Introduction

The teaching of paleontology usually emphasizes an understanding of key concepts in the discipline (evolution, extinction), applications (biostratigraphy), and skills (fossil identification). Traditional lectures and labs have changed focus over the years as the discipline has expanded into new subfields. Technological advances have allowed for more complex approaches in both research and instruction. Growing knowledge of best practices in education has increasingly inspired the use of active learning strategies to better engage students in the classroom. However, as a discipline, we remain relatively unchanged, in that we are not doing enough to address the lack of diversity in our profession. This crisis can no longer be ignored.

The Crisis

The need for diversity in Science, Technology, Engineering, and Math (STEM) has gained attention over the last few decades, yet geosciences as a discipline remains alarmingly low for participation by underrepresented groups including women, people with disabilities, and racial/ethnic minorities (Huntoon & Lane, 2007; Velasco & Jaurrieta de Velasco, 2010; Stokes et al., 2014). Data evaluated by Bernard and Cooperdock (2018) from the NSF Survey of Earned Doctorates reported that between 1973 and 2012, while PhDs awarded to White women notably increased, numbers for minority groups overall have remained consistently low. Data from 2012 showed a breakdown of PhDs by race/ethnicity as 86% (White), 4% (Hispanic/Latino), 3% (Asian or Pacific Islander), 2% (Black), 2% (more than one race), 2% (unknown), and 1% (American Indian/AK Native). In the early 2000s, women represented only 16 percent of faculty in the geosciences (Holmes et al., 2008), and in the Paleontological Society, at the professional level (i.e., not including students), only 23 percent of the membership were women (Stigall, 2013). It is also painfully obvious year after year in attending conferences (e.g., Plotnick et al., 2014, on gender representation at the North American Paleontological Convention) that we are a homogenous group especially in regards to race/ethnicity and that our discipline may not be inclusive to all individuals. Volunteered data collected in 2017 as part of membership database updates for the Paleontological Society revealed similar demographic patterns of concern from the 20 percent response rate of members (Appendix A).

Furthermore, public perception of paleontology is muddled. Our discipline is often referred to as esoteric or merely futile "stamp collecting" with little or no value in addressing the challenges of our modern world. To be excited by the allure of dinosaurs is embraced in childhood, but paleontology has repeatedly

been in danger of being deemed a science that is not worth investing in when government funding is scrutinized. We, as professionals, recognize how fossils have been instrumental in defining geologic time, correlating strata across distances, providing materials for economic resources (coal, natural gas, oil), as well as in examining evolution and how species respond to change, which is particularly relevant to the many issues we presently face as climate change and anthropogenic impacts alter our world. Yet, often the public is unaware of the utility of the fossil record in these important ways. I say all of this here because we, as paleontologists, need to better communicate our science to the masses, and that starts in the classroom with each and every student we encounter from the general introductory course to the graduate level. To effectively reach *all* students however, we must improve our pedagogical approaches, reflect on the nature and structure of our discipline, and ask whether we are being inclusive in our actions or whether we may be, in fact, unwelcoming. Thus, while it is essential to demonstrate the relevance of paleontology to all audiences (extending far beyond simply educating the next generation of paleontologists), we must also prioritize broadening participation in our discipline as well. Having professionals that represent a range of abilities, backgrounds, and identities is critical for a variety of reasons.

Research has shown that diversity is essential for bringing new perspectives to scientific problems (Wilson, 1992; Medin & Lee, 2012; Guterl, 2014; Phillips, 2014; Smith-Doerr et al., 2017; Powell, 2018), and in order to promote creativity and progress, we must work harder to lift up groups that are traditionally underrepresented in our field. Furthermore, diversity is the future. The US Census Bureau projected that by 2020 more than 50 percent of children are expected to belong to a minority racial or ethnic group as part of a so-called 'browning of America' (e.g., Chávez & Longerbeam, 2016), and as recently as 2015, a shift is already apparent in the next generation, in that babies of color now make up more than half of all new births in our nation. Slowly, we are seeing this shift in the makeup of college students, making it imperative to ask whether our existing pedagogy is effective in diverse classrooms. Even if an institution is predominantly composed of a particular racial group or socioeconomic class, mindfulness in our approaches to be more inclusive is critical in strengthening the importance and place that diversity has in science and in the public view. This need is not merely a "goal" per se, but as with all work in broadening participation, making it a *priority* is essential (Inclusive Astronomy, 2015). We must realize as educators, that who we are as individuals matters in all aspects of our lives, and in guiding the future of our discipline, we must work first to understand barriers that contribute to the homogenization of our field, and then consider how to improve things as practitioners in the classroom.

