Natural Science Education, Indigenous Knowledge, and Sustainable Development in Rural and Urban Schools in Kenya

Toward Critical Postcolonial Curriculum Policies and Practices

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Through a multi-sited qualitative study of three Kenyan secondary schools in rural Taita Hills and urban Nairobi, the volume explores the ways the dichotomy between “Western” and “indigenous” knowledge operates in Kenyan education. In particular, it examines views on natural sciences expressed by the students, teachers, the state’s curricula documents, and schools’ exam-oriented pedagogical approaches. O’Hern and Nozaki question state and local education policies and practices as they relate to natural science subjects such as agriculture, biology, and geography and their dismissal of indigenous knowledge about environment, nature, and sustainable development. They suggest the need to develop critical postcolonial curriculum policies and practices of science education to overcome knowledge-oriented binaries, emphasize sustainable development, and address the problems of inequality, the center and periphery divide, and social, cultural, and environmental injustices in Kenya and, by implication, elsewhere.

“In an era of environmental crisis and devastation, education that supports sustainability and survival of our planet is needed. Within a broader sociopolitical context of post-colonialism and globalization, this volume points out possibilities and challenges to achieve such an education. The authors propose a critical, postcolonial approach that acknowledges the contextual and situational production of all knowledge, and that de-dichotomizes indigenous from ‘Western’ scientific knowledge.”

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Research dialogs consists of books written for undergraduate and graduate students of science education, teachers, parents, policy makers, and the public at large. Research dialogs bridge theory, research, and the practice of science education. Books in the series focus on what we know about key topics in science education – including, teaching, connecting the learning of science to the culture of students, emotions and the learning of science, labs, field trips, involving parents, science and everyday life, scientific literacy, including the latest technologies to facilitate science learning, expanding the roles of students, after school programs, museums and science, doing dissections, etc.
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For Jessica, Lindsey, Maya, Corryn, and Elsie
For Kazumi and Takeji Nozaki
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FOREWORD TO NATURAL SCIENCE EDUCATION, INDIGENOUS KNOWLEDGE, AND SUSTAINABLE DEVELOPMENT IN RURAL AND URBAN SCHOOLS IN KENYA

Aside from the very evident economic and political crises that we are facing in education, we are also in the midst of what can only be called an epistemological crisis. With the rise of audit cultures (Apple, 2006; Leys, 2003), schools, teachers, and students are seen as “good” along only one measure—test scores. A good teacher is one who produces ever increasing average student test scores. A good student is one who does the same. And entire school systems are to be judged by comparative scores on the PISA ratings. Evidence is of course needed in judging education. But in the rush to install such regimes of accountability, too little thought is given to whether the knowledge that is supposedly measured by such tests is itself what students, communities, and nations actually need. What can be measured too often replaces what should be taught. An active critical examination and debate over what knowledge is needed, especially in a time of severe environmental crisis, is either delayed or seen as unnecessary or too costly. So too is the question of where such knowledge might come from. This is where Natural Science Education, Indigenous Knowledge, and Sustainable Development in Rural and Urban Schools in Kenya: Towards Critical Postcolonial Approaches to Educational Policy and Practice enters.

Let me situate this volume in the larger context of critical educational theory and practice. In Can Education Change Society? (Apple, 2013), I detail nine tasks of the critical scholar/activist in education. Among them were the following three tasks:

1. Bearing witness to negativity. That is, one should engage in describing what is actually happening in education that reproduces relations that do not support a more equal and sustainable society.
2. Illuminate the spaces of possible counter-hegemonic educational work. That is, point out the spaces and resources that already exist where a more critically democratic education can go on.
3. Act as a critical secretary. That is, critically describe the educational actions, the curricular knowledge, the teaching, and the people who are actually engaged in filling these spaces so that our efforts do not simply have the effect of increasing both cynicism and the feeling that “nothing can be done.”

Darren M. O’Hern and Yoshiko Nozaki’s insightful book engages in all three of these tasks. The aims of the volume are clear in the following quotation from their introductory chapter:

[W]hat kind of knowledge, or whose knowledge, is currently considered legitimate to be taught in natural science education in Kenya? How is such
knowledge taught in schools and under what kinds of social, cultural, and economic conditions? How do Kenyan students and teachers view alternative (e.g., indigenous) kinds of knowledge and their exclusion from (or possible inclusion in) formal curricula and pedagogical content, forms, and contexts?...

[Draw]ing upon theoretical insights from critical and postcolonial perspectives in varied social, cultural, and educational settings, this volume argues for the need to overcome the dichotomization and entrenched binary representations of Western and indigenous systems of knowledge on nature, environment, and sustainability in order to create a contextualized and empowering natural science education for Kenyan students.

These are crucial questions both ideologically and pedagogically for Kenya. But they are equally significant for every nation that is concerned with the relationship between education and the creation of an environmentally sustainable future for its people.

In and of itself, this would be sufficient to make O’Hern and Nozaki’s volume a worthy contribution. But it also makes a substantive contribution to a major focus of critical education. The book is situated within a set of much larger debates about what is considered to be “legitimate” or “official” knowledge (see, e.g., Apple, 2014). From the vast universe of possible knowledge that might be taught in schools, only some is considered worthy of the imprimatur of the state, while other knowledge is considered “popular” or less worthy. Indeed, it is a conceptual requirement for the constitution of the concept of official knowledge that there be its opposite, its constitutive outside, called popular knowledge.

