

Embracing Culturally Relevant Pedagogy to Engage Students in Chemistry: Celebrating Black Women in the Whiskey and Spirits Industry

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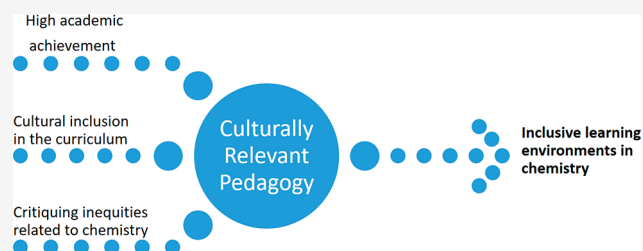
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ABSTRACT: Uncle Nearest Premium Whiskey was created in the legacy of the first African American master distiller, Nathan “Nearest” Green. His namesake spirit is currently the most-awarded American whiskey or bourbon of 2019 and 2020, and the company is owned by a Black woman, Fawn Weaver. Weaver is committed to diversifying the spirits industry and elevating people of color. Her executive team is all women, and Nearest Green’s great-great-granddaughter serves as the Master Blender of the company. This story, and others like it that are culturally relevant, can connect the chemistry students learn to real world applications and provide a narrative that centers Black women, a demographic that is often excluded from the chemistry curriculum. Additionally, this cultural context can also offer insight on equity and social change in STEM fields through the lens of women and underrepresented groups in STEM.

KEYWORDS: *Minorities in Chemistry, First-Year Undergraduate, General Organic Chemistry Collaborative, Cooperative Learning Minorities in Chemistry Women in Chemistry*



INTRODUCTION

The COVID-19 pandemic has highlighted the importance of STEM in moving our nation forward and solving problems in innovative ways. A talented workforce is key in this endeavor. However, it has been noted that the current workforce may face shortages in certain fields.^{1,2} The National Science Board (NSB) noted the “missing millions” in their Vision 2030 report that will be important in filling this talent gap.³ This included doubling the number of women and more than doubling the number of minorities in the science and engineering workforce. The field of chemistry contributes to this lack of diversity as noted in several recent articles.^{4–8} A recurring theme in these manuscripts is the need to recognize bias in the teaching of chemistry and address it by utilizing inclusive teaching practices and designing inclusive learning environments.

Historically Black colleges and universities (HBCUs) have been a successful training ground for Black undergraduates in chemistry, graduating 29% of all Black students in 2018, although only 9% of Black students attend HBCUs.^{9,10} The supportive culture that is cultivated at these institutions contributes to their success.¹¹ However, even at these noteworthy institutions, the inadequacies and sometimes discriminatory nature of traditional chemistry texts and instructional materials can alienate Black students. Black women, a group that is underrepresented by both gender and race, may be particularly impacted by the white male centered nature of chemistry.^{12–14} To truly encourage Black women to

enter and persist in the field of chemistry at all institutions, inclusive teaching strategies that acknowledge Black women’s experiences and challenge the discriminatory practices in science should be encouraged.^{15,16} As a faculty member at an HBCU for Black women, I think it is particularly important to include course content that represents the student body and recognize the unique contributions my students can offer to the course. This work discusses a pedagogical framework, culturally relevant pedagogy, that can be used in the chemistry curriculum to launch the inclusion of Black women, showcase their innovations and contributions to chemistry, and allow them to take part in delivering class content that decenters the traditional class hierarchy for a more inclusive learning environment.

