

Employing Culturally Relevant Curricula and Pedagogy to Address Equity Gaps in
Science Teacher Preparation across Two Programs

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&

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Abstract

Equity gaps in education are attributed to factors including 1) limited opportunities for students to address issues relevant to marginalized communities and 2) few teachers of color. To address both gaps, it is recommended that teacher education programs incorporate culturally relevant pedagogies (CRP), including those that explicitly address racism and other forms of discrimination. Many teacher educators, however, struggle to model CRP within discipline-specific instruction; few curricula exist for this purpose.

This study will investigate the impact of course revisions foregrounding CRP in discipline-specific science methods courses across two teacher education programs. We intend to: (1) incorporate curricular revisions that model CRP into science methods courses; (2) evaluate the impact of these revisions on students' critical consciousness as a measure of their capacity to enact CRP; (3) evaluate how curricular revisions influence students' perceptions of CRP; and (4) explore how CRP might contribute to a sense of belonging among students traditionally marginalized in science and education. To address our research questions we will employ a mixed-methods design.

The overarching goals of this research are to address equity gaps in 1) K-12 education and 2) teacher preparation that extend from limited opportunities for current and future teachers to engage in culturally relevant instruction. Faculty within the Cato College of Education will be able to use these findings to meaningfully revise discipline-specific teacher preparation programs. Findings may also inform efforts underway in other colleges to modify curricula and instruction to more closely align with culturally relevant approaches to teaching and learning.

Budget Request Page

January 15, 2022 to June 30, 2023

***BUDGET:** Request by budget category. Joint proposers must select one PI to be the lead and one department to receive this allocation.*

Lead Principal Investigator: Daniel M. Alston

Principal Investigator 800#: 800964089

Title of Project: Employing Culturally Relevant Curricula and Pedagogy to Address Equity Gaps in Science Teacher Preparation across Two Programs

Allocate operating budget to Department of: Reading and Elementary Education

Fiscal Year One (January 15, 2022 to June 30, 2022)		
Faculty Stipend	Paid directly from Academic Affairs fund on May 15, 2022	\$3,850
911250	Graduate Student Salaries	
911300	Special Pay to Faculty other than Grantee	
915000	Student (Undergraduate or Graduate) Temporary Wages	
915900	Non-student Temporary Wages	
920000	Honorarium (Individual(s) not with UNCC)	
921160	Subject Incentive Fee	

925000	*Domestic Travel (*All travel will be deferred until Year 2, 2022-2023)	--0--
926000	*Foreign Travel (*All travel will be deferred until Year 2, 2022-2023)	--0--
928000	Communication and/or Printing	
930000	Supplies	
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Contracted Services	\$165
Year One Subtotal		\$4015.00

Lead Principal Investigator: <u>Daniel M. Alston</u>		
Fiscal Year Two (July 1, 2022 to May 30, 2023)		
925000	Domestic Travel	\$3917.00
926000	Foreign Travel	
Year Two Subtotal		\$3917.00
TOTAL FUNDS REQUESTED (Year One + Year Two)		\$7932.00

Budget Narrative

To complete the proposed project, a total of \$7932.00 in financial support is being requested.

This will be a one semester project where data collection takes place in the Spring 2022 semester and the analysis and write up of the data will occur in Summer and Fall 2022. In the following Fiscal Year, plans to disseminate knowledge gained from the project will take place at the annual international conference of the Association of Science Teacher Education in Salt Lake City, UT. This project is in alignment with the intentions set forth by the SoTL grants program because it will focus on attending to the equity gaps in science education and teacher preparation, as well as improving students' sense of belonging in the fields of science and education.

Faculty Stipend (\$3,850.00)

A stipend of \$3,850 is requested in May of Fiscal Year 1 for the PI. The PI will be actively involved throughout the project (i.e., preparation and submission of IRB proposal in Fall 2021 and the instructor of record for two sections of ELED 3221 in Spring 2022). In addition, the PI will also be heavily involved in the analysis of the quantitative and qualitative data and the preparation of conference presentations and manuscripts in Summer and Fall 2022. Lastly, in Spring 2022, the PI will co-present findings from this project at the annual International Conference of the Association of Science Teacher Education.

