. The goal of dropping computers in developing countries was reached but unfortunately OLPC lacked appropriate aims and was not successful. In order for technology to be used in education it must be used a tool not as the solution to an overall lack of education.

If technology is to be a successful tool in the implementation of an interdisciplinary education system, there must be clear and precise goals attached. As Dinov (2008) explains, "In anticipation of the less obvious future challenges of education, and particularly the role of IT-enhanced and multi-disciplinary curricula, we need to debate and outline clear policies and directions for smooth transitions and timely resolutions of such unexpected conundrums" (p. 91). There is a long history of integration of technology into education including both success stories and failures. Technology can help students stay connected, communicate with educators and colleagues and make education more accessible. However, technology itself will not solve the

social injustices present in the education system. In discussing the changes of education throughout history Selwyn (2017) explains,

> History tells us that technologies do not prompt *complete* revolutions - not even the 'industrial revolution' was a complete change. Instead technologies prompt a gradual 're-mediation', retaining elements of old ways of doing things alongside the introduction of new practices and processes. (p. 105)

Never in a day has technology completely changed the way things are done. The process has always been gradual and the same is true with technology in education. If technology is to be used in an interdisciplinary curriculum, it must be simply a tool in the process, not the solution itself. For example, with OLPC, the goal was short-sighted. Every child was to get a laptop in order for education to be accessible. Although a lot of children received laptops, some lacked Wi-Fi to use it and others lacked the training necessary to use the laptop to further their education. In order for OLPC to have been successful, it needed a proper agenda including training of the equipment and educators present to teach. A laptop could be used as the tool to bring information to children in remote areas of the world but simply dropping them off and leaving would not suffice resulting in the unintended consequences of no measurable learning improvement.

When introducing technology to education it is important to create aims and visions, such as decoloniality, before simply placing the technology in the classroom. In order for education to be successful it is important that students and educators continue to communicate and interact with one another. As Facer (2011) explains, "The development of knowledge and understanding is first produced in interaction with others and then internalized" (p. 41). Students need interaction with others as well as the material in order to internalize the information and gain the knowledge. Without appropriate goals for technology, interaction can be lost by the overuse of technology in the classroom which can replace that communication. As explained by Turkle

(2016), “In the classroom conversations carry more than the details of a subject; teachers are there to help students learn how to ask questions and be dissatisfied with easy answers” (p. 8). When introducing technology to the classroom it is vital that it is used as a tool as opposed to a replacement for educators. Educators and students need to maintain conversations in order for students to learn how to become critically conscious citizens.

In line with more communication, in order for an interdisciplinary curriculum to be fully effectively used with technology, educators and students need to bridge the gap in technological knowledge. Dinov (2008) explains, “This IIT gap between the educators and students is the result of differences in perceptions of the goals of scientific training, socio-economic factors, as well as quick turnaround of technological breakthroughs” (p. 86). Part of the transition to an interdisciplinary education must include the training of both educators and students on a common goal for the introduction of technology in the curriculum. It must also provide ongoing training as the changes in technology growth are exponential.

Another reason technology may be difficult to introduce to an interdisciplinary education is the lack of support from educators. Dinov (2008) explains that the commitment from educators can be an asset or a hindrance,

> Many institutions (e.g., schools, colleges, universities, institutes and centers) provide computational resources, audio-visual and Internet-digital infrastructure, seed grants, human resources and other forms of support to entice their instructors in technology learning and creative utilization of IT in the classroom. Institutional commitment could be a significant barrier or a considerable asset in developing an IT blended curriculum. (p. 87)

To allow for the implementation of an interdisciplinary education in which subjects come together, educators must be on board and willing to use the technology. Without the support of the educators who are delivering the curriculum, an interdisciplinary approach would not be possible.

If education is to be used to create critically conscious citizens who can problem solve and think critically about multidimensional problems, interdisciplinary, decolonial education needs to be introduced to the public education system. An interdisciplinary education would allow students the opportunity to solve real world problems by looking at it from multiple different subjects at once. Here is where technology could be a considerable asset. Technology allows students to connect with other students or educators around the world, providing a wealth of knowledge in seconds. In order to successfully implement an interdisciplinary education using technology it is important to remember that technology is a *tool* not a solution. Examples such as MOOCs and OLPC have proven that without goals or a vision for an initiative, it will not be successful. If technology is used in an appropriate way as an aid to learning, an interdisciplinary education using technology can help students to solve difficult and universal problems facing the world today. An important predicament remains as captured in this statement, "However, I do believe that we need to be thinking far more carefully about *how* technology is used in schools and *why* technology is being used in schools" (Selwyn, 2017, p. 106). It is not enough to simply drop technology in schools and hope for the best. Statements and challenges like those stated above need to be addressed in order to create appropriate visions for what the technology can do and to avoid unintended consequences that prevent achieving the ultimate goal of *improving* education for all students.