The epistemological and political implications of this have their roots in the concerns expressed by the noted critical cultural theorist Raymond Williams when he demonstrated how the creation of a “selective tradition” was closely connected to the legitimation of relations of dominance and subordination in the larger society (Williams 1961). Since that time, an extensive critical literature has developed on the politics of “tradition,” on the defense and loss of collective memory, and on the sociology of school knowledge (see, e.g., Bernstein, 1977; Bourdieu, 1984; Apple, 2004; Apple, 2014; Apple, Au, & Gandin, 2009).

Yoshiko Nozaki has already contributed to this literature in important ways with her well-received book, *War Memory, Nationalism and Education in Postwar Japan, 1945-2007* (Nozaki, 2008). That book detailed the history of a very significant struggle over memory and what dominant groups decided was to be official knowledge. The book you are about to read by O’Hern and Nozaki takes up the issues surrounding the question of whose knowledge should be taught right now. It directs our attention to the conflicts over one of the most important curriculum areas—natural science and its relationship with teaching about sustainability. *Natural Science Education, Indigenous Knowledge, and Sustainable Development in Rural and Urban Schools in Kenya* brings us inside a number of schools. It provides us with an insightful picture of the contradictory interpretive frames that teachers and students employ to
make decisions about what is legitimate science and should be taught and what is popular and “indigenous” and hence seems less important.

Their analysis shows how curriculum decisions are produced and lived out in daily realities. But the book goes further in that O’Hern and Nozaki also illuminate the ways in which the realities of gendered specificities work in the curriculum and pedagogies of the schools and in the interpretive frames used to understand the issues surrounding what is considered important knowledge.

In response to these complicated dynamics, compromises, and conflicts over curriculum and pedagogy in classrooms and in the lives of teachers and students, O’Hern and Nozaki call for a new way of engaging with educational policy, curriculum, and pedagogy, one based on critical postcolonial approaches. The result is a very nuanced picture of what is happening in the teaching of knowledge that is supposed to help us honestly deal with one of the most significant sets of issues we face nationally and internationally. In the process, they challenge us to rethink the ways we understand the importance of “indigenous knowledge” (see also Smith 2012). They have produced a volume that is a very thoughtful contribution to the ongoing construction of more epistemologically and socially responsive models of educational theory and practice.

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REFERENCES

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CHAPTER 1

INTRODUCTION

Sustainability, Development, and Natural Science Education

Acquiring appropriate knowledge about the natural environment through education is one of the most vital components in our global efforts for a sustainable future; however, we—whether we are educators, researchers, policy makers, or community activists—often face challenges, contradictions, and adversaries at local levels when planning and practicing such education.¹

There is a pressing need to conduct research on the content of, and pedagogical approaches to, education for sustainability, since questions about how—and, indeed, if—the human race can sustain the globe and its societies have become topics of critical concern and debate in nearly all regions of the world in recent years.² To meet the challenge, the United Nations General Assembly has designated the years from 2005 to 2014 as the Decade of Education for Sustainable Development, suggesting that the process of education and educational institutions (e.g., schools) are crucial for ensuring the world’s sustainable future. As Kazuhiko Takemoto (2011), program director and senior fellow at the United Nations University,³ puts it:

In order to ensure a sustainable future, people of all ages and walks of life need to start thinking and acting more responsibly towards our environment. But it is impossible to ask this of anyone without first making sure that people understand a right choice from a wrong choice and that they have the information and skills needed to follow through on whatever choice they make. (para. 4)

For Takemoto, education is “the answer,” as it transforms people’s views and behaviors and provides the knowledge and skills they need for building a sustainable future. He further contends that, in order to succeed in education for sustainability, we need to understand local needs, values, and insights and take bottom-up, grassroots approaches, since “we will never be able to change people’s behaviors by simply telling them what to do” (Takemoto, 2011, para. 8). In other words, it is vital to listen to local voices that often go unheard in discussions of educational policy and implementation and comprehend layers of perspectives on teaching and learning about the natural environment.

THE PRESENT VOLUME: PURPOSE AND SIGNIFICANCE

The present volume explores natural science education, as it is practiced at the secondary level in rural and urban Kenya, in order to gain critical perspectives for
equality and sustainability in postcolonial, developing countries. In particular, the volume examines the perceptions of students and teachers concerning the knowledge and skills taught in natural science subject areas such as agriculture, biology, and geography. The volume, by analyzing their narratives regarding knowledge gained inside and outside of schools about nature, the environment, and sustainability, explicates their views on two kinds, or systems, of knowledge: knowledge encountered through teaching and learning in secondary institutions that offer ecological, environmental, and natural concepts and the knowledge gained through local activities, ethnic traditions, and/or interactions with their family members and relatives. In what ways do students and teachers in rural and urban Kenya explain and valuate—or devaluate for that matter—these two kinds of knowledge, their uses, and teaching and learning of them? As we discuss below, it is significant to examine the views on science education and knowledge in relations to critical questions, including those concerning equality, social justice, sustainable development, and globalization.