Obstacles

Why does the lack of diversity exist in the geosciences and related STEM fields? There are many contributing factors (see Inclusive Astronomy, 2015, for an in depth review of common barriers), and while we may not be able to address all barriers in the classroom, acknowledging the ways in which monocultural views of our field impact our ability to broaden participation is an important first step. The history of our discipline, how it is perceived, and how it is portrayed in popular media has led to the characterization that paleontologists are often composed of rugged (White) males who work in remote field locations dusting off dinosaur skeletons under intense conditions. This depiction does not reflect the spectrum of what paleontologists do or who we are, although admittedly, able-bodied, cis-gender White males have dominated the discipline especially in how the field is presented from a Eurocentric view; that is, in how the history of paleontology has largely focused on Western civilization. There are females and members of underrepresented groups who have contributed to paleontology, but until recently (e.g., Gold & West, 2017; Stricker, 2017; Bearded Lady Project, 2018), very little attention was given to these individuals aside from Mary Anning of England. As a result, even if students belonging to minority groups are interested in fossils, it may be that they are unable to visualize paleontology as a viable career option. Such students may not feel as though they "belong," and might fall victim to inherent biases such as 'stereotype threat' or 'imposter syndrome' as has been reported across STEM fields (Steele, 1997; Gonzales et al., 2002; Huntoon et al., 2015). STEM identity is a leading factor known to contribute to retention issues for underrepresented groups (e.g., LGBTQ students, Hughes, 2018), and this problem is indeed pervasive in geosciences (Black, 2019; Goldberg, 2019). Students from diverse backgrounds also may not have gained the necessary academic preparation to succeed in pursuing careers in STEM (Seymour & Hewitt, 1997) and/or may lack support or role models who might otherwise encourage their interests (O'Connell & Holmes, 2011, as reported for STEM). Public perception plays into this issue as well, in that first-generation students and people of color or of less economic means may have family members who do not actively promote an interest in paleontology as it may seem a frivolous or unsteady choice for employment compared to high-paying marketable jobs in medicine that are likely more promising or respected. Family criticism and fewer informal experiences in the outdoors have been cited as additional factors that may limit students of color from studying geosciences compared to their White peers (e.g., Stokes et al., 2014). In addition, students with less

privilege may be attending institutions that lack resources or opportunities to study the fossil record, which is why programs that specifically seek to expand access to authentic research such as the National Science Foundation Research Experiences for Undergraduates (REU) are so important, as students from across the nation, including at community colleges, can apply. Geosciences suffers even further due to the fact that Earth science is often not well represented at the K-12 level, leading to less exposure before students arrive at college, thereby limiting the potential for students to enroll in courses where they might learn about the fossil record in depth. See Stokes et al. (2015), Sherman-Morris and McNeal (2016), and Sexton et al. (2018) for additional information regarding perceptions that students have at the undergraduate level which factor into selecting geosciences as a potential major including differences related to gender and race/ethnicity. Furthermore, even if students initially show an interest in pursuing coursework or career paths in geosciences, factors such as racism, including that imposed by individuals (explicit and implicit), institutions, and society continue to contribute to the lack of diversity in the geosciences overall (Dutt, 2020).

While certain barriers mentioned here cannot be solved single-handedly by altering pedagogy in the classroom, what we can do is be mindful of these issues and consider how better we can address specific aspects of these challenges through student-centered instruction that is more likely to be welcoming to individuals from a variety of backgrounds and promote their success moving forward. Such culturally informed approaches are necessary regardless of the composition of the audience in a classroom, otherwise we continue to carry on the perception that paleontology is a discipline reserved primarily for privileged, able-bodied White males who want to work in the field on dinosaur bones. Bringing in diverse perspectives, emphasizing cultural connections, utilizing constructivism in building on any pre-existing knowledge of students, and fostering a sense of unity through collaborative work, are all steps in the right direction. Furthermore, we cannot rely on existing professionals from diverse backgrounds to carry the labor needed to serve as role models and advocate for underserved groups (Jimenez et al., 2019). We must all learn how to be more inclusive and promote diversity in our classroom if we are to overcome this crisis in our discipline. Understanding the inequities that exist and committing to a change in practice is essential in order to address the disparities that continue to affect the experiences of diverse students who have been underserved in their education (Williams & Lemons-Smith, 2009). This is critical not only as a social justice issue, in that all individuals should have opportunities and support to pursue any career path that they choose, but it is also vital for progress in scientific fields including paleontology.