Interdisciplinary Education & the Pandemic

When considering the use of technology for interdisciplinary education, the current situation in the United States provides a great example. In March of 2020 the entire public education system in the United States was shut down due to a global pandemic, COVID-19. In a few short days, schools had to quickly switch their entire curriculum to an online platform. From

class lectures to worksheets to tests, everything needed to be put online. Students would no longer leave their homes to attend school but could go to school from the comfort of their home. This was an unprecedented national event, schools needed to transition, and they needed to do it quickly. With no set guidelines or a rule book to follow, educators and staff began making decisions as best they could with the knowledge accessible to them. A majority of classes and work became asynchronous, meaning students did not attend class at a certain time but were assigned work and they had one to a few days to complete it. From personal experience, the first few weeks of virtual teaching and learning were an absolute mess. Communicating with students without a set schedule and teaching through a camera proved to be more difficult than most of us anticipated. I would record my lessons and upload them for students to watch on their own time. We had office hours for students to ask questions, but the majority if these teenagers did not willingly take this opportunity. Unfortunately, some students began to fall behind with the lack of structure and the inability to leave their home to attend school. Although things have changed since the spring and students are slowly starting to return to the school building, the pandemic is not over and the challenges of teaching in an online format continue to be present.

Before the pandemic technology was being used in classrooms around the country in various ways, but for the first time in history public schools were entirely online. Tests, notes and worksheets became virtual and not necessarily in the most efficient way. With the quick pivot to virtual school, teachers had to learn to use an online platform in ways they had never had to before, including creating online tests and assignments instead of the traditional pen and paper. Educators around the country and even the world began to use technology and adapt to the circumstances, and it certainly was not the same as teaching before March of 2020. Technology became a lifeline to the public education system in the United States during COVID-19 and was

used to avoid having an entire generation of students need to repeat a grade. However, for hundreds of thousands of students in poverty, particularly those in working-class communities of color, without access to the internet, colonized, exclusionary education continues to operate during the pandemic. Instead of calling it quits for a few months and starting over when the pandemic was under control, the public education system chose to use technology to its advantage and leverage it as a medium for teachers to continue to educate more privileged students with internet access. Although technology was and continues to be helpful during the COVID-19 pandemic, we must remember that technology is simply a helpful *tool* and not an overall solution to public education since colonized education continued to exist within a digital education.

In the current state of the COVID-19 pandemic, the public education system in the United States has drifted further from the idea of an interdisciplinary education and continues to be more and more specialized in nature. With having to use zoom in order to teach our subjects to students learning from home, the students have had less time for group collaboration and interaction. Teachers and students must log into zoom and continue to teach and learn through a video camera on the computer. Although there are methods of putting students in groups in the online platform, it is challenging to manage for the educator. You cannot see all of the groups at once and in my personal experience some students do not work together but they mute themselves and turn their cameras off as soon as they are in another room without the teacher present. Collaboration has certainly decreased in the current online learning environment during the COVID-19 pandemic. On top of a decrease in collaboration, classes have become more specialized and less interdisciplinary in nature. With less time being spent on class material and more time being spent on getting technology to work or cleaning a workspace, the time spent on

class topics must be focused on the specific discipline with few diversions. Districts are still expecting teachers to get through a set curriculum while adding in various other responsibilities that take up valuable time. In order to cover the same amount of material, there is little time to bring in interdisciplinary ideas and concepts to the classroom, thus memorization of material remains at the core of the public education system, even during a pandemic with increased use of technology.

Interdisciplinary education would be extremely challenging to implement in a virtual setting such as teaching during COVID-19, due to logistics such as how to implement group work and the idea that teachers must complete the same curriculum in a year with less class time. Technology is an important *tool* in classrooms and especially during a global pandemic, however for the reasons outlined above, it would be very difficult to implement an interdisciplinary educational approach while teaching and learning online.