CULTURALLY RELEVANT PEDAGOGY (CRP)

Methods to engage women and minorities in the classroom should speak to the diversity and strengths that these populations bring to the classroom. CRP, used widely in K-12 education, is based on teaching from an asset-based perspective

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that includes students' experiences, interests, and backgrounds. The theory emphasizes using real world contexts in the classroom to enrich learning and was introduced by Gloria Ladson-Billings in 1994 to ensure cultural inclusion, academic success, and allow for critiques of social and political inequities.^{17,18} (Figure 1). Storytelling is a powerful comple-

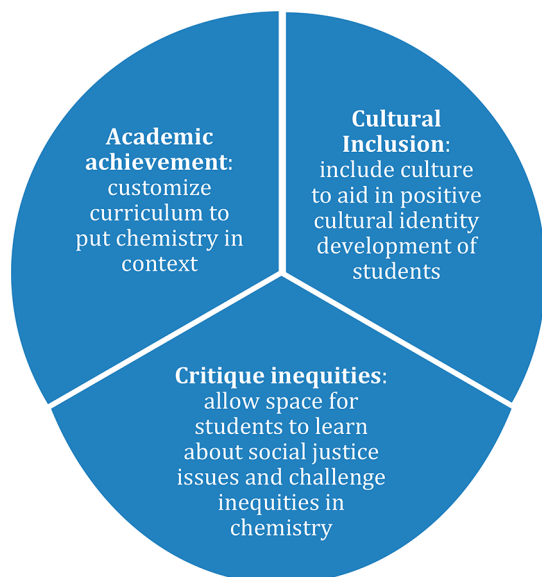


Figure 1. Culturally relevant pedagogy applied to chemistry in summary.

ment to CRP that should be expanded in chemistry.^{19,20} The American Chemical Society (ACS) has made efforts to provide information in different formats to storify science including the chemistry of spirits.²¹ Telling relevant stories and using CRP can be utilized to show the relevance of chemistry to students' lives and demonstrate how their training can be used to solve problems in society; factors the NSB has cited as effective measures in retaining students.³ The features of CRP, in practice known as culturally relevant teaching, are engrained in the culture of HBCUs. Students are generally exposed to curricula steeped in culture with references to women and the African diaspora. In nonscience courses, this curriculum is often framed in a social and political context. However, chemistry is one area where the curriculum may not have cultural or sociopolitical content to a great extent. The traditional organic chemistry curriculum is often focused on technical aspects and does not acknowledge many of the valuable contributions of women or Black chemists. Nor does it make reference to the cultural backgrounds or experiences of Black students. Efforts to add relevant connections to students are often grounded in medicinal chemistry, a relevant application, but the human element is generally removed from these activities. Thus, chemistry departments should actively reflect on their curriculum and its inclusivity to women and minorities.

There are two other pedagogical frameworks that are related to CRP that should be mentioned. One is culturally responsive pedagogy. It is often intertwined with CRP in the literature and the names may be incorrectly switched in some cases. Culturally responsive pedagogy, which was introduced by Geneva Gay in 2000, builds on the tenets of CRP by placing an emphasis on designing learning experiences based on students' culture, perspective, and experiences.^{22–24} However, it also puts a

spotlight on teacher training that engages the instructor to reflect on their strategies, practices, and cultural competencies.²² Django Paris expanded on the work of CRP to develop culturally sustaining pedagogy, which takes into account the evolution of students' identity and culture.²⁵

■ CHEMISTRY OF WHISKEY

Chemistry is essential in the innovative production of whiskeys such as the Uncle Nearest brand. In general, whiskeys differ in three ways: their source, the distillation process, and the aging process.²⁶ The source is generally a grain that goes through a fermentation process and then each whiskey maker has their own unique distillation process to isolate the whiskey. There are also a variety of aging methods utilized by whiskey makers. Chemical reactions occur in each of these steps to produce or modify hundreds of molecules that impart various flavors, aromas, and appearances to the array of whiskeys found around the globe²⁷ (Table 1). For example, copper is a preferred metal

Table 1. Snapshot of Organic Molecules in Whiskey and Their Corresponding Flavors or Aroma

