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Re-engaging Youth Who Have Been Pushed Out, In The Science Classroom

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Abstract

Providing opportunities for youth who have been 'pushed out' of traditional schools to re-engage is an issue of social justice. The lack of equitable learning opportunities in the traditional science classroom is a contributing factor to youth being pushed out. Alternative education programs have the potential to support youth who have been 'pushed out; to re-engage in science. This study investigated the factors that may contribute to the academic achievement of students in their class-based science courses at Xinaxtli Charter School, an alternative education program for youth who have been 'pushed out' in Southern California. A phenomenological research study using interviews was conducted. Students identified the Xinaxtli science classrooms as a critical and equitable science learning space with these components: educators who develop authentic relationships with students, a learning space that embodies an epistemological pluriverse inclusive of multiple perspectives and values the knowledge students bring to the classroom, the use of culturally relevant science that empowers students to make informed decisions, a localized-critical-action-based curriculum, and a wide array of equitable learning practices to re-engage students. Findings from this study underscore that a paradigm shift must occur in science education for critical and equitable learning opportunities to become commonplace.

Introduction

Providing an equitable Science, Technology, Engineering & Mathematics (STEM) education to all youth is critical to participation in a democratic society. The skills and practices that are developed through a quality STEM education allow young people to be better prepared to engage with daily life. , Barton, Turner, Varley, and Tan (2012) argue that math and science hold a powerful place in our society, provide an opportunity for high-paying professions; allow for in-depth conversations with educators, healthcare workers, and community leaders; and elucidate issues with global importance like toxic dumping, water quality, and climate change. However, many schools still promote the goal of science education as preparing students for the next step of science education, a STEM career rather than using it to develop students who could come to see science as a way to investigate and make decisions about science-related personal and social issues (Finkel, 2018).

Traditional science curriculum consists of units, lessons, and assessments often unrelated to experiences of students' everyday life. Traditional science education is reflective of a view of scientific practice that is often too far removed from the student's experiences and the issues or questions they may face in their communities

(Brickhouse et al., 2000). Further, these forms of traditional pedagogy often ignore or reinforce a culture of science that has excluded and oppressed women and people of color. This is not an education that is inclusive and supportive of students of color.

Education has been said to be the great equalizer—meaning that education can be a means to change the economic and social class into which one is born if one so chooses. Education is meant to mold a person into an individual who has agency and the ability to participate and contribute to society. However, what we in fact see is that education—specifically, the school space—treats students differently. School, ironically, can be a place where students are consistently denied an equitable education and support to succeed academically. This phenomenon can be seen when youth are 'pushed out' of school. Students who have been 'pushed out' of a traditional secondary education program are in a position to re-integrate and complete their secondary education. This population is largely composed of students of color, such as Black and Latinx (Child Trends Data Bank, 2018). For many students, challenges in the science classroom only perpetuate the dropout phenomenon. These challenges are exemplified by lower test scores and lower credits earned in science class by Black and Latinx students compared to their White peers (Dalton et al., 2018; National Research Council, 2011).

Youth who have been 'pushed out' of their high schools are a population of young people that are neglected. Once a youth dis 'pushed out' of school, it is less likely that they will complete their secondary education (ACLU, 2017). Providing pathways through alternative education programs for young people to complete a high school diploma is essential to an equitable society. Xinaxtli Charter School (XCS) is an alternative education program that provides a high school diploma pathway to young people who have been 'pushed out' of their high schools. The XCS science classroom is a space in which youth can be re-engaged and supported for academic achievement. Re-engaging and providing equitable and critical science education to youth who have been 'pushed out' of their traditional high schools is an issue of social justice. The fact remains that not all students will want to become a science professional, but all students should be able to engage with science and develop an understanding of science that allows them to make informed decisions in their lives. The purpose of this study was to investigate what factors may contribute to the academic achievement of students in their class-based science courses at XCS, from the perspective of students who have experienced academic achievement.

Students Who Are Pushed Out of Traditional Secondary Schools

A young person has been 'pushed out' of a high school when their education is discontinued prior to completing a high school diploma. The term 'pushout' is used to emphasize the school-based and social factors that lead to students leaving school (Youth United for Change, 2011). This population is largely composed of students of color (Child Trends Data Bank, 2018; McFarland et al., 2018). A report from America's Promise Alliance and its Center for Promise at Tufts University, *Don't Call Them Dropouts: Understanding The Experiences of Young People Who Leave High School Before Graduation* (2014) sought to better understand why some young people fail to graduate from high school in 4 years. The study used a mixed-methods approach in which researchers interviewed more than 200 young people in 30 facilitated group interviews in urban communities around the United States and received nearly 3,000 survey respondents from all 50 states. Three primary findings emerged from the study with regard to why students leave school before graduating: (a) clusters of factors, (b) environments are toxic, and (c) yearning for connectedness. With regard to cluster factors, it was found that disengagement with school resulted from clusters of factors. There was no single reason or factor that drove students to leave school, nor was there a general, uniform profile for a student who failed to graduate on time. Among some of the influences to leave school identified by students were support and guidance from adults, incarceration, death in the family, health challenges in the family, gangs, school safety, school policies, peer influences, and becoming a parent. With regard to toxic environments, it was found that young people who leave school were often navigating toxic environments. Elements of this toxicity were violence at home, in school, or in their neighborhood that they witnessed or personally endured, health trauma they or their family members experienced, and unsafe, unsupportive, or disrespectful school climates and policies. Further, a large number of students who left school reported being abused (30%), experiencing homelessness (22%), or spending time in juvenile detention (18%). With regard to yearning for supportive connections, researchers found that the presence or absence of connections directed many of the decisions young people made. Lack of connection with school staff (e.g., teachers), absent family members (e.g., parents), death in the family, familial abandonment, and no engagement in school all were identified by students as reasons for leaving school before graduating.

Youth are ‘pushed out’ of high schools as a result of several factors—being underserved in the classroom is just one of them. When students do not receive an equitable education, one that is engaging and provides them with support to succeed academically, they may become apathetic and lose the drive to stay in school. Challenges in the science classroom only perpetuate the ‘push out’ phenomenon, which is exemplified by lower test scores and lower credits earned in science class by Black and Latinx students compared to their White peers (Dalton et al., 2018; National Research Council, 2011).

Why Science Education?