Chapter 4

Design

Purpose

The purpose of this proposed curriculum is to help the public education system create critically conscious citizens. More specifically, this curriculum is meant to serve as an example of how to make a course interdisciplinary in nature using a chapter of a high school chemistry curriculum. By making a course interdisciplinary, students are given an opportunity to view various topics through a different disciplinary lens, giving them a more global and decolonial approach to solving problems. Allowing traditionally excluded voices to be heard in the classroom using this interdisciplinary curriculum will help to create more critically conscious citizens.

This unit plan will be completed in 14 days during 45-minute class periods that focus on measurement and calculations in chemistry. The lessons in this unit are designed to allow students the chance to learn about measuring and calculations in a chemistry classroom with a focus on mathematics and family and consumer sciences, as well. With a focus on all three subjects, students will be introduced to the topics of measuring and calculations through an interdisciplinary approach which will give them the various lenses they need in order to learn how to comprehensively solve problems. Students will also be given the chance to bring their own thoughts and knowledge into the curriculum along the way.

In only my second year of teaching I have become extremely aware of the fact that chemistry is not the favorite class of my students, nor is it the favorite class of the majority of students. As a chemistry major I obviously loved chemistry, but I always thought, with the

opportunity to do labs, most students still found a way to enjoy the subject. I have been proven incorrect; and in my personal opinion, I feel as though a lot of my students say they don't like chemistry because they have not found a way to relate the subject to their own lives and it remains a "hard science that they are not good at." This unit based on an interdisciplinary approach would give students the chance to interact with the material in a way that would relate to other subjects as well as their own lives. With a more personal and all-inclusive connection to the subject, students will hopefully gain a better understanding of the material and therefore learn how to solve broader and more complex problems leading to a more decolonial society.

The societal goal of the unit plan is to increase globalization and allow students a chance to look at the global society in which they live and make connections between what they are learning and the world around them. With a more global outlook on life and what they are learning students will be able to solve more complex and wide-ranging problems as opposed to believing that all problems in the world are specialized in nature. More voices and viewpoints in the classroom will ultimately create more critical and global thinkers.

This curriculum is meant to help connect topics in chemistry to various other subjects and in the end, help students make connections between the subject and their own lives. In order to implement the curriculum, it is important that the educator be flexible and allow students an opportunity to also contribute to the unit as needed. In connecting various subjects, we as educators can provide examples but we can also learn to incorporate the students' ideas as they come. The goal of the curriculum is to make the unit more interdisciplinary which can include ongoing collaboration with other educators as well as students throughout the unit.

Theoretical Framework

The purpose of the unit plan is to provide students an opportunity to look at topics in chemistry through an interdisciplinary lens, in particular a mathematics and family and consumer science lens. In making this unit plan, 'the cognitive view of content' described by Posner (1995) is most suited for achieving the goal of creating more critically conscious citizens through an interdisciplinary curriculum. The 'cognitive view of content' focuses on the development of the mind and problem solving which are key components of an interdisciplinary educational experience.

The world is becoming an increasingly more global society and now more than ever we need our schools to be implementing a more interdisciplinary curriculum leading to a decolonial education. In implementing this curriculum, a cognitive view of content seems best suited. Posner (1995) explains the 'cognitive view of education' in that,

> Schools emphasize rote learning too much and do not put enough emphasis on real understanding and thinking. Curricula need to allow students to construct their own knowledge based on what they already know and to use that knowledge in purposeful activities requiring decision making, problem solving, and judgements. (p. 65)

With a cognitive approach, students are constructing and using knowledge in order to solve problems and make decisions as opposed to simply being told to memorize various information. Posner (1995) quotes Resnick and Klopfer (1989), "To know something is not just to have received information but also to have interpreted it and related it to other knowledge" (pp. 3-4). It is imperative that students not only receive information but they are given the opportunity to apply the knowledge they have learned to the world they live in. By participating in an interdisciplinary educational experience, the students would be able to situate the knowledge they have learned into various subjects and disciplinary lens, giving them a more global outlook and a better understanding of others' views and positionality.

Content and Pedagogy

As detailed in Chapter 3, the lack of interdisciplinary education in public schools throughout the United States is a result of numerous factors that are embedded in our colonialized education system. Educational models such as The Banking Model of Education (Freire 1970) and Authoritarian Education reinforce teaching as imparting colonial knowledge upon students on a per subject basis. Students are not encouraged to realize decoloniality or challenge or debate what is taught or think about connecting the subjects and determine their relevance in a decolonial society. There are still huge gaps in access to education and technology and, as used thus far, technology has not closed those gaps between privileged and marginalized students. The current pandemic has created more challenges to considering a change to the education curricula as most educators are absorbed in finding ways to teach the current curricula effectively online/virtually. All that said, if we are to address the need to have students become critically conscious thinkers in a democracy, we must focus on decoloniality through an interdisciplinary education. It is with great passion that I am proposing the following curriculum which is a step toward understanding how this can be achieved.