Other Contract Services (\$165.00)

In order to transcribe the reflective interviews at the end of the semester, a transcription service (Temi) will be enlisted. Each interview will be approximately 60 minutes in length. Temi charges \$0.25 for every minute of audio and with approximately 480 minutes the transcription will cost for the interviews will be \$120. In addition, class discussions following the three curricular revisions will be recorded and transcribed at a cost of \$45.

Fiscal Year Two (\$3917.00)

In order to disseminate the findings from this project at the annual international conference for the Association of Science Teacher Education, the PI and co-PI are requesting travel funds. The co-PI, Dr. Crabtree, is an adjunct professor in Cato College of Education Department of Middle, Secondary and K-12 Education and the author of the critical inquiry narrative case study (Curricular Revision #3) that will be used in the project. Her research focuses on the potential for scientific inquiry and place-based pedagogies to support critical consciousness development among teachers and students. Dr. Crabtree will conduct the reflective interviews of Dr. Alston's students and will be the instructor of record for MDSK 6351. Further, the co-PI will assist with the data collection, analysis, and the development of manuscripts, proposals, and presentations that result from the data. The PI and co-PI plan to externally disseminate findings from this study at the annual International Conference for the Association of Science Teacher Education. This four-day conference will take place in Salt Lake City, UT in January 2023. To pay for registration (\$270), airfare (\$600), hotel lodging (\$2281), parking (\$56) and meals (\$336), Drs. Alston and Crabtree are requesting \$1958.50/person or a total of \$3917.44.



October 25, 2021

Dear SoTL Committee Members,

I am pleased to offer my support for the SoTL grant proposal, “Employing Culturally Relevant Curricula and Pedagogy to Address Equity Gaps in Science Teacher Preparation across Two Programs”, submitted by Dr. Daniel Alston and Dr. Lenora Crabtree. In the Cato College of Education, we recently underwent a redesign of all teacher preparation programs. As such, we sought to make changes that enhance current and future teachers’ awareness of and attention to equity. In Spring 2020, in response to the redesign, the project’s PIs sought to infuse a greater emphasis on equity into a course designed to prepare future elementary school teachers to teach science to young learners (ELED 3221). During this pilot work, equity literature and discussions were employed to support teacher candidates’ understanding of ways systems of oppression function within science. In addition, students engaged in a narrative case study exploring environmental justice to experience how an elementary science teacher might use Culturally Relevant Pedagogy in a classroom. As such, this proposed, multi-program project seeks to explore how current and future teachers’ experiences with culturally relevant and responsive teaching and learning supports their capacity to teach and their perceptions of culturally relevant and responsive curricula. Additionally, the PIs of this project also seek to positively impact students’ sense of belonging in the field of science, the field of education and in the Cato College of Education. With these goals in mind, this project can positively impact the K-12 equity gap in science education and in the equity gap in the field of education.

This proposed project supports the college’s vision to be a leader in educational equity through excellence and engagement. It is also in alignment with our recent teacher preparation redesign. I look forward to learning about the outcomes of this project.

Sincerely,

A handwritten signature in black ink that reads 'Teresa Petty'.

Teresa Petty
Interim Dean, Cato College of Education
UNC Charlotte

Project Narrative

PROJECT NARRATIVE

A. Specific Aims

1. Purpose

Equity gaps in science education are attributed to several factors including 1) few opportunities in science, for students to address issues relevant to marginalized communities and 2) limited numbers of teachers of color in science classrooms. To address persistent equity gaps in K-12 classrooms and the science teaching workforce, it is recommended that teacher educators incorporate culturally relevant pedagogies (CRP), including those that explicitly address racism and other forms of discrimination. While *foundational* education courses across programs in Charlotte's Cato College of Education (CCOED) have been restructured to foreground CRP, redesigning *methods* courses is an ongoing task. Models of culturally relevant science curricula and instruction are especially rare. The purpose of this project is to assess the impact of curricular revisions that foreground CRP in discipline-specific science methods courses on students' 1) capacities to enact CRP and 2) sense of belonging in teacher education and science.

2. Objectives

The objectives are:

- 1) Implement curricular revisions that foreground CRP in science methods courses across two programs, offered in varied formats, at the undergraduate and graduate levels.
- 2) Assess the impact of the revised curriculum and instructional methods on students' critical consciousness as a measure of their capacity to enact CRP.