A Call for Action

Teaching practices labeled as "culturally relevant" originated out of a desire to address achievement gaps of students who were not succeeding in US public schools, particularly individuals of color, lower Socioeconomic Status (SES), and English Language Learner (ELL) speakers. Ladson-Billings (1995, 2014) characterized the pedagogical approach as centered on principles of academic success, cultural competence, and sociopolitical consciousness. She acknowledged research by anthropologists in the 1980s who examined "culturally congruent," "culturally appropriate," "culturally responsive," and "culturally compatible" ways to strengthen connections between school and the home culture of a student to improve academic success. Her work initiated a movement of educational reform, and as stated in her culturally relevant pedagogy 2.0 'remix' paper, "Instead of asking what was wrong with African American learners, I dared to ask what was right with these students and what happened in the classrooms of teachers who seemed to experience pedagogical success with them" (Ladson-Billings, 2014, p. 74). Through that lens, we must examine the variety of approaches that integrate aspects of culture into a pedagogical framework for learning, as the research is clear: meaningful cultural connections and considerations of how people learn as related to culture can be effectively used to enhance the success of underserved students in the classroom (Irvin & Darling, 2005; Aronson & Laughter, 2016; Byrd, 2016).

Diversity, Inclusion, Equity, Culture: Definitions

The purpose of this Element is to highlight the homogenous nature of our discipline, acknowledge barriers to the success of underrepresented students, and put forth a call to action. The subsequent sections of the Element are divided into an emphasis on cultural competency in approaching pedagogy and expanding access to learners through inclusion and improved assessment practices, considerations for specific applications to make instruction of paleontology more meaningful through cultural contexts, followed by an emphasis on self-reflection prior to the final recommendations. However, before proceeding further, I offer a brief orientation into a few key concepts and language pertinent to discussions of pedagogy focused on diversity and inclusion in striving for equity in the classroom.

Diversity is often used as a way to specifically reference students who are diverse linguistically, culturally, and in regards to race and ethnicity (e.g., Adams et al., 2017). However, it can encompass many more aspects of a person's identity. Furthermore, it is critical to acknowledge that identities are intersectional (e.g., a male student may be cis-gender, straight, unmarried, neurodiverse, able-bodied, hearing-impaired, learning-disabled, Black, middle-class, Jewish, highly

educated, Hispanic, and uses pronouns they/them/theirs). It is important not to make assumptions or generalize students based on simplistic or narrow views of identities.

Inclusion focuses on ensuring that all individuals are valued in how classroom learning is constructed, especially students who might otherwise feel marginalized or excluded for any number of reasons. Typically, such practices involve strategies designed to remove impediments to learning in an effort to better meet the unique needs of all students. Classroom approaches are intended to better support and encourage participation by all learners such that students who vary in abilities, backgrounds, and identities feel as though they belong and can effectively engage in ways that promote their success in a community of learners.

Equity emphasizes providing learning opportunities and resources in support of all individuals in a classroom by recognizing that the "same" does not mean "equal" in regard to access, interests, and the needs of all individuals. Students might be disadvantaged coming into the classroom in knowledge or skills, could be resource-limited outside of school, vary in their ability and how to learn due to interpersonal, cognitive, or physical challenges, or perhaps unable to catch up or otherwise get ahead in their education for a variety of reasons. It may be the case that students of color or of lower socioeconomic status are further behind compared to their peers as a result of less access and opportunity prior to college, which is why it is critical to recognize students as individuals in order to address any disparities that may limit the success of all learners. To achieve more equitable classrooms that support a diversity of learners, approaches that are welcoming and inclusive of all individuals are essential.

Culture, as referenced in this Element, focuses primarily on the constructs of race and ethnicity and any related contexts such as language, beliefs, values, and norms. The purpose of this approach is to highlight culture as a means by which we can broaden participation of underrepresented groups in paleontology via improved cultural competency in our pedagogy (although characterizations of culture that are not explicitly linked to racial/ethnic groups are additionally included). Pedagogy that more specifically highlights accessibility and inclusion, particularly with respect to expanding diversity to include other forms of identity such as disabilities or how learners may vary in skill or processing and communicating knowledge, are also briefly woven into the discussions below.