Organization

This curriculum would be described as the spiral model, introduced by Bruner (Posner, 1995). The spiral model focuses on the idea that topics are introduced and then reintroduced at varying levels of depth and sophistication. This model is appropriate for this unit plan because the topics do not build off of one another rather they relate to one another in different ways. Therefore, topics can be introduced then reintroduced later in the unit in order to reinforce the concept. Although the spiral model may work specifically for this unit plan for measuring and calculations, most units in chemistry will be presented in a linear fashion in which students

would need to follow along with the entire unit in chronological order in order to fully comprehend. With that being said the overall curriculum for chemistry takes a linear approach however within this specific unit a somewhat spiral approach can be taken in order to help students to fully understand the material.

A table outlining the unit with days and topics within the unit follows. The table also includes daily activities that the students will complete that are interdisciplinary in nature. After the table, a description of each lesson and daily activity is provided.

Program Organization

Day	Topic	Activity
1	Scientific Notation	Real world examples
2	Accuracy & Precision	Kitchen Stations
3	Measuring	Practice/examples Chemistry
4	Measuring	Lab/Kitchen
5	Significant figures	Chemistry/Notes
6	Significant figures	Math/Notes
7	Significant figures	Lab/Kitchen
8	Dimensional Analysis	Notes/Chemistry examples
9	Dimensional Analysis	Math/Speed
10	Dimensional Analysis	In the Kitchen/Recipes
11	Density	Density Worksheet
12	Density	Density Lab/Graphing
13	Review for Unit Test	Review Worksheet
14	Unit Test	

Unit 2-Measure & Calculations

Objectives

Objectives

1. Show how very large or very small numbers can be expressed as the product of a number between 1 and 10 and a power of 10.
2. Learn the English, metric, and SI systems of measurement.
3. Use the metric system for measuring length, volume, and mass.
4. Understand how uncertainty in a measurement arises.
5. Learn to indicate a measurement's uncertainty by using significant figures.
6. Learn to determine the number of significant figures in a calculated result.
7. Learn how dimensional analysis can be used to solve various types of problems.
8. Define density and its units.

Unit 2-Measuring & Calculations

Day 1

Students will be taught using a slideshow about scientific notation and how to go from numbers to scientific notation and vice versa. Once finished with the notes the students will be asked to work in groups and go around the room completing various real-life examples. Once the students have completed the work they will then try to match the scientific notation with the real-life example it represents. This activity will allow students the opportunity to practice the concept of scientific notation then use the concept in real world examples in order to connect the topic to their own lives. Students not only learn about scientific notation in chemistry class but also use scientific notation in math class as well.

Real world Scientific Notation Examples:

Scientific Notation	**Real world example**
7×10^{9}	Population of the world
2.4×10^{5}	Distance from Earth to Moon (Miles)
9.3×10^{7}	Distance from Earth to Sun (Miles)
1.0×10^{14}	Number of cells in human body
2.4×10^{-3}	Diameter of grain of sand (Inches)
9.11×10^{-31}	Mass of an electron (kg)

Unit 2-Measuring & Calculations

Day 2

Students will be taught the difference between accuracy and precision in terms of definitions. The students will then get the opportunity to practice using accuracy and precision in the kitchen. Students will work in groups and be given various dry and liquid measuring cups. They will be asked to determine the weight of various materials that they have brought in after measuring with different measuring cups. The students will begin to notice the lack of accuracy between measuring cups. The students will also be asked to measure the same material multiple times in order to determine the precision of the measuring device they are using. When the students are done at each station they will be asked to compare the measurements they got with the standard mass of one cup of each material they measured. I will use flour, sugar and water as examples but any material can be used. By allowing students the opportunity to see accuracy and precision using materials and cups they have in their kitchen they will be able to relate the concept to multiple subjects leading to a better understanding of the material.

Stations:

1. Weigh 1 cup of flour using two different dry measuring cups.
2. Weigh 1 cup of flour using one dry measuring cup and one liquid measuring cup.
3. Weigh 1 cup of sugar using a dry measuring cup and complete three times.
4. Weigh 1 cup of water using a liquid measuring cup and complete three times.
5. Weigh 1 cup of water using a dry measuring cup and complete three times.