- 3) Evaluate how curricular revisions that foreground CRP influence students' perceptions of culturally relevant teaching and learning.
- 4) Explore how curricular revisions that foreground CRP might contribute to a sense of belonging in teacher education generally, and science teaching specifically, among students traditionally marginalized in science.
- 5) Disseminate findings to methods instructors throughout CCOED and across science disciplines at Charlotte, and to the broader teacher education and science education communities.

3. Research Questions

The research questions for this study are:

- 1) What impact does the inclusion of curricula and teaching practices that foreground CRP in discipline-specific science methods courses have on students' critical consciousness?
- 2) How do varied curricular innovations that foreground CRP influence students' perceptions of culturally relevant teaching and learning?
- 3) How does incorporating CRP in discipline-specific science methods courses impact students' sense of belonging in science and education?

4. Rationale

The curricular innovations implemented and evaluated through this research will support the capacity of students in science methods courses across two programs to engage in culturally relevant science instruction in their current, and future classrooms. In addition, findings from this

research will inform teacher preparation in science and other disciplines within CCOED.

Ultimately, this multi-program study has the potential to address equity gaps in science education and other disciplines.

Equipping educators to engage in “culturally sustaining pedagogies that challenge systems of oppression” (CCOED Statement on Racial Justice, 2020) is central to the mission of CCOED. As members of the Education Preparation in Action Cadre (EPAC), a group convened to further the equity vision of CCOED, the PI and co-PI have been involved in efforts to attend to equity in discipline-specific methods instruction. Preliminary data from implementation of course revisions in ELED 3221 reveal heightened interest in teaching science among Teacher Candidates and excitement around ways justice-oriented curricula might support student engagement. Limited empirical research, however, has been conducted. This project also aligns with the college’s commitment to “recruit and retain a more diverse student body” (CCOED Statement on Racial Justice, 2020). Curricular innovations that address ways racism and other forms of discrimination have restricted access to science, but also highlight how marginalized individuals have engaged in science, have the potential to promote a sense of belonging in science *and* teacher education. Evaluating the impact of these innovations will increase our knowledge of how to support the entrance and persistence of students from diverse backgrounds into the teaching profession in general, and science education, specifically.

Focusing on students’ sense of belonging aligns with work being done within the Student Experience Project and may contribute to efforts to address equity gaps at the university level. Opportunities to explore issues of concern for marginalized communities (i.e., CRP) support student interest, engagement, and persistence and contribute to a sense of belonging. Subsequently, evaluation of the curricular innovations employed through this research may

inform faculty engaged in similar efforts across the university.

5. Impact

The goal of this project is to address equity gaps in science education and teacher preparation. The proposed study will attend to that goal by evaluating how three curricular interventions 1) support the capacity of 60 undergraduate and graduate students in science methods courses across two programs in CCOED to enact CRP and 2) contribute to a sense of belonging in science and teacher education among students' whose identities have been marginalized in those fields. Teacher educators and others may use these findings to inform similar curricular innovations in other discipline-specific contexts.

B. Literature Review

Equity in science education is essential in our changing society (Atwater et al., 2014). As researchers continue to explore how equity gaps in science and engineering might be addressed, they highlight opportunities for K-12 students to engage in meaningful science education as central to this goal (Duschl et al., 2007; Fouad & Santana, 2017). In accordance, experts in science education (e.g., Brown et al., 2018; Mensah, 2011; Morales-Doyle, 2017) and science teacher education (e.g. Underwood & Mensah, 2018) point to the conceptual framework of CRP which emphasizes student learning, cultural competence, and the development of students' socio-political consciousness (Ladson-Billings, 1995, p. 476).

Although CRP is often mistakenly described as a strategy through which educators incorporate facets of a student's home culture to support their learning, Ladson-Billings (2009) conceptualized culturally relevant curriculum and instruction as that which "[prepares students to question] the structural inequality, the racism, and the injustice that exist in society" (p. 140). To further explore this idea, Ladson-Billings (1995) points to the concept of critical consciousness,

the ability to “recognize, understand, and disrupt inequitable systems” (Freire, 1970, p. 80). Systems of oppression are complex and varied; in addition to race, dimensions including gender, class, and sexual identity play important roles (Collins, 2017). A lack of critical consciousness limits the capacity of teachers to enact CRP (Ladson-Billings, 2011).