It is essential that educators continue to find ways to maintain young people’s interest in science and support their ability and willingness to use scientific information as a part of individual and collective decision-making (Finkel, 2018). We are living in a time when misinformation saturates our daily lives in many facets, be it social media, mainstream media, or day-to-day conversations. As statements become estranged from evidence, it is crucial that science classrooms provide young people with the tools and practice to engage, access, and utilize a science based on evidence when making decisions that impact their lives.

We are currently experiencing a pandemic due to SARS-CoV-2 Virus that causes the Covid-19 disease. An accurate understanding of scientific content regarding viruses and the ability to access data that provide evidence-based claims about viruses allow one to make informed decisions about their health and well-being. One of the impacts of misinformation is the ability of people with a platform to tie their agenda to science-based phenomena. A major issue arises when this practice is used to tie science phenomena to issues of race, as we are seeing in this pandemic. In an article posted on the Yale School of Medicine Website by their vice chair for diversity, equity, and inclusion for pediatrics, Dr. Marietta Vazquez (2020) speaks of a spike in discrimination and xenophobic attacks on Asian Americans and Asians around the world. Dr. Vazquez noted that when the virus that causes covid-19 is referred to as the "Wuhan Virus" or the "Chinese Virus," it can stigmatize people of Asian background and can create a bias toward them. The reality is that viruses do not discriminate, and what someone looks like has no bearing on how likely they are to get sick from Covid-19. According to Dr. Vazquez, this stigma—and the behavior tied to it—can prevent people who may need medical help from getting it. This is just one example of how misinformation about scientific phenomena can spread negative effects.

Science has a long history of racism. It has been used to support racist thoughts and the actions that go with them. In *Superior*, Angela Saini (2019) talked about the social construct of race and how science is intertwined with it. She explained how modern ideas of race were formed during the height of European colonialism, and how White European men used race science embedded with ideologies of social Darwinism and eugenics to justify the conquest, enslavement, and extermination of non-White people. Further, she explicated how race is an arbitrary way to categorize people motivated by political agendas, not scientific goals. Saini maintained that racism has never left science and, if left unchecked, can reinforce racist conclusions. As an example, she described researchers seeking a biological basis for African Americans' high rates of hypertension. Racializing this association to tie a predisposition of illness to the genetics of African American people reinforces an "inferiority" mindset. Saini further asserted that evidence supports that environmental factors, such as diet, stress, and poverty resulting from discrimination are the primary causes of higher rates of hypertension in African American communities. Looking at scientific phenomena through a critical lens allows students to access underlying messages, deconstruct them, and reformulate them in the context of their lived realities.

According to Finkel (2018), attacks on science and scientific ways of knowing have contributed to a climate in which unsubstantiated claims are accepted without question:

> Over the past decade, attacks on science knowledge and attempts to legislate and restrict science teaching have again become a regular part of the U.S. landscape around a variety of issues that include the theory of evolution, human-caused climate change, and the safety of vaccinations. (p. 42)

The World Resource Institute (WRI) is a global research institute that spans 60 countries and focuses on critical issues at the intersection of environment and development: climate, energy, food, forests, water, cities, and the ocean. According to WRI researcher Kelly Levin (2017), "Science and truth are under siege all around us. High-level decision-makers in the United States are casting doubt on scientific understanding, defending false information, and making decisions in the absence of evidence" (Levin, 2017). Ellingboe et al. (2015) gave an example based on climate change deniers in Congress: as of 2015, over 56% of Representatives either denied or questioned the science behind human-caused climate change, though a plethora of scientific evidence speaks to the human causes of climate change (NASA, 2019). Therefore, it is imperative that young people are given science classes that develop their understanding of scientific phenomena and the agency to engage with them.

Alternative Education Programs

Alternative education programs that support youth who have been 'pushed out to re-engage in education are spaces of promise. The understanding is that young people who are 'pushed out' their traditional secondary schools do so for a number of reasons—lack of motivation due to school-based factors, apathy toward academics, lack of school support for pregnant students, incarceration, financial hardships, family responsibilities, or whatever the reason may be—schools and educators must make a concerted effort to provide supportive learning environments to re-engage young people. “Re-engagement is the process by which young people who have either left school without graduating or who are at risk of dropping out of school re-connect with systems that allow them to complete a high school diploma or equivalent” (America’s Promise Alliance, 2014, p. 3). Programs that focus on re-engaging young people must provide a quality education and be designed to be malleable to the multiple contexts of each of their members. Additionally, Bloom (2010) found that a re-engagement program should not set out to “fix” its participants; rather, it should provide young people with multiple opportunities to succeed in and out of the classroom and to develop healthy relationships.

Theoretical Perspectives

When accounting for youth who have been ‘pushed out’, there is limited literature that provides ways this group of students can be supported to engage and thrive in the science classroom. Considering factors that may contribute to student academic achievement, this study drew from various literature on supporting engagement, empowerment, and student achievement in the classroom.

In *Visible Learning*, John Hattie (2009) sought to understand the influences on achievement in students. To do so, he analyzed over 800 meta-analyses on factors that contributed to student academic achievement. Among the many findings, Hattie found that teachers played a major role in student achievement. Some of the most powerful indicators of the quality of teachers from highest to lowest effect size were as follows: the teacher had a deeper understanding of their teaching and its effect on student learning; the teacher had a high level of passion for teaching and learning; the teacher had a deep understanding of their subject; the teacher had a problem-solving disposition toward teaching; teacher promoted a positive climate; the teacher had respect for their students, challenging and encouraging them to think (Hattie, 2009). Valenzuela (1999) argued for *authentic caring* by educators. Authentic caring is defined as a trusting relationship developed by educators with students that is the cornerstone for all learning (Valenzuela, 1999). Authentic caring requires the development of a trusting teacher-student relationship, which includes an understanding of the students’ cultural world and their structural positions (Valenzuela, 1999).

Science educators must serve as transformative individuals in the classroom. Rodriguez (1998) provided a model for educators based on a socio-transformative constructivist orientation (STC), a vehicle that links multicultural education to social constructivism. Through this orientation, educators can provide a space in which science content and student experience can be collaboratively transformed to meet social justice goals. The STC orientation consists of four elements: (a) dialogic conversation, which refers to an understanding of “who is doing the talking?” and where is knowledge coming from; (b) authentic activity, where learners are provided opportunities to engage in activities relevant to their everyday lives; (c) metacognition, reflection on what and why students are being asked to learn something; and (d) reflexivity, which refers to a way of examining a culture of power with regard to knowledge and how it is produced and reproduced (Rodriguez 1998).