Unit 2-Measuring & Calculations

Day 3

After learning about scientific notation and accuracy and precision the students will be taught about measuring. We will spend the first day going over notes about measuring as well as spending time using various tools in the chemistry lab to measure different objects. Stations will be set up around the room with different measuring tools and objects that students will use to measure. Students will record their observations and we will go over all of the stations and proper measuring techniques at the end of class. As homework, the students should be asked to go home and measure various items around their house in order to truly connect the topic to their personal lives.

Stations:

1. 50-mL Graduated Cylinder filled with water. Food coloring will be added to help visually.
2. Beaker filled with water. Food coloring will be added to help visually.
3. 25-mL Graduated Cylinder filled with water. Food coloring will be added to help visually.
4. Standard Ruler and a box of tissues.
5. Ruler with minimal markings and a sponge.
6. 100-mL Erlenmeyer flask filled with water. Food coloring will be added to help visually.

Unit 2-Measuring & Calculations

Day 4

Students will be spending day 4 measuring various objects using different kitchen tools. Students spent the day before practicing measuring using chemistry lab equipment whereas today they will take the concept of measuring and use their knowledge to measure out various ingredients in order to make no bake PB & Jam bars. (Or students can bring in their own recipe!)

BAR

3 cups miniature marshmallows (Dry measuring cup)

1 cup crunchy peanut butter (Dry measuring cup)

1/2 cup Land O Lakes® Butter

4 1/2 cups crisp rice cereal (Dry measuring cup)

FILLING

2/3 cup strawberry, apricot *or* peach jam (Dry measuring cup)

TOPPING

1/2 cup milk *or* semi-sweet chocolate baking chips (Liquid measuring cup)

1 tablespoon crunchy peanut butter (Dry measuring spoon)

2 teaspoons shortening (Dry measuring spoon)

In order to follow the recipe students will need to measure various ingredients using both dry and liquid measuring cups based on the type of ingredient. This lesson will connect the idea of measuring water and objects in the chemistry lab to cooking in their kitchen at home and show students the similarities between the two.

Unit 2-Measuring & Calculations

Day 5

After learning about scientific notation, accuracy and precision, and measuring, the students will then be taught about the concept of significant figures. The students learn about significant figures in order to teach them that they cannot be more accurate than the tool they are using to measure something with. We will begin by going over the notes about significant figures and then we will spend time practicing by going over examples of numbers where students need to determine how many significant figures are present in each number. After practicing as a class, we will play a significant figure race. Students will be placed in groups and given a set of numbers on paper/card stock. I will ask questions such as, how many significant figures are in the number ____, or which number is more accurate, and the groups will need to configure the cards with the correct answer. The group that does it the quickest would gain points.

Unit 2-Measuring & Calculations

Day 6

On day 2 of significant figures we will spend time relating significant figures to math class. Students will work in groups to complete a worksheet that involves significant figures and mathematical operations. The worksheet can be found in Appendix A.

Unit 2-Measuring & Calculations

Day 7

On the last day of significant figures students will spend time measuring various ingredients for a cooking recipe and reporting how much of each ingredient they actually used. They will measure each ingredient as they normally would and they would report with one extra digit what they measured the ingredient to be. This will allow students to see the relationship between significant figures and cooking in a kitchen, not just in math and science. By reporting the values they used with one extra digit of uncertainty we can, as a class, compare the recipes each student made and discuss the variations that can occur while cooking based on the equipment being used to measure. Some of the class will be spent on the recipe while some of the class will be spent discussing the variations and uncertainty the students encountered.

Unit 2-Measuring & Calculations

Day 8

Students will begin discussing the idea of Dimensional Analysis. They will be given notes with the definition of dimensional analysis followed by examples of dimensional analysis in the chemistry lab. I will place various examples around the room in which students will walk around and complete the dimensional analysis conversions.

Example problems:

1. Convert height of student in inches to height in centimeters
2. Convert mL of water in graduated cylinder to grams
3. Convert mass of pencil in grams to kilograms
4. Convert height of student in meters to kilometers
5. Convert mL of water in graduated cylinder to L
6. Convert mass of pencil in grams to milligrams

Unit 2-Measuring & Calculations

Day 9

Students will take their knowledge of dimensional analysis in the chemistry lab and apply it to dimensional analysis in mathematics. The students will be given a game board filled with dimensional analysis problems focusing on real world examples such as speed. The students will play with a partner and the first person to get BINGO, by completing five dimensional analysis questions correctly, wins. The game board can be found in Appendix B.

