Culturally Relevant Pedagogy and the 5E Lesson Plan

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Menchaca (2001) described traditional curricula and textbooks as homogeneous and "culturally unfamiliar" to minority students because they "often fail to address culturally relevant content and concepts" (p. 84). Jones, Pang, and Rodriguez (2001) further stated that when diverse student groups hold views that "differ from the Western or mainland canonical learning, they are more likely to find themselves in conflict with the curriculum being taught" (p. 36). When students' experiences go unrecognized, they are more likely to become disengaged and/or alienated from learning experiences (Yoon and Martin 2019). On the other hand, students whose language and culture align with their school's majority population are advantaged in the learning process over those whose language and culture do not (Yoon and Martin 2019).

Culturally Responsive Curricula (CRC)

In response to increasingly diverse student groups in U.S. schools, educational researchers have developed curricula that respond to students' unique needs, cultures, and experiences. Curricula that embrace a pedagogy of empowerment are known as Culturally Responsive Curricula (CRC), and such curricula specific to science are referred to as Culturally Responsive Science Curricula (CRsC). CRsC allow students to learn science within a culturally familiar context that permits them to connect new science knowledge to previous experiences and knowledge (Menchaca 2001).

Like CRC, CRsC provide alternative textual representations of science that challenges traditional cultural assumptions (Menchaca 2001). Moreover, the use of CRsC has also been shown to increase student engagement with content (Nykiel-Herbert 2010), boost students' school attendance (Bernard 2004), improve their grade point averages, and encourage the formation of positive racial self-images (Butler-Barnes et al. 2017). Therefore, CRsC is critical to the educational success of underrepresented students.

Culturally Relevant Pedagogy (CRP)

Ladson-Billings developed the pedagogical model known as Culturally Relevant Pedagogy (CRP) after studying exemplary teachers of African American students for three years (1995). CRP is a form of teaching that engages students who have been historically excluded from mainstream educational practices due to cultural and experiential differences. Ladson-Billings maintained that CRP is built on three foundational tenets: *Academic Achievement, Cultural Competence*, and *Socio-political Consciousness*.

The tenet of *Academic Achievement* maintains that teachers who embrace CRP presume that all students can learn, clearly communicate to their students what success looks like in the context of their classrooms; know their subject matter and their students; are capable of effectively teaching the content; espouse a critical consciousness pertaining to the curricula; and recognize that academic achievement takes various forms (1995).

The tenet of *Cultural Competence* maintains that culturally relevant teachers are knowledgeable about students' culture and communities and their role in learning; view students' cultures as foundational to learning; and actively utilize those local and global cultures in pedagogy.

Finally, the tenet of *Socio-political Consciousness* maintains that culturally relevant teachers demonstrate *Socio-political Consciousness* by obtaining knowledge about the larger socio-political contexts of their school, community, country, and world; are invested in the public good; plan instruction and learning experiences to intentionally connect students to the greater social context; and believe that students' accomplishments directly impact their quality of life (Ladson-Billings 1995).

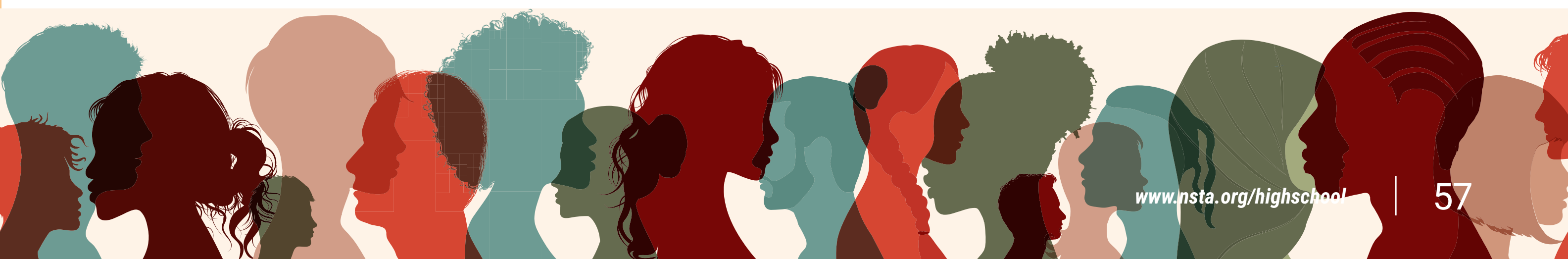
Culturally Responsive Pedagogy (CRsP)

While CRP and CRsP have been used interchangeably, there are some nuances that distinguish them from one another. CRsP was developed by Gay (2010), who built upon the foundational work of Gadson-Billings regarding CRP. According to Gay, CRsP involves teachers intentionally seeking opportunities to learn about diverse student groups' interests, their previous knowledge and life experiences, and then crafting pedagogical practices and learning experiences that encompass all of those elements, creating a teaching atmosphere in which diverse student groups might thrive (2010). The primary differences between CRP and CRsP are that CRsP focuses on teaching strategies and practices while CRP seeks to empower disenfranchised students intellectually, emotionally, socially, and politically.