According to Lee (2011) when "non-mainstream" students (i.e., students of color, from low-income families, and/or learning English as a new language) do not succeed in the science classroom, it can be attributed to a lack of equitable learning opportunities. An equitable learning opportunity occurs when school science "(a) values and respects the experiences that all students bring from their homes and communities, (b) articulates this cultural and linguistic knowledge with disciplinary knowledge, and (c) offers sufficient educational resources to support science learning" (Lee, 2011, p. 3). This approach can lead to engagement, relevance, a sense of agency to create knowledge, and ultimately academic success in the science classroom. Using culturally relevant pedagogy in a science classroom can serve as a framework for maintaining student interests, engaging students, and supporting academic success in a science classroom. A synthesis conducted by Aronson and Laughter (2016) looked at culturally relevant education in several education fields, including math and science. Drawing from social-justice-oriented pedagogies, such as culturally relevant pedagogy (Ladson-Billings, 1995) and culturally responsive teaching (Gay, 2013), their synthesis found that culturally relevant education consists of the following:

- Using constructivist methods to develop bridges connecting students' cultural references with academic skills and concepts;
- Engaging students in critical reflection about their own lives and society;
- Facilitating students' cultural competence, which entails supporting students to recognize the value in their own cultural beliefs and practices while gaining access to STEM culture; and
- Unmasking oppressive systems through the critique of discourses of power.

Specifically, culturally relevant pedagogy, as proposed by Ladson Billings (1995) promotes the idea that science content is connected to students' interests and concerns, meaningfully integrating students' culture into the curriculum and elevating students' sociopolitical consciousness by investigating real issues in local contexts.

Student engagement in math and science coursework is important to developing the preparation and persistence necessary to succeed in science and to pursue a college education and/or a career in STEM (Maltese & Tai, 2010). Additionally, student engagement is positively correlated to teacher support—the more support given to a student by an educator, the more a student was engaged in class (Akey, 2006; Garcia-Reid, Reid, & Peterson, 2005). Further, it has been found that students who noted that their teachers were supportive and cared about their success were more likely to be engaged in the classroom as well as perform well academically (Akey, 2006; Heller et al., 2003). Students who are engaged in school are likely to achieve greater academic success (Skinner et al., 2008). Educators can further support youth engagement by developing a classroom space that has a culture of achievement. Teachers can also contribute to student engagement by developing interactive and relevant lessons and activities and being encouraging and supportive of students. Akey (2006) found that students learn more when they are active, rather than passive, participants in the learning process and when they can relate to what is being taught. Also, drawing connections between the information taught and real life can be an effective way of engaging students in lessons (Heller et al., 2003).

Traditional education systems tend to keep students on predetermined paths to master set knowledge and skills as opposed to encouraging risk-taking, decision-making, and collective creativity (National Academy of Engineers, 2015). According to Chen and Zhang (2016), this framework treats knowledge as a static entity and educational objectives are based on student acquisition of a well-established body of knowledge. The acquisition of knowledge is guided through pre-sequenced learning contents and activities and pre-set performance measures to keep students on track. To prepare youth to develop solutions to the issues that face us today and, in the future, we must utilize a framework or method in which students are engaged in real-world knowledge practices. According to Bereiter (2002), it is necessary to develop models of education that support innovation, in which knowledge is treated as shared conceptual artifacts that are continually contributed to by members of a community. Bereiter (2002) argues that this should be at the center of education because it adopts the approach of knowledge-creating organizations. As Chen and Zhang (2016) have argued:

> Education in line with real-world knowledge processes should treat learning as a matter of collaboratively developing shared knowledge objects and artifacts through sustained inquiry and interactions, a practice absent in typical learning experiences in schools emphasizing efficient coverage of static-state knowledge and skills. (p. 141)

Knowledge building is a pedagogy that promotes knowledge creation as the central goal of education, framing education around real-world knowledge-creating processes (Scardamalia & Bereiter, 2003).

Xinaxtli Charter School Critical Science Education

XCS practices an interdisciplinary project-based approach to education. In contrast to traditional science education where content tends to be fragmented and compartmentalized, XCS strives to teach science in a multifaceted and integrated manner, through an authentic learning approach. As a school, each XCS location develops a Community Action Project (CAP) in an effort to bridge academic learning with relevant issues that concern students and the communities they live in. The focus of the CAP is developed by the students, staff, and community members through a social investigation.

The CAP is a schoolwide project where all students collaborate to develop a project around a specific community concern. Within each classroom then, XCS educators are charged with the development of curricula that are: 1) relevant to students' lived realities in their communities, 2) challenge dominant ideologies that are embedded in the humanities, math, and science disciplines, and 3) make learning an authentic and empowering experience that challenges existing inequities. To support the aforementioned charges, the XCS science curriculum is unique in that it is grounded in STEM (Science, Technology, Engineering & Math) competencies and culture competencies (see Appendix). According to XCS, STEM competencies are meant to frame a learning environment for young people who are traditionally underrepresented in STEM fields, including women and students of color, to become scientific thinkers who can use STEM to solve 21st-century issues, globally and in their communities. They include the following: questions and defining problems, models, investigations, interpreting and analyzing data, constructing explanations and design solutions, engagement in arguments from evidence, use of tools, and obtaining, evaluating, and communicating information.

According to XCS, the culture competencies are meant to bridge the gap between the classroom and the community and are essential to fulfilling the school's vision of social justice. They are meant to incorporate consciousness of social issues as well as skills that are needed to take action and build collaboration. They include the following: love and care, leadership, success, social consciousness & action, support & healing, and collaboration. Together, the science and culture competencies promote a critical science perspective that runs counter to the worldview promoted by traditional secondary schools. Additionally, XCS utilizes a unique approach to grading via Authentic Performance Tasks (APT), this is contrary to the standardized testing approach used by many traditional high schools. An APT is an alternative assessment to the standardized test approach taken by many traditional high schools. An APT is an applied learning project that encourages students to connect the classroom content with real-world phenomena. Students are graded across XCS courses in the following manner: 30% APT academics, 30% APT culture, 30% Skill building, and 10% Attendance & Participation. The APT academic is based on the academic portion of their project, whether a humanities course or a STEM course. The APT culture is based on the culture competencies. The skill building is based on all other class assignments. Finally, attendance and participation. Students can only receive an A, B, C, or Incomplete as a grade for any class. An Incomplete, would mean that a student did not receive any credit for that class.