Compound	Functional Group	Flavor or Aroma
Guaiaicol	Phenol, ether	Smoky, medicinal
<i>cis</i> -3-Methyl-4-octanolide (whiskey lactone)	Lactone	Woody, coconut
Furfural	Aldehyde	Grainy
Acetic acid	Carboxylic acid	Sour
Diacetyl	Ketone	Nutty, buttery
Ethyl hexanoate	Ester	Fruity, floral
Dimethylsulfate	Thiol	Burnt, rubbery

for stills because it serves to create whiskey with a better flavor profile.²⁸ Casks used to store the liquor also have chemical components that add to the aroma and flavor profiles. One study done by researchers at UC Davis looked at a variety of bourbons and whiskeys (60 total) and found over 4000 different compounds in the samples.²⁹ This work was able to show that each spirit had a unique chemical composition and that bourbons and whiskeys could be easily categorized based on the presence or lack of characteristic fatty acids and tannins. Thus, not only is the production of whiskey based on chemical reactions and techniques such as distillation but also the overall process offers chemists opportunities to conduct chemical analyses that expand the field of chemistry. The common compounds used in whiskey production can be used in assignments to provide application related context that engages students and promotes academic achievement.

■ CULTURAL INCLUSION

An important factor in engaging and retaining women and minorities in chemistry is including them in the chemistry curriculum. The story of Nearest Green is a piece of history that can be brought into the classroom to discuss chemistry from a cultural context. Nearest was a lead distiller in Lincoln County Tennessee before Emancipation and afterward as a free man.³⁰ Slaves made up the labor force in the whiskey industry, as they did in many industries at the time. In the course of his work, Green taught his methods to a young boy, Jasper Newton, now known as Jack Daniels. The contributions of Green to the Jack Daniels brand were only recently publicly acknowledged.³¹ When Fawn Weaver, the CEO of Uncle Nearest Premium

Whiskey, was introduced to the story of Green, she took it upon herself to write about him in detail and visited Lynchburg on her 40th birthday to collect interviews about Green. Her hopes were to write a book and movie about the master distiller. Those efforts would be combined with a commemorative bottle of whiskey to honor Nearest. After Weaver visited Lynchburg, her dream expanded, and she and her husband set out to build the whiskey brand as Green's legacy. Although Green was not a chemist, his work is an example of the historical development of chemistry. The development of scientific processes by Black people in the United States (US) is largely undocumented historically due to slavery and afterward, racism. The literature suggests that documenting the development of science and giving credit to underrepresented populations for their contributions and achievements can counter existing racial prejudices while also fostering connections to current students.⁵

Weaver's work has been tremendously successful in many ways, but it also highlights the lack of women and Black women in the spirits industry, especially at the executive level or as master blenders. Weaver's executive team is composed of a dynamic group of women; however, the spirits industry is primarily associated with men, although women have long been involved, yet seldom acknowledged.^{32,33} Currently, Black women including Joy Spence (Appleton estate), Chanel Turner (Fou-Dré), and Naledi Goottschi (Ledi Craft Gin) are blazing trails in the industry.³⁴ Forbes has a series entitled "Women Running the Liquor World" that also highlights women in top roles.³⁵ The roles that these women play in the industry, their journeys, and the challenges they have faced can be an integrated into the curriculum alongside the technical aspects of the course. This would serve to demonstrate applications of chemical techniques, the ubiquity of chemical compounds in spirits, and the leadership and resilience of the women in these roles.

■ ACADEMIC SUCCESS

The topic of whiskey is highly interdisciplinary and can be approached from political, economic, religious, and biological perspectives in addition to its chemical relevancy. For example, artificial intelligence is being used to help consumers identify whiskeys that may be suitable for their palate through an app and to create recipes for distillers based on consumer preferences.^{36,37} Technology-based applications such as this are engaging for students. The integration of technology is current, but historically whiskey has been an active topic in the study of chemistry. Studies highlighting the distillation process and investigation of compounds can be found from the early 1900s.³⁸ Since that time, a myriad of publications have discussed whiskey in relation to chemistry.^{39–42} This context provides a useful entry point to introduce students to the distillation process or analytical techniques to remind them that the information they learn is important in industry. A few of these published investigations have involved students in whiskey flavoring investigations and other processes to engage them in their courses and research.^{42–46} The topic of whiskey ties into the organic chemistry laboratory quite nicely. Both distillation and filtration are paramount to the production of whiskey. The Lincoln County Process that was perfected by Green is often credited with the unique flavor of Tennessee Whiskey.⁴⁷ This process involves filtering the whiskey through charcoal, a process often used by chemists. Dilution is another technique that is intrinsic to whiskey production and consumption. The amount of water in whiskey can alter the flavor profile when drinking whiskey, and chemistry has explanations for this phenom-