NGSS connection to culturally relevant/responsive pedagogy and curricula

The *Next Generation Science Standards (NGSS)* were partly created in response to barriers and challenges culturally diverse student groups often face in science classrooms, were purposely designed in a culturally relevant/responsive manner (NGSS Lead States 2013), and repeatedly employ the phrase "all students" with regard to every student's access and opportunity to engage with and succeed in science. The *NGSS* also focus on the challenges faced by underrepresented student groups who engage in scientific inquiry, a strategy critical for meaningful science learning to take place that "can help bridge cultural backgrounds and foster science learning success" (Ghattas and Carver 2017, p. 60).

Furthermore, the three-dimensional learning aspect of the *NGSS* (consisting of science and engineering practices, crosscutting concepts, and disciplinary core ideas) is representative



of culturally relevant/responsive pedagogy and curricula. For example, the *NGSS science and engineering practices* are modeled after inquiry-based strategies utilized by scientists and engineers and enhance the science academic success of both African American students and White students (Geier et al. 2008), while decreasing achievement gaps between them (Wilson et al. 2010). *Crosscutting concepts* refer to practices applicable and occurring across disciplines (scale, pattern, and cause and effect, for example) and for underserved students, "repeated and contrastive experiences" lead to content mastery (NGSS Lead States 2013, p. 3). Finally, *disciplinary core ideas* are the fundamental ideas critical to comprehension of a particular science discipline that relate to personal and societal concerns and provide the personal or cultural connection to science content critical for the science academic success of diverse student groups (NGSS Lead States 2013).

Evaluating lessons for cultural relevance/ responsivity

A recent literature search revealed a dearth of procedures for holistically evaluating 5E science lesson plans for cultural relevance/responsivity. However, the *Educators Evaluating the Quality of Instructional Products (EQuIP)* rubric, version 3.0 (2016) (recommended by the *NGSS* for assessing curricular alignment to the *NGSS*) includes an element that addresses whether or not examined science curricula support instruction and learning for all students. Both the *NGSS* and the *National Science Teaching Association* recommend use of the rubric.

In response to the lack of rubrics available for holistically assessing lesson plans for culturally relevant/responsive elements I developed such a rubric (Figure 1; see Online Connections) for teachers to use as a tool to evaluate 5E science lesson plans and associated resources for CRC, CRP and CRsP. The rubric draws from multiple evaluation instruments: (1) The Center for Collaboration's Fairness, Bias, and Cultural-Responsiveness Checklist (*https://www.doe.in.gov/school-advance Whitement/siresourcehub/fairness-bias-and-cultural-responsiveness-checklist-assessments*); (2) The Culturally Responsive-Sustaining STEAM Curriculum Scorecard (*https://steinhardt.nyu.edu/sites/default/files/2021-02/CRSE-STEAMScorecard_FIN_optimized%20%281%29.pdf*); and (3) The Culturally Responsive Walkthrough Tool (*https://theequityinstitute.org/wp-content/uploads/2019/08/culturally-responsive-walkthrough-tool-2-1.pdf*). The rubric (Figure 1; see Online Connections) includes descriptions of culturally responsive items across four quality levels (excellent, acceptable, developing, and unacceptable) and seven criteria, and is designed for assessing 5E lesson plans.

Conventional lesson to culturally responsive/ relevant lesson

The literature also lacks studies pertaining to strategies teachers might employ to modify a conventional science 5E lesson so that it includes Culturally Responsive/Relevant Pedagogical and curricular elements. In response to that research gap in the literature and to facilitate lesson plan modification, Table 1 (see Online Connections) provides a selection of culturally relevant and responsive pedagogical strategies suitable for each E. As teachers review conventional lesson plans, they can delete traditional strategies and replace them with Culturally Responsive/Relevant strategies or add Culturally Responsive/Relevant strategies from the list with relative ease.