Methodology

In the Fall of 2019, a phenomenological research study using interviews was conducted at XCS. This study was part of a larger mixed methods study that was grounded in the following research question: What factors contribute to students' academic achievement in their science classrooms at XCS? For this qualitative portion of the study the goal was to understand from the perspective of students who were experiencing success in the class-based science courses, what factors may be contributing to their academic achievement. Academic achievement is operationally defined by their having passed at least two class-based science courses at XCS with an A or B grade.

Location of Study

Xinaxtli Charter School is a Western Association of Schools and Colleges (WASC) accredited alternative education program for youth who have been 'pushed out' of their traditional schools. At the time of this study (2019), this alternative education program was providing a pathway for completion of the high school diploma for youth ages 16 to 29 at 18 different school sites throughout Los Angeles, San Bernardino, Riverside, Fresno, and San Diego. At the beginning of the 2019–2020 academic year, XCS had 1,135 total students enrolled, however only 621 of those students were adults enrolled in the class-based program. This number of students does change as students enter and exit XCS over the course of the academic year. The majority of the students enrolled at XCS were students of color; 64.5% Hispanic or Latino, 21.5% Black or African American, 1.3% American Indian/Alaskan Native, 0.6% Asian, 0.5% Middle Eastern, 4.3% White, and 7.3% unspecified. With regard to gender, 59.5% of students identified as male, 40.3% of students identified as female, and 0.2% of students identified as nonbinary. Roughly, 94.4% of XCS students were classified as socioeconomically disadvantaged, as measured by qualifying for the national free or reduced lunch program. Students classified as English Learners totaled 20.6% across all sites. Youth who enrolled at XCS are considered status dropouts prior to enrollment. Youth who enrolled in XCS programs were generally over-aged, under-credited, or both. According to XCS, 85% of youth who committed to XCS for one- and one-half years graduated with a high school diploma. XCS was selected as a location of study because of the specific demographic it serves, that of youth who have been 'pushed out' from traditional high schools. Additionally, it is a space where students who have not succeeded at traditional high schools have achieved academically by passing their courses. Lastly, XCS is unique from other alternative education programs in that it offers a high school diploma as opposed to a General Educational Development (GED) credential.

Data Collection

The sampling strategy used was a convenience sample gathered from the 18 locations across the XCS network. The sample consisted of adult students from XCS. Recruitment and interviewing of participants were conducted in two phases, from September 2019 through November 2019. The first phase entailed the researcher emailing counselors at all XCS locations and asking for their support in identifying adult students for potential participation in the study. The candidates sought for the interviews were adult students who had passed at least two XCS science classes with an A or B grade. Once the counselor responded with a list of potential students, the researcher emailed the students directly and asked if they would be willing to be interviewed. Once a student agreed to be interviewed, a consent form was sent via email to the students. Once a student agreed to the consent form, a time was set up for a phone interview, as this was most convenient for the student. Each interview was audio-recorded. The audio-recorded interviews were then transcribed verbatim. The interview consisted of 23 questions (Table 1).

Table 1. Interview Questions

1.	Do you consider yourself a “high achiever in school”? In science class?
2.	Has your achievement in school changed from your other schools to XCS? In science class?
3.	Do you feel engaged in science class?
4.	What do you feel contributes to you being engaged in science class?
5.	What do you feel takes away from your engagement in science class?
6.	Do you feel that you can create knowledge in science class?
7.	What are some examples of you creating knowledge in science class?
8.	How would you describe your science teacher?
9.	What are the qualities (both positive and negative) that your science teacher brings into the classroom?
10.	How would you explain your relationship to science?
11.	Do you feel that science is relevant to you? Please explain.
12.	What is your opinion of the XCS science classes?
13.	What is your opinion of the Authentic Performance Tasks?
14.	When you work on Authentic Performance Tasks, do you feel you are creating knowledge?
15.	Do you think that science can be used to solve issues in your community? In your life?
16.	Which XCS location do you attend?
17.	Why do you feel you stopped attending your previous High School?
18.	What led you to enroll at XCS?
19.	What do you identify as ethnically/racially?
20.	What gender do you identify as?
21.	What are your future educational goals?
22.	What are your future career goals?
23.	Do you have any questions for me?

The participants were asked questions designed to capture their backgrounds. This consisted of participant age, gender, ethnicity, amount of science classes taken, amount of science classes passed, and the reason why they decided to enroll at XCS. The participants were also asked about their academic achievement in the science classroom and what they felt contributed to it. The interview questions related to academic achievement were based on the theoretical perspectives in the literature review that focused on supporting student success in the science classroom.

Data Analysis

Thematic analysis was used to search for themes related to student academic achievement (Miles, Huberman & Saldaña, 2019; Saldaña 2016). The audio recordings were initially recorded on a smartphone and uploaded to the researcher's Google Drive, to which only the researcher had access. Braun and Clarke's (2006) six-step thematic analysis guideline for qualitative research was used to guide the coding analysis.

First, the researcher familiarized themselves with my data as they developed and conducted the interviews. Braun and Clarke emphasized repeated reading in an active way and jotting down initial thoughts and notes, which was done by listening to all the interviews and reading all the transcribed interviews twice. Then notes were taken on broad patterns that emerged in the data.

The second guideline Braun and Clarke suggested is generating initial coding of ideas that emerge from the transcripts. The data was coded by the researcher as opposed to using a software program. An Excel document was used to record all codes. Once all the data was, themes were looked for. According to Braun and Clarke, this is the third guideline for qualitative data analysis. The codes were sorted into themes by drawing out a thematic map.

The fourth step in data analysis is to review the themes as suggested by Braun and Clarke. Themes were reviewed to ensure that they were clear, coherent, and supported by the data. The initial thematic map was revised to produce the final thematic map.

The fifth guideline Braun and Clarke suggested is to define and name themes with the goal of identifying the essence of each theme. There was one theme and five subthemes, which were color-coded on an Excel spreadsheet. Braun and Clarke's final guideline for qualitative thematic data analysis is to produce the report.

Results

The purpose of this thematic analysis was to explore the experiences of adult XCS students within their XCS science classes, specifically with regard to their academic achievement. In this study, there was one source of qualitative data, 10 adult XCS student interviews. The participants consisted of five currently enrolled students and five XCS alumni. These interviews provided detailed information about the student's experience with class-based science courses at XCS. Demographic information for the interview participants is provided in Table 2.