Natural Science Education and Epistemological Tensions of School Knowledge

Presently, the study of grassroots views on natural science education for sustainable development is critically important in countries such as Kenya, where dramatic environmental degradation has occurred over the past twenty years. As natural resources continue to deteriorate from deforestation in coastal (Fondo & Martens, 1998) and interior (Kironchi & Mbuvi, 1996) areas, industrial pollutants accumulate (Jumba, Kisia, & Kock, 2007), and greenhouse gas emissions skyrocket (Bailis, Ezzati, & Kammen, 2003), Kenyan education must offer natural science knowledge and skills that promote sustainable development to enable Kenyan students and young adults to fashion appropriate responses to such crises.

Historically, however, concerted efforts and initiatives that address the need for education focusing on sustainability have received scant attention and inadequate support in Kenya. Some researchers (e.g., Ho, 1998) even suggest that such efforts, if actually designed and implemented, would ultimately be derailed given the pervasive pressures of formal syllabi and credentialing examinations. Critical questions of school curriculum and knowledge (e.g., Apple, 1979; Whitty, 1985) should be raised here: what kind of knowledge, or whose knowledge, is currently considered legitimate to be taught in natural science education in Kenya? How is such knowledge taught in schools and under what kinds of social, cultural, and economic conditions? How do Kenyan students and teachers view alternative (e.g., indigenous) kinds of knowledge and their exclusion from (or possible inclusion in) formal curricula and pedagogical content, forms, and contexts?

The academic literature concerning science education in Kenya (and beyond), however, tends to lack critical inquiries into the issues of curriculum, pedagogy, and assessment of educational knowledge about nature, environment, and sustainability (and the epistemologies behind such knowledge). In particular, little research has juxtaposed the viewpoints of the state and those of students, teachers, and local
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communities on these issues, despite the invaluable insights such research can offer for bottom-up approaches to sustainability education.

To fill the gap, the present volume directs its attention to two kinds of educational knowledge: one taught through instruction in natural science classrooms in schools and the other learned through experiences in localized and out-of-school contexts. It explores the ways various actors such as the state (in its curriculum and policy texts), students, and teachers talk about the two by identifying and analyzing the epistemological tensions—and dichotomization—that exist in the texts and narratives of these actors.

In recent decades, knowledge held by local people and communities—sometimes referred to as “indigenous knowledge” (Ogunniyi & Ogawa, 2008)—has received considerable attention from donor agencies and non-governmental organizations alike, as it can play a critical role in the empowerment of local peoples and the development of rural (and, to a lesser extent, urban) areas. Volumes have been compiled that chart the usage of such knowledge in specific contexts and promote the preservation of non-Western epistemologies and practices (e.g., World Bank, 2004). Once exclusively oral in nature, this kind of knowledge has increasingly been categorized and cataloged (as recorded, written texts) under the pretext of “knowledge sharing” (Agrawal, 2002). Although we should welcome the attention to indigenous knowledge, as it represents a paradigm shift to grassroots approaches to (international) development and sustainability, we should be cautious. Research needs to be conducted to see if the two kinds of knowledge are still misleadingly represented in binary terms, where Western knowledge is cast as objective, neutral, and scientific and pitted against the contextually-derived and situated nature of indigenous knowledge.

Despite the fact that several studies examine indigenous knowledge in various Kenyan educational contexts (e.g., Gitari, 2006; Kithinji, 2000), indigenous knowledge has yet to be regarded as part of formal natural science education. Remarkably absent are analyses that investigate students’ and teachers’ responses to the official knowledge (e.g., Apple, 2000) of natural science education vis-à-vis their perceptions of indigenous knowledge about nature, environment, and sustainability. The present volume is not content with knowing the views of adults or community professionals regarding indigenous knowledge, nor does it investigate indigenous knowledge in Kenya in an effort to “catalog” the information for natural science education in schools. Instead, drawing upon theoretical insights from critical and postcolonial perspectives in varied social, cultural, and educational settings, this volume argues for the need to overcome the dichotomization and entrenched binary representations of Western and indigenous systems of knowledge on nature, environment, and sustainability in order to create a contextualized and empowering natural science education for Kenyan students.

The State, Inequality, and Globalization

Research into the broad category of science education is voluminous and diverse in attention. Problems that are explored range from curricular issues concerning testing
formats (e.g., Peyton, 2010) or conceptual retention of specific topics (e.g., Franco & Taber, 2009) to social issues such as the engagement of various student populations with science instruction (e.g., Barton, Tan, & Rivet, 2008). Sub-fields of science education, such as natural science or environmental education, can further expand angles of focus to include the interplay of humanistic factors and social, political, and economic influences with science education (e.g., Strife, 2010). The concept of education for sustainability entails even more complex entanglements of natural science and human science dimensions and includes not only issues of the environment but also those of economy, culture, society, peace, and justice (Gadotti, 2010).