on.^{48,49} Analytical techniques such as mass spectrometry, gas chromatography, and dispersive liquid–liquid microextraction have also been introduced in the context of whiskey chemistry in advanced laboratories.^{46,50–52} Because of the great variety of questions that can be posed from the perspective of the chemical concepts, techniques, or chemical interactions in whiskey, whiskey chemistry is applicable in courses from general chemistry to advanced courses. Publications on this topic are skewed toward laboratory activities. Transitioning this type of work to the lecture in a culturally relevant manner can assist students in connecting the concepts with the applications from a different perspective. I shared the story of Nearest Green and Fawn Weaver with my students as a model for a special project that discussed chemistry in a social or cultural context. This spurred the students to think about other topics that are related to organic chemistry that were important or interesting to them. They then performed research and created problems based on the specific organic molecules that were pertinent to their topics (further discussed in [Implementation of CRP in the Curriculum](#)).

■ SOCIAL AND POLITICAL INEQUITIES

Although Weaver has successfully launched the Uncle Nearest brand, the spirits industry is not known as a space for Black women. Weaver is on a mission to change that by spearheading efforts for racial equality and justice in the whiskey industry. She has partnered with the Jack Daniels brand on The Nearest and Jack Advancement Initiative. It proposes the creation of the Nearest Green School of Distilling, a Leadership Acceleration Program, and a Business Incubation Program to increase the number of women and minorities in the industry.⁵³ This three-pronged approach will reach individuals at different points in their careers from variety of backgrounds. Weaver hopes the approach will not only assist in creating a pipeline into the whiskey industry but also help put women and people of color in leadership roles in existing companies or their own start-ups. The Kentucky Distillers' Association Lifting Spirits Foundation is another entity looking to advance women and people of color.⁵⁴ They fund scholarships at the University of Kentucky's distillation, wine, and brewing studies program.

Victoria Eady Butler, the great-great-granddaughter of Nearest Green, is the master blender at Uncle Nearest Whiskey distillery. Weaver reached out to Green's descendants when she set out to blend whiskey in his legacy. Butler accepted the offer and fortuitously ended up in her current position after showing an affinity for the job.⁵⁵ Butler's title directly opposes the whitewashed, masculine reputation of the spirits industry by centering Black leadership and honoring the contributions of a master Black distiller. In a restorative justice vein, Butler is also the director of the nonprofit Nearest Green Foundation, which offers full scholarships to the descendants of Nearest Green that desire to attend any college through the PhD level. Samara Rivers is another woman advocating for equity in the whiskey industry. She created the Black Bourbon Society to celebrate Black whiskey drinkers because she noticed that whiskey brands were not acknowledging this population.^{56,57} Marketing and branding for whiskey companies primarily focuses on white males and takes little notice of Black people, especially Black women. Until the Civil Rights movement, whiskey marketing often contained racist imagery that belittled and mocked Black people. Rivers has worked to target Black whiskey enthusiasts in hopes of illuminating the value of this demographic, a direct contradiction of historical marketing efforts. She thinks reaching

out to this untapped consumer base can also offer opportunities to increase diversity and inclusion in the spirits industry and innovation by bringing new ideas and experiences to the space. Highlighting the career pathways and opportunities available in this dynamic industry can contribute to the diverse applications of chemistry that students are aware of and can connect to their learning. Joy Spence, the first woman in the spirits industry to earn the title of Master Blender, started her career as a chemist at Appleton Estate before going on to win the National Medal of Science and Technology for work in highlighting Jamaican rum. A budding chemist may find inspiration in her story or that of Fawn Weaver as they find their own career paths.