Table 2. Demographic Information for Interview Participants

Participant	Age	Race/Ethnicity	Gender	GPA	Xinaxtli Science Classes Passed	Status
Xochitl	18	Mexican American	Female	2.48	4	Graduated
Nicole	22	Black	Female	3.00	3	Graduated
Miguel	18	Hispanic	Male	2.58	4	Current Student
Jacob Mendoza	21	Hispanic	Male	3.45	2	Current Student
Ariyan Parker	21	Black/African American	Female	No Response	2	Graduated
Zacharie	19	Hispanic	Male	3.41	3	Graduated
Erendira	24	Hispanic and Latina	Female	2.90	3	Graduated
Paola	18	Hispanic	Female	3.02	2	Current Student
Jason	18	White	Male	3.09	3	Current Student
Felipe	27	Latino	Male	1.67	2	Current Student

Themes

The thematic analysis developed a theme of the critical and equitable science learning space (CESLS) that supported student re-engagement and academic achievement in their science classes. This one theme consisted of five sub-themes with various components. Figure 1 provides a brief description of the critical and equitable science learning space and the components of each sub-theme.

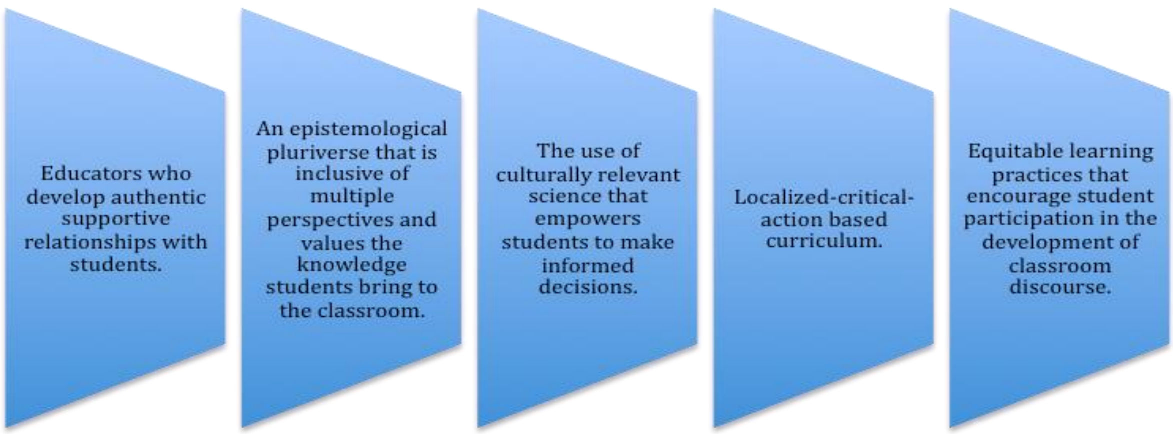

Figure 1. Critical and Equitable Science Learning Space

In analyzing the data, students expressed experiencing a transformation when it came to academic achievement in their science classes. They described a change in academic achievement and in motivation in transitioning from previous schools to XCS and current academic achievement in XCS science classes. This change was further exemplified by the fact that all participants had either received a D or F grade in science classes at their previous high schools. However, they had all passed two or more science classes at XCS with a grade of B or higher.

Change in Achievement

When transitioning to XCS they all noted a change in their academic achievement from their pre-XCS school experiences to their YCSC school experiences. This change came in the form of academic success and motivation. All participants were currently experiencing success in XCS science courses or had experienced success if they had already graduated from XCS. This transformation students expressed they experienced was supported by a critical and equitable science learning space that consisted of the following: educators who develop authentic supportive relationships with students, an epistemological pluriverse that is inclusive of multiple perspectives, and values the knowledge students bring to the classroom, the use of culturally relevant science that empowers students to make informed decisions, a localized-critical-action based curriculum, and a wide array of equitable learning practices.

Equitable Learning Practices

Equitable learning practices are those that provide opportunities to engage students. They provide multiple entry points into the class content and contribute to a classroom where all students are included. Among the factors that students identified as equitable learning practices were hands-on activities, visual stimulation, doing while someone teaches, simplified topics, dialoguing with peers and their teacher, scientific topics relevant to them, experiments and science labs, activities that encourage students to get to know each other, and science based on a real-life perspective. The excerpts in Table 3 illustrate the impact of equitable learning practices on students at XCS.

Table 3. Participant Voices on Equitable Learning Practices

Participant	Quotes
Zacharie	*Well, I really love like hands on projects . . . I prefer more visuals and like doing things because I know for me like if I actually do the things while someone teaches me I learn better that way.*
Ariyan	*When I asked questions, she answers them . . . she doesn't just like, push it to the side. Sometimes we'll go off topic and we'll talk about other scientific things like in the world, and it'll open our eyes . . . they (the teacher) have stories to go with it, like personal experience."*
Xochitl	*I think it's more hands on than in other schools . . . in YCSC it's more doing experiments…*
Felipe	*The teacher was really friendly, so she got everyone to talk. And she had fun activities where we compete against each other members making it into a game and really interactive.*
Jason	*Different places that that the School goes for trips and stuff like that, like the STEM fair…Um,*

Participant	Quotes
	I mean, the labs are very engaging, I'm able to really get involved in those, very hands on stuff like that.
Nicole	*The ice breakers and getting to know one another…I feel like hands*-on things and when they *(teachers) allow us to work in groups . . . pretty much they allow us to work together and communicate.*
Angel	*when she (teacher) asks a question and it opens people's eyes on how the world is looked at from different peoples perspective…It's engaging because it gets everybody's opinion and thinking like debating…*

Epistemological Pluriverse

The Xinaxtli science classroom was aligned with the principles of an epistemological pluriverse in that it encouraged the juxtaposition of student personal experience and scientific knowledge. With regard to student's sense of agency to create knowledge, one component emerged from the data: student knowledge creation. Participants identified student knowledge creation as consisting of the following factors: a student's interpretation, a student realization, a student experience, a connection to the student, something different that has not been seen before, learning something then changing it, and a visualization of how content can be applied in a real-world setting. The excerpts in Table 4 illustrate the impact of an epistemological pluriverse on students at XCS.