Education for sustainability, therefore, can be seen as a more expansive concept that goes beyond the existing notion (and academic boundaries) of science education or natural science education. As such, the issues of curriculum, pedagogy, and assessment of educational knowledge about nature, environment, and sustainability and the views of students and teachers regarding these issues need to be situated in local, national, and global contexts that recognize social, cultural, and economic dynamics. It is in these contexts that differential powers operate and influence and narratives are constructed relaying the interactions of human dynamics and power.

To investigate the contradictions and complexities of natural science education for sustainability at grassroots levels, the lenses of critical social and cultural theories (e.g., Apple, 1979; Weis, Fine, & Dimitriadis, 2009) must be used to examine the issue relationally. In Kenya, one of the most critical dynamics of education is the strong state control over local schools. State education policies that target the content, organization, and implementation of natural science curricula have numerous consequences on practices at the classroom level that are often unaccounted for by such policy initiatives. Critical examinations of these policies and practices can reveal the unseen difficulties, contradictions, and negotiations that must be traversed by administrators, teachers, students, parents, and community members during the pursuit of comprehensive and appropriate natural science knowledge and skills at local sites.

Kenya’s social and historical context as a de-colonized, developing country with notable internal diversity and occasional eruptions of violent conflicts presents another dimension for considerations of natural science education for sustainable development. The country’s rural and urban disparities, which are manifest in the science-oriented schooling of pupils, appear to be widening despite efforts by the state to promote uniformity through centralized syllabi and the reliance on national testing in natural science subjects. In a national context where uneven development—whether in terms of economic, educational, or physical resources—has a profound effect on the natural environment and the health and well-being of citizens, critical inquiry must uncover difficulties in the natural science education of students. Important questions include: In what ways do conceptions of science and knowledge about the natural environment differ across social and cultural differences (such as class, gender, and race/ethnicity), geographic locations, and generations? How should educators deal with such diversity in their practices? How can recent
social and cultural theories (such as critical and postcolonial theories) inform new practices of science education that will promote sustainable development for all Kenyans?

To envision a critical and contextualized sustainability education for all Kenyan students today, we cannot overlook gender dynamics operating in social, cultural, and educational contexts in Africa. Stambach’s (2000) and Mungai’s (2002) volumes detail the challenges faced by women (predominantly in rural locations) in their pursuit of education and are important ethnographic studies of community life and schooling in Tanzania and Kenya, respectively. Researchers who explore the issues of gender, curriculum, and pedagogy can move beyond the works that focus on classic issue of gender gaps in education to comparatively examine gendered knowledge in increasingly disparate and distanced rural and urban areas across the African continent. The present volume sheds light on the gender dimension and gendered conception of natural science knowledge in Kenya (and Africa) by understanding the perspectives of teachers and students in single-sex and mixed-sex institutions in rural and urban locations.

Finally, an analysis of the narratives of Kenyan students and teachers provides an understanding of the changing climate of natural science education and environmental knowledge in non-Western, postcolonial contexts. These perspectives are especially valuable in the era of globalization, as national education systems attempt to implement decentralized models of curricular administration (Astiz, Wiseman, & Baker, 2002) and many students in developing countries are increasingly interested in acquiring knowledge and skills in science and technology and participating in the global knowledge economy. By analyzing students’ and teachers’ views on science and knowledge about the natural environment, this volume offers postcolonial dynamics of “lived perspectives” (Nozaki, 2005) for natural science education for sustainability.

ETHNOGRAPHIC, QUALITATIVE STUDY: VIEWS FROM STUDENTS AND TEACHERS

The present study employs ethnographic, qualitative research methods and methodologies to explore challenges, contradictions, and struggles that contemporary policies and practices involving natural science education pose for students and teachers in Kenya—and elsewhere by implication. Through the use of ethnographic data, the study offers empirical insights into the ways students and teachers speak to curricula, pedagogies, and assessments of Kenyan natural science education vis-à-vis their views on indigenous knowledge, local practices, ethnic beliefs, and folklore. The data, collected by O’Hern with Nozaki’s supervision at three distinctive schools in Kenya from April to November in 2005, are regarded as “thick” layers of interpretation (Geertz, 1973). As such, the present study makes unique contributions to educational research in general, and critical education studies in particular (e.g., Apple, 1995, 2000, 2004; Apple & Weis, 1983; Apple, Au, & Gandin, 2009; Weinstein, 1998; Pedroni, 2007).
First, it focuses on the data and analysis on daily practices of schools, students, and teachers. Although the topics of science education and Western and non-Western knowledge have been addressed in works discussing education in African contexts (e.g., Cleghorn, Merritt, & Abagi, 1989; Gitari, 2006; Jegede, 1997; Ogunniyi & Ogawa, 2008), few volumes have included the ethnographic data registering daily practices of schools with descriptions of local contexts and conditions of living from grassroots perspectives. For example, Gitari (2006) examines the topics of health and healing in a rural location through discussions with local residents in Kenya. This work demonstrates that several contextual processes (such as “inner sensing”) and the use of localized objects (e.g., plant and animal products) are important for individuals when developing knowledge concerning health and healing. Gitari also notes that such contextual components and objects are not embraced in formal science instruction. Gitari’s study provides excellent narrative information from adults and elders in the community; however, the attitudes and perspectives of teachers and students towards such methods of learning for concepts in health and healing are not considered.