Current and future science teachers need opportunities to consider the role of science in the perpetuation of systemic inequities and how it might be leveraged to create a more just and equitable society (Morales-Doyle, 2017; Sheth, 2019). In a study of pre-service teachers enrolled in CRP-infused science methods courses, participants with heightened critical consciousness were more likely to 1) employ an asset frame when discussing students and 2) recognize the importance of supporting students’ socio-political consciousness (Jones & Morgaen, 2021). Approaching science education through a critical lens is especially important for those who have been marginalized by race. According to Mensah and Jackson (2018), “due to their educational experiences, both teacher educators and science teacher educators must be open to interrogating and revealing the structural forms of race, racism, and power that manifest through curriculum and pedagogy and cause alienation and exclusion for pre-service teachers of color in their educational history” (p. 31). Additional research is needed to explore how science teacher educators might employ CRP and other critical frameworks to support critical consciousness development among current and future teachers, and increase a sense of belong for those whose identities have been marginalized in science and education (Brown & Crippen, 2017; Mensah & Jackson, 2018; Underwood & Mensah, 2018).

C. Methods

Study Participants

The participants will be students enrolled in the following science methods courses in Spring

2022. Each course will include curricular revisions that forefront CRP.

- ELED 3221: Teaching Science to Elementary School Learners
 - Instructor: Daniel Alston
 - 100% Face to Face
 - 50 undergraduate students

- MDSK 6351: Advanced Methods in Middle and Secondary Science
 - Instructor: Lenora Crabtree
 - 100% Synchronous Online
 - 10 graduate students

Common Course Elements and Data Sources

This proposal's unifying focus is on how three curricular revisions forefronting CRP support pre- and in-service teachers' capacity to enact CRP, as well as their sense of belonging in the fields of science and education. All courses will include the following elements:

Curricular Revision #1: Students will engage in a modified version of the Draw a Scientist (DAST) activity (Chambers, 1983). Given a prompt, students will draw a scientist and discuss the stereotypes exhibited. To further explore how racism and sexism have historically limited opportunities in science, students will read two biographical trade books and compose a reflection that explores how the discussion and readings influence their perceptions of science.

Curricular Revision #2: Students will read *Oppression by Scientific Method: The Use of Science*

to *Other Sexual Minorities* (Mohr, 2009) and engage in an online discussion around ways science has been used to perpetuate dominant narratives. Following the reading and discussion post, the instructors will facilitate a synchronous discussion to further explore historical systems of oppression in science that target individuals who identify as LGBTQ+.

Curricular Revision #3: Students will engage in an instructional case study (Crabtree & High, 2019) that examines the origins of the environmental justice movement in Warren County, NC and respond to questions designed to prompt their thinking about how people from historically marginalized populations have engaged in science (i.e., seen science as meaningful to their communities) and used science to challenge systems of oppression.

Contemporary Critical Consciousness Survey: At the beginning and end of the semester, students will complete an online survey designed to measure critical consciousness (Shin et al., 2016).

Reflective Interview: At the end of the semester, instructors will use purposeful sampling to identify and interview 8 students who may have experienced marginalization in science or education due to aspects of their identity (i.e. race, ethnicity, language, gender). Interview questions will be open-ended and offer participants opportunities to reflect on their experiences in science and education historically, and during this discipline-specific methods course.

Analysis

We will use a mixed-methods approach (Creswell & Plano Clark, 2017) to assess this

project's impact on : 1) participants' perceptions of and capacity to enact CRP and 2) participants' sense of belonging in the fields of science and education. Quantitative analysis will focus on pre- and post-critical consciousness survey scores. We will use a dependent t-test to determine whether participants' critical consciousness changed across the time period in which they were enrolled in the science methods course. Qualitative data including: 1) transcripts of class discussions; 2) course artifacts (online discussions, reflections, and responses); and 3) interview transcripts will be analysed using a constant comparative approach (Glaser, 1965). Through this coding process, we will identify themes related to students' experiences of CRP in the science methods courses. Findings and conclusions will be drawn from analysis of quantitative data (critical consciousness surveys, N = 60), qualitative data (class discussions and other course artifacts; N = 60), and interview data (N=8).