Table 4. Participant Voices on the Epistemological Pluriverse

Participant	Quotes
Zacharie	*What I learned from the teacher and like putting my own interpretations into what you're saying and giving my own feedback and like what I think about it*
Ariyan	*So the whole class, we all come together and just like think about it [a topic] and talk about it and tell our different experiences and stuff. Then you kind of connect it (science topic) to your life and say oh, yeah, this is how I see this.*
Xochitl	*We all [students] sometimes put our thoughts together and come up with something different. For example, making candles we put different fragrances which contain different chemicals in them and made them react different sometimes . . . something different that no one really saw was how the candle would react …*
Jason	*Learning new things about the world, experiencing new things, I guess is a better way to put it. When you experienced it, it kind of ingrained in my mind a little bit more.*
Felipe	*I start to visualize whatever is being taught in my head. You know how it works in the real world because I'm actually trying to understand how I can apply those things yet.*

Authentic Educators

Educators are viewed as authentic when they are committed to the development of supportive and trusting relationships with students and where students are shown that they matter. Further, authentic educators are willing to go above and beyond to support student success in and out of the classroom. The relationship between students and authentic educators was described by participants as friendly/positive, taking consideration of all students, motivating, encouraging, connecting with students on a personal level, understanding students have personal lives with issues that come up, and determined to see all students succeed. The excerpts in Table 5 illustrate the impact of authentic educators on students at XCS.

Table 5. Participant Voices on Authentic Educators

Participant	**Quotes**
Zacharie	*He (teacher) like took into consideration like every student . . . like how they learn, so I really like that too . . . I know he was very knowledgeable in his field . . . just overall . . . he understood people and you have to teach them.* *My science teacher really like gave off like a friend, like a very positive and friendly vibe, which I really like . . . overall my science teacher was like a really nice guy and he understood people.*
Xochitl	*She understands people pretty well, especially in certain events. Other teachers will not understand you because they have not gone through the things that you have gone through. She works with whatever you have to do.*
Ariyan	*She's very connected [to students] . . . she gets with the students on a personal level. She talks to them; she doesn't just treat them like children, but that you know are in high school. She actually tries to help us.*
Miguel	*She has like a lot of fun learning perspective and like she is a grounded person . . . we would talk about funny topics like how certain chemicals work. Some positive qualities she has she is always determined to see an assignment or pass a test in a high percentage.*

Culturally Relevant Science

Students expressed that science that was culturally relevant to them empowered them to make informed decisions and conduct effective problem-solving. All participants expressed that they felt science related to them to some extent. When describing how they saw science as relevant to themselves, participants expressed the following: supports you to take action, can inform decisions, is relevant to some careers or future education, awareness of issues, and provides evidence. The excerpts in Table 6 illustrate the impact of culturally relevant science on students at XCS.

Table 6. Participant Voices on Culturally Relevant Science

Participant	Quotes
Zacharie	*I'm pretty sure science is relevant to anyone in my opinion. Okay, so probably like a prime example is probably like climate change. That's relevant to everybody because like, if, like we know about our planet, like we know what we have to do to fix it…science can be used to solve a lot of things…I know since we already know about climate change, we can take action about it.*
Ariyan	*Yeah, I feel like it's relevant to everybody. I find value in science because it teaches a lot to different people and in a format where everybody can understand, it's not just for one person.*
Paola	*Yeah . . . so like if people knew what the pollution was like then they would pick up more or they would understand how to reduce pollution.*
Miguel	*It helps me to be aware of what I eat or what I use because I might learn something about technology or radiation like something that can hurt me. Or whatever I eat might not be good for me as well and like . . . if I eat something healthy or drink more water it might help me feel better and its important to me because it helps me as a person*

Localized-Critical-Action-Based Curriculum

XCS encouraged a project-based approach in the classroom by implementing authentic performance tasks (APT), and it emphasized the inclusion of social justice. A localized-critical-action-based curriculum emerged from the data and was identified by students as relevant, supportive, and action based. All participants expressed a positive disposition to the XCS science curriculum. Participants described that the XCS science curriculum was relevant to them and supportive of their experience. Factors they felt contributed to this relevance were: that it was open to their experience, used topics they could relate to, allowed them to work in collaboration with classmates, and allowed them to learn at their own pace. Participants described the XCS science curriculum as action-based because it encouraged them to frame science issues in their own lived experience, critically analyze its impact, and use that understanding to take action. The excerpts in Table 7 illustrate the impact of localized-critical-action-based curriculum on students at XCS.

Table 7. Participant Voices on Localized-Critical-Action-Based Curriculum

Participant	Quotes
Ariyan	*Sometimes I study things that I never knew before and learn something different . . . last time I was doing something that has to do with the water where you know, sometimes it's not safe to drink water from the like, out of the water hoses because it could be contaminated with other stuff chemicals and stuff and then yet yeah, taken into get it*

Participant	Quotes
	cleaned and filtered and I didn't even know about that.
Angel	*Like right now we are learning about fast foods and what type of chemicals . . . it's bad for your health to eat a lot of that and that also opened up my eyes because I like to eat Taco bell and McDonalds and stuff like that and now I'm thinking about making my own food at home.*
Jason	*Plenty of ways that science can connect to the outside world, which can also connect to the community and you're always able to tie it in somehow. I mean, Yeah, I know the city that we live in is very, it's not the nicest city . . . and science can help us fix that.*
Destiny	*Those [APTs] are also interesting ... some were more interesting than others. The one where we focused on a gun march, participating. That one was a big issue in the country. That one was really great. And we were helping out with the fires that had just happened. I enjoyed doing that.*

Discussion

This study was motivated by a few concerns: the observation that a critical understanding of science is necessary to daily life decisions, the observation that traditional science education reflects a view that science is only for those who choose to go into a STEM field, and the observation that students of color are 'pushed out' at higher rates than their classmates. This study found that XCS science classes support student re-engagement and academic achievement. Through thematic analysis, the theme of a critical and equitable science learning space emerged. Students identified the XCS science classrooms as such a learning space with the following components: educators who develop authentic supportive relationships with students, an epistemological pluriverse inclusive of multiple perspectives and values the knowledge students bring to the classroom, the use of culturally relevant science that empowers students to make informed decisions, a localized-critical-action-based curriculum, and a wide array of equitable learning practices.