In the contexts of research on Kenyan education, albeit limited in number, important studies exist that employ qualitative methods as they investigate topics such as classroom conversations (e.g., Pontefract & Hardman, 2005) and teachers’ understandings of democracy and democratic citizenship (e.g., Kubow, 2007). However, such studies do not necessarily focus on the voices of students and teachers concerning the practical utility and intellectual instrumentality of knowledge held by local people and communities and their views on the exclusion and inclusion—pros and cons—of such local and communal knowledge in formal natural science instruction. It could be argued that it is necessary to intensively interact with rural and urban students, teachers, and administrators as they perform their daily educational duties in their respective schools in order to gain in-depth understanding of different perspectives concerning educational knowledge taught in schools and communities.

In studies of Kenyan society and cultures, although attention has been paid to the kinds of knowledge circulating among local people and communities (Munguti, 1997; Watson, Adams, & Mutiso, 1998), most studies focus almost exclusively on societal views of, and adult interactions with, such kinds of knowledge. The present volume shifts the focus from actors outside of educational institutions (typically rural adults and communities) to students and teachers in secondary schools and targets schools and classrooms as crucial sites for understanding the perspectives of educational stakeholders on natural science knowledge. With the help of ethnographic data from Kenyan rural and urban adolescents, educators, and classrooms, the present study allows us to begin a critical debate concerning the current state of natural science education, the role of knowledge held by local people and communities, and the (possible) merits of diverse epistemologies in the future of sustainability education.
DATA COLLECTION: MULTI-SITED ETHNOGRAPHIC WORK

For the present study, data collection, conducted by O’Hern with Nozaki’s supervision, took place in three Kenyan secondary schools, each with the designation of “provincial school” by the Kenyan Ministry of Education (MOE, hereafter). Although the nuances of instruction and learning concerning issues of natural science education for sustainability can certainly be gained through the investigation of natural science education in any primary, secondary, or post-secondary educational institutions, the present study centers on natural science education in secondary schools for two reasons. First, secondary school students are usually better equipped than primary school students to discuss their interactions (as frequent or infrequent as they are) with grandparents’ and elders’ indigenous practices and beliefs pertaining to natural sciences or the environment. Second, Kenyan students at this level, as opposed to students at post-secondary levels, have daily interactions with natural science education in schools and, thus, are better candidates for expressing—with their own stories of daily experiences—their views on natural science education and indigenous knowledge.

Multi-sited, multi-case study

The present study is a multi-sited, or multi-case, ethnographic study—a research design that meets methodological challenges in the era of globalization. This is because it allows qualitative researchers to demonstrate that seemingly independent events at one site are indeed connected to events at other sites at deeper levels (Weis, Fine, & Dimitriadis, 2009), and suits well for registering heterogeneity, subtlety, and complexity that exist within a society and culture (e.g., Inokuchi & Nozaki 2010). That is, the data that include the narratives of both rural and urban Kenyan students and teachers from three distinctive sites not only present the alarming disparity that exists in the science-oriented schooling of pupils in these populations (despite the uniformity of centralized syllabi and national testing in the natural sciences),13 but also show the heterogeneity of the forces, language, and ideas that work to preserve social, cultural, and economic inequalities though teaching specific kinds of school knowledge and maintaining the binary of the West and indigenous (Kenya in this study) relationship.

Using the multi-sited, or multi-case, approach, the present study is designed not to overlook the differences, compromises, and negotiations—or “variations, multiplicities, and contradictions” (Nozaki, 2009, p. 486)—that exist within Kenyan society in general, and its natural science education for sustainability at grassroots levels in particular, in order to avoid—as much as possible—creating another binary. For cross-cultural studies, it is critical to “elucidate a complex and uneven topography” (Said, 1993, p. 318) within a nation, region, or geography to see the connections between peoples, cultures, histories, and societies, while understanding the relative autonomy of its intricate socio-historical experiences and conditions of living. In this sense, we would argue, the present volume offers “a fresh imaginary”
for critical research methods and methodologies (Weis, Fine, & Dimitriadis, 2009, p. 437) that help us capture the “rippling effects” (p. 438) of actions in one place influencing those in another place in the age of an increasingly globalizing world.14

Ethnographic approach

Ethnographic approaches were taken for the data collection. Qualitative research, according to Bogdan and Biklen (2003), requires an approach to social phenomena that is open-ended and “allows the subjects to answer from their own frame of reference rather than from one structured by pre-arranged questions” (p. 3). In the field of education, qualitative approaches can be referred to as “naturalistic because the researcher frequents places where the events he or she is interested in naturally occur” (Bogdan and Biklen, 2003, p. 3). Ethnographers in the field of education usually observe students, teachers, and their interactions in school, while participating in the activities at school (and in its communities). The ethnographic researcher’s aim is the demonstration of plausibility and validity of assertions in his/her analysis, and, for that aim, it is necessary for the researcher to collect data not only from interviews but also from observations and to triangulate the situation (Erickson, 1986). Recording observations consisting of concrete descriptions in social processes and contexts is important. The researchers should record observations and write them up with care and self-conscious awareness, though, in any form of recording method (field notes, audio-taping, video-taping and filming), one can never record everything, as some selection must be made (Hammersley & Atkinson, 1983).