Unit 2-Measuring & Calculations

Day 10

On the last day for dimensional analysis practice and review the students will be applying their knowledge to the kitchen. Students will be asked to make either half, double, one third, two thirds, three times, or one fifth of a recipe they bring in. Students will be asked to change the amount of each ingredient based on what amount of the recipe they are given at each station. The recipes the students can adjust could be anything from dinner meals to dessert to snacks. Some examples include: Chicken pot pie, pumpkin pie, birthday cake, no-bake snack bars, etc!

Unit 2-Measuring & Calculations

Day 11

The last topic of the unit is density and students will spend this day learning about the formula for density and calculating density values for various scenarios. Stations can be set up around the room with examples where students will work in groups to calculate the density of an object and compare that density to the known density value to determine what the object is made of! Problems found at: http://www.algebralab.org/practice/practice.aspx?file=word_density.xml

Stations:

1. What is the density of a piece of wood that has a mass of 25.0 grams and a volume of 29.4 cm^3?

2. A piece of wood that measures 3.0 cm by 6.0 cm by 4.0 cm has a mass of 80.0 grams. What is the density of the wood? Would the piece of wood float in water? (volume = *L* x *W* x *H*)

3. A cup of gold colored metal beads was measured to have a mass 425 grams. By water displacement, the volume of the beads was calculated to be 48.0 cm^3. Given the following densities, identify the metal.
    a. Gold: 19.3 g/mL
    b. Copper: 8.86 g/mL
    c. Bronze: 9.87 g/mL

4. I threw a plastic ball in the pool for my dog to fetch. The mass of the ball was 125 grams. What must the volume be to have a density of 0.500 g/mL. (I want it to float of course!)

5. An ice cube measuring 5.80 cm by 5.80 cm by 5.80 cm has a density of 0.917 g/mL. What is the mass?

6. Gasoline is a non-polar liquid that will float on water. 450 grams of gasoline is spilled into a puddle of water. If the density of gasoline is 0.665 g/mL, what volume of gasoline is spilled?

Unit 2-Measuring & Calculations

Day 12

Students will work in groups to complete a lab about density. The lab worksheet can be found in Appendix C. Students will measure the mass and volume for two different metals. With that data, they will graph the mass vs. volume for each one in order to determine the density of each metal. They will then compare the density they found with the known density of the metal and look for any errors in the lab.

Unit 2-Measuring & Calculations

Day 13

Students will spend the day reviewing notes, labs, and worksheets from unit 2 in order to study for the unit 2 test.

Unit 2-Measuring & Calculations

Day 14

Students will take a test on unit 2.

Implementation Issues

As described by Posner (1995) there are frame factors than can affect how successful this program will be when implemented in a real school. Implementation of a curriculum is different from curriculum development on paper. Moving a curriculum from paper into a live situation brings challenges that can hinder the success of a great written curriculum. The unit plan presented in this paper acts as a guide for implementing a more interdisciplinary curriculum in public high schools using a unit specifically taught in chemistry class. It is important to consider the frame factors that may pose a challenge to implementing a unit plan as presented above. The factors specific to this proposed unit plan/curriculum include, temporal, economic, and personal frame factors.

The first frame factor that may inhibit the successful implementation of an interdisciplinary curriculum is the lack of time available for new ideas. Educators have specific standards and objectives they must reach that were set forth by state and federal education officials which is out of their control. This unit plan/curriculum idea asks teachers to spend time making their curriculums more interdisciplinary in nature which may require more class time to implement which they may not have. Not only is time limited in class but educators are given limited time to write the unit plans and class activities they plan to use. Adding more work to teachers' plates and asking them to fit more activities and information into their classes is a difficult task.

Along with a temporal frame factor, implementing an interdisciplinary approach poses an economic hindrance as well. In order to successfully implement an interdisciplinary unit plan or curriculum teachers may need to receive training on best practices which would cost money. On top of needed training, if schools chose to implement an already existing interdisciplinary

curriculum such as the IB program, that would cost the schools and districts money. With limited funds in schools, adding a curriculum that could cost the school money may not be received as well as hoped.