Student Academic Achievement-Critical & Equitable Science Learning Space

Based on our thematic analysis, academic achievement came in two forms for the students of XCS. The first was a change in academic achievement by XCS students from their previous high school science courses to their current XCS science courses. This change was two-fold: a change in motivation and a change in academic success. The second form of academic achievement identified by participants was current academic achievement, meaning they were completing XCS science courses, whereas they had trouble completing science courses at their previous schools. In addition, academic achievement was exhibited by XCS science classes passed by students, which is they received an A or B grade. Given that students of color, such as Black and Latinx students, perform at lower levels on assessments and earn fewer credits, on average, than their White peers in the traditional high school science classroom, it is important to note the change in academic achievement for students at XCS (Dalton et al., 2018; NAEP, 2015; National Center for Education Statistics, 2017).

A multifaceted approach is necessary when seeking to re-engage young people who have been ‘pushed out’ and provide an equitable and critical science education. When participants noted their current academic achievement in their science courses at XSC, it was supported by all components of the equitable and critical learning space, not just one. That is, the XCS science classroom was a space where students are able to re-engage in STEM education. Findings from this study support previous literature on supporting student engagement, empowerment, and achievement in the science classroom.

Equitable Learning Practices

Traditional science classrooms tend to promote a standardized view of knowledge that is pre-defined and utilize universal teaching methods with the goal of performing well on a test (Kincheloe, 2008). When educators are expected to “teach to the test,” they are not allowed to engage students in the practice of learning and knowledge creation; rather, their role is that of information deliverer. Such a pedagogical model has been found to have a negative impact on teacher practice and achievement by students of color in math and science (Lomax et al., 1995). Lee (2011) argues that when “non-mainstream” students (i.e. students of color, from low-income families, and/or learning English as a new language) are provided a science education that “(a) values and respects the experiences that all students bring from their homes and communities, (b) articulates this cultural and linguistic knowledge with disciplinary knowledge, and (c) offers sufficient educational resources to support science learning”, it can lead to engagement, relevance, sense of agency to create knowledge, and ultimately academic success in the science classroom to support science learning” (Lee, 2011, p. 3). The CESLS is an example of such a space where multiple components contribute to academic achievement. Based on thematic analysis, a component of the CESLS was the use of equitable learning practices identified in science class as consisting of hands-on activities, visual stimulation, simplified topics, dialoguing with peers and teacher, science topics relevant to them, experiments, community-building activities, and science based in real life perspectives.

Authentic Educators

Additionally, the literature speaks to the importance of educators in facilitating spaces of learning (Valenzuela, 1999; Rodriguez, 1998; Hattie, 2009). Science educators play a pivotal role in student academic success. The attitude an educator has about who can and cannot succeed in school can be communicated in a number of ways, explicitly and implicitly, to students (Rosenthal & Jacobsen 1968), which can in turn impact a student’s success in the science classroom. As such, sometimes students do not engage in school and underperform because of deficit thinking by their teachers. The CESLS is facilitated by the student-teacher relationship, which is at the core of the space. Participants spoke about how the positive and caring relationship they had with educators was authentic. Based on our thematic analysis, a component of the CESLS was an authentic educator who develops trusting and supportive relationships with students. An authentic educator was identified as students as having knowledge in the given discipline; having a fun learning perspective; providing extra support; working with students individually; dialoguing with students; having friendly and positive vibes; taking into consideration all students; motivating, encouraging, and connecting with students on a personal level; being considerate of students' lives and issues outside of school, and showing a determination to see all students succeed.

Localized-Critical-Action-Based Curriculum

The curriculum and overall approach to education that XCS utilizes are also effective. With the goal of providing an equitable education that supports student academic achievement in science class, the XCS science curriculum can be seen as a vehicle. The curriculum is student-centered and provides students with opportunities to engage in knowledge creation through authentic performance tasks. Researchers have argued that the science classroom should serve to develop students who challenge social inequality through teaching, curriculum, and social transformation (Dos Santos, 2009; Finkel 2018; Mutegi, 2011; Rodriguez, 1998). Further, Moje (2007) maintained that teaching science for social justice "not only provides access to mainstream knowledge and practices but also provides opportunities to question, challenge, and reconstruct knowledge. Social justice pedagogy should, in other words, offer possibilities for transformation" (p. 4). As proposed by social justice science education, the YCSC science curriculum encouraged students to use scientific knowledge and skills to contribute to navigating, critically questioning, and examining issues related to their social factors (Rodriguez, 1998, 2015). Participants described the XCS science curriculum as encouraging them to frame science issues in their own lived experience, critically analyze its impact, and use that understanding to take action.

Epistemological Puriverse

According to Kincheloe (2008), an epistemological pluriverse is a space in which students and teachers can juxtapose their personal experiences with multiple types of knowledge. It is a space in which many social worlds can mingle and a praxiological space where action based on multiple realities can come to fruition. Research suggests that by engaging students with opportunities to be critical consumers and producers of knowledge, and by supporting them to develop a strong sense of agency, they can experience a positive change for themselves (Lee & Buxton, 2010; Rodriguez, 2015). Based on the thematic analysis, it was found that the XCS science classroom was aligned with the principles of an epistemological pluriverse in that it encouraged the juxtaposition of student personal experience and scientific knowledge.

Culturally Relevant Science

Culturally relevant pedagogy, as described by Ladson Billings (1995), posits that content should be connected to students' interests and concerns, meaningfully integrating students' culture into the curriculum and elevating students' socio-political consciousness by investigating real issues in local contexts. Students expressed that science that was culturally relevant to them, empowered them to make informed decisions and conduct effective problem-solving. All participants expressed that they felt science related to them to some extent. When describing how they saw science as relevant to themselves, participants expressed the following: supports you to take action, informs their decisions, relevant to some careers or future education, awareness of issues, and provides evidence.

Implications for Practice

The findings of this study may provide insights to educators, educational program directors, education researchers, and community organizations that strive to re-engage young people who have been ‘pushed out’ of traditional high schools. In addition, this study may contribute to a critical pedagogy of science that supports the development of all students who enter a science space to be creators of knowledge. Based on the findings of this study, below are implications in applied practice for educators and science curricula.