The ethnographic research actions of sitting in classrooms (and conducting interviews) cannot be undertaken without prior consideration of the methodological issues involved with field research in an international setting. Here, it is noteworthy to comment on the challenges associated with representing the thoughts, feelings, and actions (or perspectives) of participants without forcing informants’ experiences into a mode that is utterly foreign to them, an issue Bogdan and Biklen (2003) termed the “participant perspectives” problem (p. 23). Understanding the lived perspectives is not an easy task (Nozaki, 2006)—and understanding those of rural and urban secondary students and teachers in an analysis of natural science education in a developing country is no exception. There are multiple ways to interpret student experiences and interactions in classrooms and on school compounds. By privileging student perspectives and attempting to understand their point of view in regards to the use and value of natural science knowledge, their experiences with such knowledge may be distorted. Yet, as Bogdan and Biklen (2003) contend, “approaching people with a goal of trying to understand their point of view, while not perfect, distorts the informants’ experience the least” (p. 23).

One way to minimize distorting effects is to observe interactions among students and between students and teachers or administrators inside and outside classrooms. It is understood that researchers’ roles and (perceived) identities as outsiders may preclude them from fully observing or comprehending interactions in classrooms and...
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school environments, such as those occurring in natural science classes in rural and urban Kenyan schools. However, preconceptions about discussion topics, schooling in rural and urban areas, and, more broadly, contemporary education in Kenya, can (and should) be continually challenged in an attempt to dislodge these very preconceptions—or “bracket” them (Ely, 1991, p. 50)—and try to interpret layers of meanings students and teachers in three schools make through their experiences with the acquisition, prioritization, and valuation of various natural science knowledge.

To be sure, although the data collection methods for the present volume did not depart radically from the classic paradigm of ethnographic study, the authors have keenly been aware of the power relations that are both inherent and created between field researchers and research participants. We would contend that, as researchers (either native or from outside) become visible and active in their target communities and engage the researched in detailed conversations, the researchers must reflect on their position as holders of specific knowledge and investigators of complex phenomena. They should understand the ways their position influence, or otherwise impact, the research, and remain open to alternative research methodologies (e.g., action research, participatory evaluation, and participatory action research [PAR]) that can disrupt established power relations in conducting research. (For further discussion, see Chapter Three).

Study Sites Selections

In the early stages of designing the research, it was envisioned that O’Hern’s contacts at individual schools would be established prior to his arrival in Kenya with the aid of pre-arranged institutional relationships. However, most, if not all, of the legwork for the data collection was carried out in Nairobi in early April 2005 because of the difficulties involved in the long distance negotiations, which included coordinating his Research Associate position at the Institute for Development Studies at the University of Nairobi, obtaining government research clearance for the duration of the fieldwork through the MOE, initiating contact with the urban schools and gaining permission for the research activities at each institution, and arranging for housing in both the rural and urban locations.

While it is not uncommon for foreign researchers to be met with some obstacles when initiating fieldwork, the challenges O’Hern faced resulted in a number of minor, yet noteworthy, alterations to the original data collection plan for the present study. For example, originally observations and interviews were to be conducted at two sites—one non-boarding school in a rural location and one in an urban location. Non-boarding schools were sought because students enrolled at such institutions typically live near the school and therefore could perhaps be classified as rural or urban students with less difficulty than students who may have been raised in a rural region but attended boarding school in an urban environment. Furthermore, it was assumed that non-boarding students—both in rural and urban contexts—might have had more consistent interactions with grandparents and community elders, individuals who practice indigenous natural science knowledge. Yet, as research
preparations took shape in Nairobi, it became apparent that finding a non-boarding co-education institution in Nairobi was difficult, since single sex, full-boarding secondary institutions were far more common in the greater Nairobi area. Most of the students in such schools were, however, fully urban coming from nearby areas.

After a good deal of considerations and negotiations, three schools were selected as research sites. The first institution, Forest Secondary School (pseudonym), was located in rural Taita-Taveta District in the Coast Province of southeastern Kenya. The school rested approximately ten kilometers (6.2 miles) from Wundanyi, the largest town in the Taita Hills and district headquarters for Kenyan government offices. The hilly areas surrounding Wundanyi were populated mainly by small-scale farmers and lack electrification, running water, and paved roads. The school enrolled both males and females, either boarding students or “day scholars” (students who returned home after each day’s classes). The second and third research sites were situated on the outskirts of Nairobi’s Central Business District, within 10 kilometers of one another. The first urban school, Uhuru Girls Secondary (pseudonym), was boarding institution for females, while the second, Central Boys Secondary (pseudonym), was an all-male boarding school. Enrollments at the urban schools are nearly double that of the rural school. Most of the urban students are from Nairobi Province or regions within close proximity to the capital city.