Schools may not have the time or money but one last frame factor to consider is one Posner (1995) describes as a personal frame factor. A personal frame factor is the idea that teachers may not be on board to implement an interdisciplinary curriculum if they do not believe it will be successful. In order for the curriculum or unit plan to be successful, the educator implementing the plan must be on board and hopeful that the program will be effective. Although an interdisciplinary curriculum seems to be a positive alternative to the current public education system, frame factors such as time, money or attitude of educators must be considered before attempting to implement such a curriculum in schools.

Chapter 5

Assessment and Evaluation

Assessment and Evaluation

The success of the curriculum presented above can be determined through collaboration between all of the educators involved. In this case, I would work with the family and consumer sciences teacher as well as the math teacher to look at various data points. Those data points include percentage of assignment completion and participation in class. The curriculum is intended to allow students to look at chemistry topics from various lens and viewpoints in order to gain a broader understanding of the material. By looking at assignment completion and participation in class we can evaluate the connectedness of the students with the material and their willingness to engage in the curriculum. Another measure would be a comparison of test scores in an interdisciplinary chemistry class vs. a non-interdisciplinary chemistry class. By comparing the two, we can see if scores have improved by making the class more relevant to the students' lives. Students who are more engaged with the material may perform better in the class due to more attention and care taken for the information learned. It is important to discuss with the teachers from each subject about how they grade and what they are looking for in order to maintain the integrity of the interdisciplinary approach.

Evaluation for the Developer/Facilitator

As stated above, the developer/facilitator needs various pieces of information in order to determine the effectiveness of this curriculum both at the end and during the program. In order to assess the curriculum along the way in order to make any changes needed while the students are still participating in the program the facilitator needs to use formative assessment tools every few

days. Formative assessments can include asking the students questions at the end of each topic to monitor for understanding. Another formative assessment that should be used is the use of exit tickets or question cards at the end of each topic to evaluate what the students have learned and what material was not absorbed. Not only is formative assessment throughout the program important but summative assessments and evaluations at the end of the program will prove just as useful. The facilitator can use assignment completion, assignment grades and class participation to assess whether the students have gained an understanding of the material through an interdisciplinary approach to learning. Another way to measure the success of an interdisciplinary curriculum would be to survey the students about their connectedness to the subject matter. Students can be surveyed before the unit begins about their interests and connectedness to the subject based on their previous experiences in a non-interdisciplinary setting. They can then be surveyed at the end of the unit with the same questions in order to gain a better understanding of how the students feel about the subject and if their connectedness and engagement in the subject shifted. An example survey is below.

Example Survey

	SA	**A**	**D**	**SD**
I enjoy science class.				
I perform well in science class.				
Science class has nothing to do with my other classes.				
Science class is relevant to my life.				
Science is hard.				

Key: SA: Strongly Agree; A: Agree; D: Disagree; SD: Strongly Disagree

Evaluation for the Participant/Student

Not only is it important that the facilitator gain valuable information regarding the effectiveness of the program but the students involved should also receive valuable feedback on whether the program was useful. It is important that participants are given the results to this survey in order to give them a better understanding of their thoughts and connectedness to the subject both before and after an interdisciplinary approach is taken. Participants can use the survey results as an indication of effectiveness of the program based on their shift in connectedness and engagement to the subject. Seeing the results of the survey from before the program and after the program will give students a chance to see the effectiveness of the program based on any shifts they see in engagement with the subject. It is important for students to see their progress and understand what it is they have learned and gained from progressing through a curriculum, and specifically in this case, an interdisciplinary curriculum.

Evaluation for the Administration/Management

It is imperative that those in authority also be given evidence that proves the effectiveness of an interdisciplinary curriculum. As stated in chapter 3, the authoritarian model is not the ideal model for public education in the United States, however we must not forget the realities in which we live. This curriculum is designed to be implemented within the current public education model meaning those in authority must be given proof that the curriculum is valid and worth the change in structure; otherwise change may not occur. The authorities in schools should be given all of the information above including class participation, assignment completion and survey results as well as feedback from the educators involved. All of the data including numbers and survey results is important to show the effectiveness of any program. Specifically, with an interdisciplinary curriculum, it is imperative that the educators implementing the program also

give feedback as to how the students participated and what went well and what did not. The power of educator feedback should not be ignored and must be part of the assessment and evaluation tools used to prove the effectiveness of an interdisciplinary curriculum. In order to prove the effectiveness of the program, assignment completion, class participation, survey results and educator feedback should be presented to those in authority in order to hopefully show a positive shift in connectedness and engagement to the subject in question.