Pedagogy of Culture and Inclusion

Theory and Practice

Teaching practices that incorporate culture are defined differently depending on how elements of culture are used in structuring pedagogy. Terms in the literature

that overlap conceptually in advocating for cultural competency as essential to education but are not quite equivalent in meaning include, although are not limited to, the following: culturally relevant (Ladson-Billings, 1995), culturally responsive (Wlodkowski & Ginsberg, 1995; Gay, 2000; Hammond, 2015), culturally strengths-based (Chávez & Longerbeam, 2016), culturally-revitalizing (McCartney & Lee, 2014), and culturally-sustaining (Paris, 2012; Paris & Alim, 2014). Even if authors use the same suite of words to label their pedagogy, that may not mean they are referencing parallel classroom approaches (see Brown-Jeffy & Cooper, 2011, and Aronson & Laughter, 2016, for a synthesis of research and practice that further explores several of the models referenced above). Specific practices highlighted in this Element emphasize different aspects of how culture can be considered as a foundation for improving student outcomes following recommendations described by Wlodkowski and Ginsberg (1995), Hammond (2015), and Gay (2018). Through this window into similar, yet different, visions of how culture can be used as an educational framework (as well as a note of caution below to avoid misinterpretations before practices are implemented), we can consider how best to effect change in paleontology upon desiring to be more equitable and inclusive to enhance the participation of underrepresented groups in our discipline.

Misconceptions

There are several misconceptions that many authors caution against in reflecting on how to adopt new classroom strategies that use culture as a means for broadening participation and promoting the success of diverse students that should be acknowledged before exploring how to proceed in practice. For example, if seeking to attract more Black students to the discipline, simply adding examples of paleontological discoveries in Africa that may be more appealing to that audience is not necessarily appropriate in isolation. Even though cultural relevance is desirable and should be incorporated, it is not enough to attempt to insert culture into learning but rather that learning should be offered within the context of culture (Pewewardy, 1993). Approaches that are *culturally responsive* go well beyond the use of examples that might appeal to certain audiences by considering *how* best people learn. In addition, simplistic interpretations of infusing culture into lessons can be problematic thereby requiring a paradigm shift in how culture is utilized in pedagogy (Sleeter, 2011, 2012; Ladson-Billings, 2014). Furthermore, race and culture are often confounded as being interchangeable in meaning, which can lead to problems in the implementation of approaches meant to support diversity (Irvin & Darling, 2005). Culturally responsive pedagogy is not equivalent to multicultural education even though it may be misconstrued as being the same (Hammond, 2015).

The celebration of diversity that is often a focus of multicultural education does not incorporate pedagogy that is based on how people learn as a reflection of their identities. Ideas such as collectivism in learning, importance of building learning capacity, bridging connections, addressing implicit bias, and providing affirmation and validation for students are components of a view of culturally responsive pedagogy that may not even require an explicit incorporation of race/ethnicity, and such methodologies can be successful in supporting all students regardless of their specific backgrounds (Hammond, 2015). To that end, approaches characterized as culturally responsive can be even more inclusive than are originally perceived to be in name, in that all learners gain from such efforts in considering culture as more than simply elements related to race or ethnicity (e.g., gender identity, sexual orientation, neurotype, learning/physical disabilities, class, urban vs. rural, etc.). Finally, in seeking to embrace culture in broadening participation in the classroom through pedagogy, caution is needed in order to avoid instances of appropriation, that is, even if the intent is seemingly positive, it is essential to avoid inappropriate emulation of culture and the related negative impacts that could result in such misguided attempts to strive for cultural competency in pedagogy.

Teaching Practices

There is no single model that is universally accepted regarding how best culture can be utilized as a framework in striving for the academic success of diverse and all students in the classroom. However, commonalities in various pedagogical approaches include a respect for the cultural identities of all learners, drawing on the existing knowledge of students, and encouraging any intrinsic motivation for learning as influenced by emotions and cultural beliefs instead of focusing on institutional rewards (Wlodkowski & Ginsberg, 1995; Gay, 2018). Furthermore, pedagogy need not necessarily 'look' cultural as such approaches can be useful for all students from a neuroscience perspective (Hammond, 2015). For example, incorporating specifics regarding a particular underrepresented group should not be the only focus, but rather instruction that fosters the active engagement of how all students can best participate, learn, and communicate as a community is what is needed. Approaches that are student-centered with collaborative learning that is active, inquiry-based, experiential, or focused on projects or problem-solving can serve as a foundation for better supporting all students in an inclusive manner and for engaging diverse learners in the absence of specific cultural references. Likewise, it is important to consider our own identities and assumptions in how we, as instructors, learn about the world as that impacts how we approach guiding our students in the classroom (Hailu et al., 2017).