■ RESOURCES AND IDEAS FOR INCORPORATING CRP FOR NEW PRACTITIONERS

If one wishes to include CRP in their chemistry classroom, there are several ways to go about it. As with any teaching innovation, faculty should reflect on what they want to achieve by using this pedagogy and carefully plan how they will incorporate it into the curriculum. It is often best to start slowly and build up class content so that there is time for reflection and revision after implementation. For CRP, it is logical to frame instructional activities around resources that connect chemistry to everyday life, include aspects of culture, or social justice. As an organic chemist, I have utilized several resources. These resources can serve as a meaningful starting point in creating course content that operationalizes CRP. NOVA has a video series, Percy Julian: Chemistry and Civil Rights, that highlights Julian's scientific achievements in synthesizing cortisone from soybeans and his total synthesis of physostigmine, used to treat glaucoma.⁵⁸ Although these are just a few of his accomplishments, Julian is often referred to as The Forgotten Genius, also the title of a 2007 NOVA film,⁵⁹ because many of his scientific advancements are not commonly recognized.^{60–62} This omission is not an anomaly. The literature describes a high rate of scientific novelty among underrepresented groups in science and discusses how their ideas are discounted and their achievements are not widely recognized.⁶³ The NOVA series also addresses social justice as it includes videos about Julian's academic career in the segregated US and his successful enterprise in employing other Black chemists through his chemical company synthesizing steroid intermediates, although he was often targeted in racial attacks. I have included Julian's work in the organic chemistry curriculum and highlighted the achievements and adversity he faced. This served to implement CRP in my courses to foster academic achievement within a cultural and sociopolitical context. The videos can be watched during class or outside class with an in-class discussion or contextual questions can be included on assignments. A more in-depth discussion into the challenges that currently face Black and other minority chemists can also be supported by literature sources.^{4–8} If the instructor is comfortable with a video that is more controversial, the Comedy Central series "Drunk History" also has an episode where Percy Julian is played by Jordan Peele, a popular comedian among college age students. This video features a slew of compounds synthesized by Julian who had over 100 patents in his career.⁶²

Another source that can be used to bring relevant chemistry into the classroom includes the infographics found on the Compound Interest site.⁶⁴ They include topics from whiskey to wet dog smell and explain the chemistry behind the topic or phenomena. They also have categories such as chemical concerns, chemical warfare, and chemical history that group

topics of interest in society. The chemical history has three infographics containing women in chemistry including three Black women chemists. I plan to incorporate a similar project in my course where students create infographics of current Black women scientists. In this way, students can construct knowledge from a cultural perspective that also allows them to become aware of scientists who look like them. Faculty can also take a few minutes in class to ask students what hot topics in the media are related to chemistry. One instance of this in my classroom brought on a discussion about a viral video of a woman who was trending because she had gorilla glue stuck in her hair. We discussed possible solutions she should try and the discussion was continued through the culmination of the issue in which a surgeon, with a background in chemistry, created a solvent to safely remove the glue without harming the individual's scalp.⁶⁵