Data collection at all three schools progressed under similar timeframes and with few difficulties. At each school, a set of qualitative research methods used to collect observational and interview data included: participant observation in agriculture, biology, and geography classes, semi-structured, open-ended interviews with students and teachers, and the administration of short questionnaires with the interviewees. In addition, documents were also collected from ministry resources and Kenya’s main English-language daily newspapers that pertained to secondary education, testing, or syllabi. However, there were some discernable differences in the ways that students, teachers, and community members responded to presence of O’Hern in each setting. Such reactions, whether they occurred on school compounds or in other locations, undoubtedly shaped the interactions with each community and also affected the recorded observations of teaching and learning in rural and urban schools (for further discussion on the issues of research processes and decisions, see Chapter 3: Methods and Methodology).

OVERVIEW OF CHAPTERS

Chapter Two reviews the literature that informs this research and identifies theoretical debates that are used during the analysis of the ethnographic data collected in rural and urban schools. This chapter examines works that interrogate natural science education using critical perspectives in numerous social and national contexts, including Kenya as well as other countries in Africa. The second chapter includes a review of the literature that delineates Western scientific knowledge and indigenous knowledge. The second chapter also explores theories of curriculum that aid in
reconceptualizing natural science education in Kenyan secondary schools. Chapter Three discusses the methods and methodology employed for the present study. It situates this study within the tradition of critical educational studies, but goes beyond that to argue for a multi-sited ethnographic study with an international focus.

Chapter Four begins with a discussion of the history and organizational structure of the formal education system in Kenya and also contains information on curriculum development and textbook selection for the natural sciences, evaluation at the secondary level, and pedagogical practices in secondary science classrooms. The chapter provides an analysis of formal education in Kenya, beginning with a discussion of the historical context of formal schooling and tracing the development of the education system through the pre-colonial, colonial, and postcolonial periods. The fourth chapter also includes an examination of contemporary issues facing schools and the education system in Kenya and the influences that globalization has on the Kenyan system. We conclude with an overview of state agencies that are tied to the administration of schooling in Kenya, the development of curricula, the assessment of school knowledge at the secondary level, and the impact of these agencies on daily practices in schools.

The next three chapters present ethnographic case studies from rural and urban schools and document interactions with students and teachers who live and work in two highly disparate areas in Kenya. The chapters document the daily instructional practices in the natural sciences at each school and provide observational and narrative accounts of instructors’ and students’ interactions with, and perspectives of, school science and environmentally-oriented indigenous knowledge, beliefs, and practices. Chapter Five focuses on these processes at Forest Secondary School in rural Taita-Taveta District. Chapter Six examines natural science education at Central Boys Secondary, an all-male institution located in Nairobi, while Chapter Seven discusses Uhuru Girls Secondary, an all-female school situated in close proximity to Nairobi’s central business district.

The final chapter of the volume, Chapter Eight, begins by relating the implications of this study for efforts and discussions that address the issues of sustainability and natural science education, especially in African contexts. The chapter also discusses the narratives of rural and urban teachers and students concerning indigenous and schooled natural science knowledge and highlights historical factors, formal and structural arrangements, and new realities wrought by globalization that contribute to the current marginalization of indigenous knowledge in science education in Kenya. Finally, we use critical and postcolonial insights to propose effective pedagogy that displaces the dichotomization of Western scientific and indigenous knowledge about the natural environment and produces a contextually-relevant and globally-connected sustainability education for all students.

NOTES

1 Although we recognize debates concerning the conceptual notions attached to terms such as “education for sustainability” and “education for sustainable development (ESD)” (e.g., Gadotti, 2010), in the
present volume the terms “education for sustainability,” “education for sustainable development,” and “sustainability education” are used interchangeably.

2 In this volume, “science education” means “natural science education.” By that we do not mean to ignore the existence of social and human sciences as sciences in a broader sense, but they are usually not part of “science education” taught in schools.

3 Takemoto is also Senior Advisor to the Japanese Minister of the Environment.

4 This volume employs the term “natural science” to separate out the subjects of agriculture, biology, and geography, as these are the actual subjects that teach about the natural environment. Other science classes exist in secondary schools in Kenya: computer science, social science classes (like economics or political science/government), and, of course, physical science (physics). The volume uses the term “natural science” because it includes all classes about the natural environment but not all Kenya’s science classes. For example, it includes geology if the schools teach it, but it never includes physics or chemistry because, although these subjects have practical applications in the natural world and are fundamental to understanding our natural surroundings, their content mastery involves more mathematics than it does an understanding of ecological, environmental, and/or natural concepts.

We use natural science to include science classes that specifically focus—at one time or another, like biology does in its “ecology” and “botany” units—on some aspect of the natural environment.

5 For further discussion on the two kinds, or systems, of knowledge, see Chapter Two.

6 The concept of “education for a sustainable future” involves both natural science and human science dimensions. For example, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) lists the following natural science and human science dimensions as part of “Education for Sustainable Development”: Biodiversity, Climate Change, Cultural Diversity, Indigenous Knowledge, Disaster Risk Reduction, Poverty Reduction, Gender Equality, Health Promotion, Sustainable Lifestyle, Peace and Human Security, Water, and Sustainable Urbanization.

7 A more detailed explanation of the selection of research sites for the present study is provided briefly in Chapter One. Chapter Three: Methods and Methodology contains supplemental information concerning research methodology, data collection at each site, and data analysis.