Table 1 Themes that encompass varying perspectives of how culturally responsive pedagogy can be implemented and recommended approaches

Students as Individuals	**Engaging Practices**	**Bridging Connections**
Learn all names and demonstrate support for student-centered learning	Promote ***small groups learning*** by setting up collaboration opportunities	Bring in ***guest speakers and inspiring role models*** who are best suited to relate to students
Endeavor to know ***students as people*** and model a welcoming atmosphere for all individuals	***Gamify lessons*** and capitalize on the energy and fun that brings to learning	Make use of ***relevant quotes, vocabulary, and metaphors*** in being mindful of all audiences
Provide opportunities for differentiated instruction such as via use of ***learning stations***	***Tell stories*** and have students create narratives to demonstrate understanding	Integrate ***appropriate and positive media*** in desiring to reach and empower all students
Encourage ***ownership*** and contribution of student ideas in assignments and projects	Explore ***real world problems*** that can be motivating in drawing upon a need to learn	Call upon the sense of place by using examples of ***familiar and meaningful places*** to students
Consider the range of ***access and opportunities*** that students have coming into a classroom	Develop opportunities for learning experiences that ***build community***	Integrate learning about subject material via ***cultural contexts*** by highlighting such connections

To effectively embrace and strive for a mindset as instructors that is centered in culturally responsive pedagogy, I offer here a framework that highlights how better to support diversity and inclusion in the classroom by a) recognizing students as individuals, b) utilizing engaging practices for learning, and c) bridging meaningful connections. Table 1 highlights a collection of approaches that fall under the umbrella of what could be considered as culturally responsive and inclusive depending on the model, whereby students are valued as

individuals who vary in needs and interests, activities that foster active participation and community learning are emphasized, and specific connections as related to culture or identity allow students to identify with class material in more meaningful ways. Each of these categories is discussed in more depth below and accompanied by examples that I utilize in my own classroom.

Students as Individuals: Motivation for learning is influenced by personal values and goals. Allowing students to explore and build upon their own learning experiences provides an opportunity to foster the academic growth of individuals in the classroom (e.g., Hailu et al., 2017). Giving students options in claiming ownership over what they learn makes educational experiences more meaningful with lasting impacts. For example, in my paleontology course, I have purposefully given choices to students to make learning more appealing by allowing them to select papers of their choosing in doing literature critiques, selecting a particular mass extinction or major event in Earth history to study in depth from multiple perspectives (biological, chemical, geological), or utilizing any variety of everyday objects to demonstrate an understanding of phylogeny, etc. Likewise, I have set up stations that allow students to explore concepts in paleontology across multiple modes of learning. In addition, students might be given the chance to individually study specimens at their own pace or navigate learning in flexible groups that vary depending on the learning objectives and the unique skills that individual members may bring to group work. Providing an opportunity for students to answer open-ended questions allows for beginner through advanced interpretations that can both accommodate and challenge the needs of all learners as well as promote an opportunity for individuals to more deeply connect to the material based on how they learn and what is meaningful to them. See Santamaria (2009) for more on differentiated instruction as related to culturally responsive pedagogy.

Engaging Practices: The immensity of the fossil record in understanding the sequence of events through geologic time can be daunting for students to "memorize" when presented to them. To make it more engaging and spark curiosity in learners, I have changed my approaches such that in any classes in which students learn about the history of life and Earth, instead of reading or listening to me, I have them begin by studying a set of twenty-four picture cards for different events in Earth history. They work in pairs discussing their reasoning for what they think the order of events might be as they work to arrange the cards in order from the formation of Earth to the present day. One of my students came up with the idea for this activity in order to 'make it social' and 'gamify' the lesson to enhance collaborative active learning of Earth history.

Over the years, I have worked to incorporate more storytelling as a way to communicate science and articulate learning outcomes as well. Traditions of