■ IMPLEMENTATION OF CRP IN THE CURRICULUM

Over the course of the past few years, I have incorporated culturally relevant activities and discussions in the organic chemistry I and II lecture at Spelman College through both informal discussion and formal assignments. The whiskey infographics from Compound Interest assisted me in designing a special project in my organic II lecture during the spring of 2021. The maximum course enrollment is set at 40 for the organic II course in the spring. The class was held virtually, and the project allowed students to review the concepts of the course in a real-world context. This multimedia assignment contained a group and individual component and allowed students to select a topic that was related to chemistry that also had cultural or social relevance. In their project presentation, students discussed the relevance of the topic and then related it to organic chemistry. They had to highlight chemical information related to their topic and the chemistry of the functional groups within their topic including alkenes, alkynes, aromatics, carbonyls, and carboxylic acids derivatives. They also had to discuss an additional element that they found interesting about the topic such as alternative job opportunities or the relationship between the topic and laboratory techniques. To illustrate the requirements for the project, I created a model presentation based on Uncle Nearest Premium Whiskey, which highlighted the historical achievements of Nearest Green and the current leadership of Fawn Weaver that have been discussed in this manuscript. The model highlighted several chemicals containing different functional groups that are produced in whiskey production or added for flavor and aroma. The model also connected the chemical techniques involved in whiskey distilling, career opportunities, and scholarships in the field. I presented the model during class to introduce the project. After viewing the model, students worked in groups of four to select their own topics, which included the following: Cigarettes and Vapes, Chemistry and the Social Impact of Plan B, Rainbow within Chemistry-Dyes, Organic Farming and Pesticides, Cannabis and Prison Reform, Maternal Death and Pregnancy Hormones, Opioid Epidemic, and Snowfall and the Crack Epidemic. Students input their topics in a shared document so that no groups would have the same topic. While the group portion of the project primarily focused on the cultural/social relevance, the individual portion of the project emphasized the academic achievement tenet of CRP. Students had to create three exam-type questions related to the compounds in their project at a basic, moderate, and challenging level. Models were also provided for the questions with the challenging question being a multistep synthesis that required the application of

several reactions reviewed in the course. In addition to creating the problems, the students also had to provide answers and an explanation/strategy for solving each question. They conferred with their group to make sure none of their questions were similar.

STUDENT FEEDBACK

In the spring of 2021, students gave feedback, as a type of formative assessment, on the nontraditional assessments and assignments in the organic lecture relating to culture via an anonymous survey. From the 40 students enrolled in the course, 32 provided course feedback. Of the 32 survey respondents, 91% said they felt that the course was relevant to their lives or experiences. While the sample size is small, the consistency of such responses stands out. Indeed, 10 of the 32 respondents used some level of superlative, such as “very relevant” or “super relevant” to describe their perception of the course material to their life experiences. The emphasis on content learning related to student interests and experiences is an example of culturally sustaining pedagogy that places the lives and communities of marginalized students front and center in the curriculum.¹⁸

A separate survey question prompted students to reflect on whether the culturally relevant assignments and assessments had an effect on their feelings about the organic chemistry course. Responses in this case were arguably less enthusiastic but still reflected a broad sense of student appreciation for providing real-life applications for the chemistry content. This formative assessment assisted in the development of teaching resources. The data collection on culturally relevant teaching in organic chemistry was approved through the Spelman College Institutional Review Board.

CONSIDERATIONS AND IMPLICATIONS

Fawn Weaver’s dynamic story and activism offer an opportunity to engage CRP in a way that centers successful women in the male-dominated whiskey industry and also provides a model for social change. Integrating narratives such as this into chemistry courses can initiate conversation and engage students in meaningful ways; however, this undertaking should be done in a reflective manner. Cultural competence is required to engage with students from different backgrounds in a way that is respectful and effective.^{66,67} Engaging in this work can also involve polarizing topics. Brown University has created a resource guide for discussing controversial subjects in the classroom so that opposing perspectives are acknowledged and the practice of civil discourse can be demonstrated.⁶⁸ Many of the topics that are relevant to student’s lives may be controversial; however, these are the type of topics that often require political action. Tackling controversial topics from a perspective of teaching and learning allows students to develop their voices and gain confidence as individuals capable of initiating social change.

As a Black woman myself, the story of Fawn Weaver is inspirational. Although she is not a chemist, she made me more interested in researching the chemistry of whiskey. Her role in diversity and equity efforts opened my eyes to new pathways for inclusion in chemistry fields. She has blazed her own path in a way that has uplifted others, set a model for inclusivity in the top ranks of a successful corporation, and demonstrated social change. I think her story would engage all students while centering women in an industry that is fueled by chemistry.

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Notes

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