Samples of conventional 5E lesson modified to be culturally responsive/relevant

To further facilitate the modification of a conventional lesson, a sample of a culturally responsive 5E lesson plan at the ninth-grade level on physical and chemical changes with the cul-

turally responsive/relevant components in italics (taken from Table 1) follows what I have used with my students many times. Table 2 (see Online Connections) contains information pertaining to station set-up, and procedures and safety precautions for each station.

Physical and chemical lab

This lesson can be completed in one 50-minute class session. Safety precautions include use of goggles throughout, care with the paring knife and matches, pan of water to extinguish the fire, and gloves for the acetone station.

Engage

To pique students' curiosity about the lesson, I begin by holding up a piece of paper and asking the following questions in this order: "What is this?" (Possible answer: paper); "Now that we have established this is paper, in what ways can we change it? (crumple it up, cut it, tear it, shred it, wet it, burn it). As students answer, I change the paper in ways students suggest (saving burning for later). After each modification, I ask: "Has the paper changed? Is it still considered paper? Can we reverse the change?" Usually, students respond in the affirmative to the first two questions and come to the conclusion that we can almost get it back to its initial condition by taping, gluing, smoothing, letting it dry.

Next, I ask: "Are there any other ways that the paper could change? If so, what are they?" (Yes, by burning it.) Then I burn a small piece of paper in front of the class. After it has cooled, I pick it up and ask "Is this change different from the previous changes?" (yes, no.) "If so, why or why not?" (Because it is ash. Because most of it is gone. Because it looks nothing like it did before.) I then ask, "Can we reverse this change? Why or why not?" (No, because you cannot unburn it.)

Explore

Culturally responsive/relevant strategies:

1. Learning environment is student-centered and collaborative.
2. Students are paired by gender (males with males and females with females) to avoid males assuming dominant roles.
3. Constructivist approaches to learning are utilized.
4. Learning experiences (investigations) are authentic and relevant to all students.
5. Teacher is available to help students make real-life connections between the content and their culture.
6. Collaborative and cooperative learning approaches are implemented.
7. All students are actively engaged.

Next, students create a chart in their digital science notebooks into which they will place their data/answers from each of the seven stations in the Explore portion of the lesson (see Table 2 with a sample line completed), are paired with a lab partner of the same gender (if possible) and are asked to bring their goggles and science notebooks to each station. At each station, student pairs first record in their tables the physical and chemical properties of the item(s) present based upon their observations and discussion with one another. Students are next directed to make a specific change to the item(s), indicating whether the change was physical or chemical and why. Finally, they list the evidence for the change they made in their table.

Explain

Culturally responsive/relevant strategies:

1. Teacher incorporates all students' lived experiences, cultures, communities into the learning environment.
2. Teacher creates class community in which all students' contributions are heard and valued.
3. Teacher asks for student volunteers only.

After the investigation is finished and students are back in their seats, I begin presenting the content pertinent to the physical and chemical changes exploration just completed. I start by asking students (I use the stick method— randomly draw student names to answer by pulling craft sticks with student names on them out of a jar) to explain/describe some of their findings and in doing so, to compare their findings with those of their classmates. Next, I have each lab pair come to the board and record examples of physical and chemical properties they observed in the lab. Next, as a class we discuss the definitions of physical and chemical properties and elicit new examples of each:

- **Physical property:** one that can be observed or measured without changing the chemical nature of the substance. Examples: color, texture, shape, phase (solid, liquid gas), luster (how it reacts to light), malleability (ability to bend), ductility (ability to be drawn into a thin wire, etc).

TABLE 3

Card sort.

Physical Properties	Chemical Properties	Physical Changes	Chemical Changes
Definition:	Definition:	Definition:	Definition:
Examples	Examples:	Examples:	Examples:

- **Chemical property:** a property or characteristic of a substance that is observed during a reaction in which the chemical composition or identity of the substance is changed. Examples: burning of wood, boiling an egg, baking a cake, digesting food, etc.

Students are then asked to describe what they think the attributes of a physical change are followed by the attributes of a chemical change and then provide examples of each. I then provide formal definitions and additional examples:

- **Physical change:** a reversible change in the physical properties of a substance such as size or shape (size, phase change, breaking glass, shredding paper, etc.).
- **Chemical change:** an irreversible chemical reaction involving the rearrangement of the atoms of one or more substances and a change in their composition resulting in the formation of at least one new substance (flammability, gas formation, precipitate formation, noticeable odor formation, change in color, etc.).