When providing feedback and assessment about an interdisciplinary curriculum we must consider all the parties involved from participant to educator to authority. Each group of people must be presented with various pieces of information in order to properly assess the effectiveness of the program. Just as the word interdisciplinary implies, there are multiple parts coming together in order to determine the value of an interdisciplinary education. All of the pieces must be used in order to see the entire picture of the usefulness of the curriculum proposed in Chapter Four.

Looking Ahead

It is important to remember my positionality and the experiences and social institutions that have led me here. I personally believe in the importance of an interdisciplinary and decolonial education in creating critically conscious citizens able to actively engage and participate in a democracy. By providing students with an interdisciplinary approach to education we are providing students a broader and more global lens with which to look at the world. Nothing in the world is nicely wrapped within one specific discipline and it is hard to come to terms with the fact that education in the United States is teaching students that everything is separate. I have had the privilege to spend time learning in other parts of the world throughout my life and the eye-opening experiences I have had have been life changing. Not

every student will spend time abroad or have that opportunity but beginning to dismantle the current education system and slowly replace it with something more global and comprehensive is a step in the right direction.

Lastly, it is important to consider the idea of interdisciplinary education in the context of varying districts, disciplines and socioeconomic backgrounds. Each subject and community will require varying levels of differences to what I have presented here in order to be successful. Moving forward with this study, looking at interdisciplinary education in terms of socioeconomic background and school district variability would provide more insight into the topic and its overall effectiveness in different areas.

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APPENDIX

Appendix A

Significant Figures Worksheet

1. Indicate how many significant figures there are in each of the following measured values.

246.32	_____	1.008	_____	700000	_____
107.854	_____	0.00340	_____	350.670	_____
100.3	_____	14.600	_____	1.0000	_____
0.678	_____	0.0001	_____	320001	_____

2. Calculate the answers to the appropriate number of significant figures.

32.567	246.24	658.0
135.0	238.278	23.5478
+ 1.4567	+ 98.3	+ 1345.29

3. Calculate the answers to the appropriate number of significant figures.

a) 23.7 x 3.8	=	_____	e) 43.678 x 64.1	=	_____
b) 45.76 x 0.25	=	_____	f) 1.678 / 0.42	=	_____
c) 81.04 x 0.010	=	_____	g) 28.367 / 3.74	=	_____
d) 6.47 x 64.5	=	_____	h) 4278 / 1.006	=	_____

Appendix B

B	I	N	G	O
Convert 12 in to km	Convert 5 g/mL to g/L	Convert 16 tablespoons to cups	Convert 500 km to mm	Convert 100 cm to mm
Convert 5 feet to inches	Convert 60 mph to kph	Convert 100 g/L to mg/L	Convert 100mL to kL	Convert 8 pints to gallons
Convert 50 mL to L	Convert 8 km to cm	FREE	Convert 24 cm to m	Convert 854 mL to kL
Convert 8 cups to quarts	Convert 5 meters to inches	Convert 50 L to mL	Convert 10 mg/mL to g/L	Convert 5 feet to meters
Convert 500 mm to km	Convert 90 liters to quarts	Convert 5 cm to feet	Convert 100 kph to mph	Convert 50 L to kL

Appendix C

Density Lab Name: _____

(16 pts) Name: _____

Period: _____ Name: _____

Density can easily be calculated from laboratory data by taking the mass of a sample of matter and dividing it by the volume of that sample. The volume can be determined using geometry for regularly shaped objects or the water displacement method for irregularly shaped objects. Unfortunately, this type of experiment gives just a single snap shot for the density of the sample. Another method involves measuring the mass and volume of multiple different sized samples of the same type of matter and then graphing the mass as a function of volume. The slope of the graph is the density of the object. That is what you will be doing today in lab. Make sure you collect at least five data points for each type of sample.

1) Fill in the following data table. Make sure you data points have the correct significant figures and units.

Data Table 1: Mass and Volume Data for Zinc Samples: (2pts)

Sample Number	Volume of Sample (mL)	Mass of Sample (g)
1		
2		
3		
4		
5		

Data Table 2: Mass and Volume Data for Aluminum Samples: (2pts)

Sample Number	Volume of Sample (mL)	Mass of Sample (g)
1		
2		
3		
4		
5		

2) Use a computer to generate a graph that represents the two data sets above. Make sure your graph has an appropriate title, your axes are labeled and have units, there is a linear fit line for each