Re-engagement in STEM Education

The majority of students in our study had attended multiple high schools prior to enrolling at their respective XCS locations. One of the major issues that students spoke about with respect to their science class experience at their previous high school was a lack of engagement. Some of the factors that contributed to their disengagement in science class were disruptions and distractions by other students in the classroom, unprepared lessons by educators, “busy work” that has no substance, excessive use of slideshows, extensive note-taking, educator not engaging the class in dialogue, and “boring” topics. Disengagement may impact a student in many different ways and for many different reasons. As educators working with young people, it is our responsibility to consistently reflect on and remix our practice to provide a more engaging classroom environment. Some suggestions for cultivating an engaging science classroom follow.

First, understanding that there are no “one size fits all” strategies for engaging students. Practices that support engagement in one classroom may not necessarily support engagement in another classroom. Every classroom must be developed in conjunction with the students and educators in that specific classroom community. A suggestion is that from day one begin, educators begin to build community in their classroom: dialogue with students about how the classroom can be equitable for all of them; develop classroom guidelines, and speak with students about how issues should be resolved if they arise. Valuing student input can contribute to a sense of respect that students feel. In addition, undertake consistent check-ins with students on how they are doing. These check-ins should not serve as an opportunity to tell students how they need to “improve,” but rather be an opportunity for students to speak with the educator one on one and let them know how they are doing or if they need any support.

Second, equitable learning practices should be integrated into daily lessons. Equitable learning practices contribute to student participation in the development of classroom discourse; examples of such practices are collaborative activities that encourage student dialogue, hands-on activities, culturally relevant science topics in which generative themes are based on student experience, authentic inquiry (i.e., student curiosity is encouraged), visually stimulating lessons that attempt to bring science phenomenon to life, and a reduction in educator-led lectures. I want to highlight this last point about educator-led lectures. As educators, we sometimes feel that if we are not directly lecturing we are not doing our job. This is not the case; as educators, we must provide a space in which student experience and voice can juxtapose with science content so that student knowledge creation can occur. A reduction in science lectures does not mean that an educator never lectures. It means that the lecture is not the centerpiece of the class lesson, rather it is a supplement to the lesson.

Third, alternative measures of assessment should be implemented. STEM education should stop relying on standardized tests for more than what it is: a narrow view of an individual's ability to memorize a predetermined set of information. Kincheloe (2008) argued that knowledge is culturally produced and thus requires the construction of criteria for evaluating its quality. Alternative measures of assessment need to be implemented, such as authentic performance tasks. One suggestion is to use an authentic performance task that allows students to show their understanding of the content through the application of STEM content—for example, a project-based approach in which students actively work through a project in conjunction with their STEM course. Authentic performance tasks encourage a less constrained and more localized curriculum that allows educators to develop content that integrates students' lived experiences.

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Appendix. STEM and Culture Competencies Implemented by XCS Science Educators

	STEM Competencies
Questions & Defining Problems	Learners formulae their own questions or hypotheses (if/then statements) to evaluate empirically testable questions.
Models	Learners construct and revise models to explain phenomena and discuss the limitations and precisions of the model.
Investigations	Learners develop original procedures and protocols to plan and conduct a full investigation to produce data that serve as the basis for evidence.
Interpret & Analyze Data	Learners independently represent and analyze data to identify patterns, trends, or relationships. They interpret data in light of models and theories.
Construct Explanations & Design Solutions	Learners construct their own explanations for STEM phenomena and develop a design prototype for an evidence-based solution.
Obtain, Evaluate, and Communicate Information	Learners can independently analyze evidence (often in the form of data) and formulate their own conclusions/explanations.
Engage in Arguments From Evidence	Learners adequately describe content and layout to be used to communicate and justify their conclusions and explanations.
Tools	Learners are sufficiently familiar with tools appropriate for their course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations.
	Culture Competencies
Love & Care	● Listens with empathy ● Honors & respects the voices of others (staff-student, student-student, staff-community, student-community) ● Honest & open communication ● Self-love and embracing of various identities ● Unconditional love & support for others ● Respect and genuine relationship-building with others
Leadership	● Demonstrates commitment to the space's mission, vision, policies, established agreements, core values and follows-through on expectations ● Sets goals, follows-through on action plans, and self-reflects for improvement

	● Can envision and apply their leadership abilities in future post-secondary education, career pathways, and their own life ● Can define and demonstrate ethics and integrity ● Demonstrates effective communication, discovers their communication style, and applies in various settings ● Acts as key players in culture-building and decision-making in the space
Success	● Develops and implements a plan for emotional, physical, spiritual/secular, intellectual, career, and financial growth & transformation ● Demonstrates intellectual curiosity & humility ● Self-knowledge of identity, positionality, talents & skills ● Sense of purpose: apply self-knowledge towards a goal that has a wider impact beyond oneself ● Reframes "success" to counter dominant notions of success
Collaboration	● Works to achieve the program vision, mission, goals, objectives, and outcomes ● Engages in discussion & dialogue for collaboration ● Honors team agreements ● Creates and participates in collective goals, objectives, process, & outcomes with people from diverse backgrounds ● Honors collectively identified benchmarks, scheduled activities, and deadlines ● Inclusive and acknowledging of all stakeholders (community, staff, students, alumni, family, etc.) ● Utilizes resources (technological, material, human) to maximize collaboration efforts ● Reflects on participation in collaborative projects
Social Consciousness & Action	● Embraces funds of knowledge: informs the school community of their lived/community realities ● Participates in collaborative social investigation (needs assessment; asset-mapping; power analysis; identifies and understands injustice, oppression, and inequity) ● Able to name key players, power dynamics, privilege, and how it plays out in a setting ● Shows solidarity for self & others through empathy, actions that respect needed support, raising awareness, and advocacy (e.g. lobbying, petitioning, filing a legal challenge, protesting, campaigning, story-based messaging) ● Promotes self & community autonomy (resource development, budget development, program development) ● Participates in community action projects to address urgent community

	concerns
Support & Healing	● Understands, upholds, and promotes restorative justice practices of building community and going through a process to restore relationships when people are harmed/experience conflict, violations, offensive behavior, and injustices, they ● Contributes to and upholds collectively created respect agreements and discipline process ● Feels like a valued and appreciated member of the community where they are recognized for their assets, not their challenges ● Feels safe to express their ideas and trusts that they will be supported if they share constructive feedback and/or break community agreements ● Is committed to a transformative justice approach where there is critical reflection and efforts to combat systemic roots of harm and promotes decisions that are grounded in the best interest of the collective ● Upholds the collectively created system that proactively addresses retention and attendance. ● Upholds and is committed to cultivating critical hope, critical agents of transformation, and self-determination as referenced in the PCCP framework