I next ask students to provide examples of both physical and chemical changes they have personally experienced. (Physical: shrinking an item of clothing in a dryer, making Popsicles, sawing a piece of wood in half, etc. Chemical: fireworks exploding, leaving a bicycle out in the rain to rust, etc.)

Elaborate

Culturally responsive/relevant strategies:

1. Students are paired by gender (males with males and females with females) to avoid the possibility that some males might assume dominant roles.
2. Collaborative and cooperative learning approaches are implemented.
3. Students are engaged in decision making.
4. Students have input, choice, and voice.
5. All students are actively engaged.
6. Learning environment is student-centered and collaborative.

Students are placed in pairs (paired by gender and ability, so that a more advanced student is paired with a less advanced student, if possible) and each pair will receive a set of cards with definitions on some and examples of physical and chemical properties and physical and chemical changes on others. The students will create a table in their science notebooks (see Table 3) consisting of four columns, labeled physical properties, chemical properties, physical changes, and chemical changes, one row for definitions and one row for examples. Working together, each pair will then sort their cards into four groups according to the column headings. (Some cards will feature definitions, while others describe physical and chemical properties and physical and chemical changes.)

Evaluate

Culturally responsive/relevant strategies:

1. Self-evaluation is utilized.
2. Multiple types of assessment options are provided.
3. Assessment privacy is protected and respected.

I now offer students choice pertaining to the type of assessment they would prefer from the following options:

- **Option 1:** Given photos of physical and chemical changes, students identify them by circling either "physical change" or "chemical change" (printed below each card's photo). Students will then draw and label their own example of both a physical and chemical change and will receive two items for which they will list physical and chemical properties.

FIGURE 3

Checklist of physical/chemical changes/properties.

Physical/Chemical Changes/Properties Option 3

- ❑ 1. Definitions of physical and chemical properties are included and are accurate (4 points).
- ❑ 2. Definitions of physical and chemical changes are included and are accurate (4 points).
- ❑ 3. Five examples (each) of physical and chemical properties are included and are accurate (10 points).
- ❑ 4. Five examples (each) of physical and chemical changes are included and are accurate (10 points).

Score: _____ /28

- **Option 2:** Students create a digital entry for the investigations in the science notebooks. Figure 2 (see Online Connections) provides the rubric for assessing notebook entries. I will assess the entry using the rubric and students will self-assess using the same rubric. Grade will be the average of both rubric scores.
- **Option 3:** Students create a song, rap, poem, or skit that incorporates the following: definitions and 10 examples of physical and chemical properties, definitions and 10 examples of physical and chemical changes. Students perform the song for me in private, and I evaluate their performance using a checklist to mark off required elements as they are included (see Figure 3).

Table 4 (see Online Connections) depicts a second example of the modification of a conventional 5E watershed lesson plan with little to no CRP/CRsP to a lesson infused with CRP/CRsP strategies designed for 10th-grade environmental science students. Gadson-Billings's three foundational components of CRT are included along with elements of creativity and storying.

Conclusion

In conclusion, Culturally Responsive/Relevant Pedagogy and Curricula are beneficial to students because they help bridge the gap between academic content and the diverse backgrounds of student groups, help better prepare teachers to provide educational experiences and materials that encourage and celebrate the inclusion of students' lived experiences, cultures, and identities, communicate to students that their experiences, cultures, and beliefs are valued and serve to empower all students intellectually, emotionally, socially, and politically.

ONLINE CONNECTIONS

Figure 1. Cultural Relevance/Responsiveness Lesson Evaluation Rubric: *https://bit.ly/3nar6GV*

Figure 2. Digital Science Lab Notebook Rubric: *https://bit.ly/3hbFECm*

Table 1. Culturally Relevant/Responsive Pedagogical Strategies for use with the 5E Lesson Plan: *https://bit.ly/3tqwvee*

Table 2. Physical and Chemical and Lab Stations Set Up/Procedures/Safety: *https://bit.ly/2WZu0Dc*

Table 4. Traditional to Culturally Responsive/Relevant Modifications (African American Culture): *https://bit.ly/3BN7xsk*

EQuIP Rubric for lessons and units: Science, version 3: Next Generation Science Standards: *https://www.nextgenscience.org/sites/default/files/EQuIP%20Rubric%20for%20Science%20v3.pdf*

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