Limitations

While we acknowledge the benefits of enacting this study across two programs within CCOED, we acknowledge that a cross-program study has limitations. For example, the two courses involved in this study are offered to future (ELED 3221) and current teachers (MDSK 6351) with varying degrees of classroom experience. Further, Dr. Crabtree's expertise is in urban education and she often forefronts equity in her teaching. Factors, such as these, could confound our analyses. To attend to these limitations, we have focused our study on common course elements and data sources. Additionally, the open-ended nature of the interviews will provide insights into which aspects of a course students perceive to have significant impact. To attend to potential limitations resulting from the professor-student dynamic, reflective interviews for ELED 3221 will be conducted by Dr. Crabtree, while Dr. Alston will conduct interviews for MDSK 6351. Participants will be informed that responses will have no bearing on course grades.

D. Evaluation

The success of our project will be assessed using data collected via the critical consciousness survey; recorded class discussions; online discussions, reflections, and responses; and reflective interviews. We expect to see a positive change in critical consciousness, and by inference, increased capacity to enact CRP. We also expect qualitative data to inform how engaging in culturally relevant teaching and learning relates to improved critical consciousness, changes in perceptions of CRP, and a sense of belonging in the fields of science and education. Thus, our project will be evaluated on whether it: 1) affects change in students' critical consciousness, 2) improves perceptions of CRP and 3) increases a sense of belonging in the fields of science and/or education among students who identify with marginalized groups.

The following table illustrates the alignment of our data sources and the research questions/objectives. Sample questions are included to provide a clearer picture of how the research questions will be addressed.

Research Question / Objective	Data Source(s)	Sample Questions/Items
What impact does the inclusion of curricula and teaching practices that foreground CRP in discipline-specific science methods courses have on students' critical consciousness?	Contemporary Critical Consciousness Measure (CCCM)	<ul style="list-style-type: none">● Most poor people are poor because they are unable to manage their expenses well.● The overrepresentation of Blacks and Latinos in prison is directly related to racist disciplinary policies in public schools.● Gay, lesbian, and bisexual individuals should have all the same opportunities in our society as straight people.

<p>How do varied curricular innovations that foreground CRP influence students' perceptions of culturally relevant teaching and learning?</p>	<ul style="list-style-type: none"> ● Recorded class discussions ● Online discussions, reflections, and responses ● Reflective interviews 	<ul style="list-style-type: none"> ● Historically, how have opportunities for people to participate in science been impacted by their identity? In what ways are limitations still present? ● How might a teacher support students' understanding of the potential for science to oppress or liberate?
<p>How does incorporating CRP in discipline-specific science methods courses impact students' sense of belonging in science and education?</p>	<ul style="list-style-type: none"> ● Recorded class discussions ● Online discussions, reflections, and responses ● Reflective interviews 	<ul style="list-style-type: none"> ● Describe some of your experiences with science as a K12 student. ● In what ways were the activities in which you participated in this course similar to your previous experiences? How were they different? How did this experience impact your thoughts and feelings around teaching science?

E. Knowledge Dissemination

We plan to disseminate the results from this study in the following ways:

- Campus:
 - Share research findings with REEL and MDSK faculty to inform ongoing initiatives among teacher educators.
 - Present findings to other programs in CCOED during a college-wide faculty meeting.
 - Share our research process and findings with members of CCOED EPAC
 - Present findings at Charlotte's 2022 SoTL Showcase

- Publications:
 - Prepare and submit manuscripts to peer-reviewed journals. Target journals include the *Journal of Science Teacher Education* and *Cultural Studies in Science Education*.
- National/International Presentations:
 - Present findings at the Association for Science Teacher Education (ASTE) conference.

F. Human Subjects

If our proposal is accepted, we plan on submitting an IRB for approval.

G. Extramural Funding

While no extramural funding is currently being sought for this study, the results from this study may be used to seek additional funding in the future.

H. Timeline

Fall 2021	Finalize curricular revisions and apply for IRB approval
Spring 2022	Systematically collect data through the semester
Summer 2022	Process and analyze data
Fall 2022	Prepare manuscripts(s) and presentation(s)
Spring 2023	Present findings and finalize publication(s)

References

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