8 From 1996 until 1998, O’Hern also worked in the Taita-region of Kenya as a volunteer with the U.S. Peace Corps. As an agroforestry extensionist, he worked with community groups, schools, and churches on reforestation projects and other conservation and environmental education projects.

9 Nozaki did not visit Kenya; however, she and O’Hern maintained on-and-off communications by emails (and fax once) throughout the data collection phase. There were some intense communications at the beginning and, again, at the ending phase. This experience suggests that, with today’s technological advances, field researchers can collaborate while being in different places.

10 Other studies employ qualitative methods to examine Kenyan education policies and interactions in classrooms and focus on science education (e.g., Cleghorn, Merritt, & Abagi, 1989) and, more specifically, indigenous knowledge and science curricula and education (e.g., Gitari, 2003, 2006).

11 For example, Pontefract and Hardman (2005) is a study of classroom discourse in Kenyan primary schools that involves an evaluation of English, mathematics, and science lessons in nine schools spread across urban and rural areas. In order to intensively analyze the discourse variations by teachers and the nature of participation by primary students aged approximately five to thirteen, entire lessons were audio-taped and the researchers later performed discourse analyses. Although Pontefract and Hardman also add layers of information by interviewing teachers and administering a survey questionnaire, their study relies heavily on audio recordings, and not classroom-based observations or interviews, as the primary data source.

12 For example, some studies spotlight the use of indigenous and Western knowledge in agricultural-related activities and natural resource management (e.g., Wane & Chandler, 2002), while others target the usage of indigenous botanical or herbal knowledge in the treatment and prevention of disease (e.g., Sindiga, 1994). Gitari (2003) provides a thorough critique of the secondary biology syllabus and the extent to which indigenous knowledge concerning the topics of health and healing are incorporated into formal schooling in a rural location. These and other studies, however, fail to include the roles of young Kenyans in these practices and their perspectives concerning indigenous knowledge about nature and environment.

13 Chapter Three contains supplemental information concerning the specific schools that were selected as research sites, as well as data collection at each site and data analysis.

14 For further discussion, see Chapter Three.
Science education, including natural science education, has been studied and debated across the globe for more than half a century. As such, there are a number of works that review this large body of literature from various perspectives. Few such reviews, however, focus on works that contain, or lead to, critical analyses of natural science education in Kenya, Africa, and the United States. In order to begin a reconceptualization of natural science education in Kenyan schools—and, by implication, elsewhere—for a sustainable future, it is necessary to examine existing literature from critical and postcolonial perspectives. The questions here include: How has the literature addressed the influences and meanings of state policies that define the official knowledge of science education? How are the implications these policies have on classroom practice in several intra- and international contexts viewed? To what extent and in what ways has the literature addressed the challenges of science education policies and practices in relation to contemporary issues such as diversity, social justice, globalization, and sustainable development? How has the literature conceptualized and examined Western scientific knowledge and indigenous knowledge and analyzed the relationships between the two?

THE STATE, SCHOOLS, AND NATURAL SCIENCE CURRICULUM AND PEDAGOGY

Michael Apple’s (1995, 2000) work on relationships between knowledge, power, and society offers us a starting point. From Apple’s perspective, the knowledge of a subject area that is deemed most worthy or legitimate is the official knowledge that is embodied in the formal curriculum. An exploration of official knowledge can reveal not only the types of knowledge that find their way into curricula and schools, but also the processes through which knowledge and values are legitimated by individuals or groups in positions of power in society. Through the definition, legitimization, and dissemination of official knowledge by groups of social and economic elite—by direct state power or through various cultural practices that are commonsensical and hegemonic—societal inequality can be maintained. It follows that if there is a predominance of content aligned with a specific kind of knowledge (e.g., the Western scientific tradition) in the agriculture, biology, and geography curricula, or if there
is a struggle over official knowledge sanctioned for these subject matters, it raises questions concerning the societal power granted to different groups by promoting or marginalizing certain kinds of knowledge. We would suggest, however, that national contexts play a role in terms of where we observe manifestations of such politics of official knowledge and what particular aspects (e.g., policies, topics, and themes) become contentious. This is not to suggest that external (e.g., global) influences cannot play significant roles in the selection and de-selection of certain types of knowledge by certain groups within national contexts (as we address the interplay of globalization and education policy and practice more fully in Chapter Four), but that global influences are always situational within a given national and regional context.

NATURAL SCIENCE EDUCATION IN KENYA AND AFRICA:
STATE POLICIES AND EVERYDAY PRACTICES

In Kenya, an examination of the syllabi organized by the Kenya Institute of Education (hereafter KIE, 2002) for secondary agriculture, biology, and geography—the major subject areas that constitute what we refer to as “natural science education”—reveals the significance assigned to the study of scientific disciplines in general, and these subject areas in particular. For instance, the general objectives listed in the agriculture syllabus read: “Create awareness of the role of agriculture in industrial and technological development” and “Demonstrate that farming is a dignified and profitable occupation” (p. 97). Similarly, all secondary students enrolled in biology should be able to “Demonstrate resourcefulness, relevant technical skills and scientific thinking necessary for economic development” and be aware that “Biology is the precursor of biotechnology which is a tool for industrial and technological development” (p. 80). Geography students, furthermore, are required to “Recognize different types of environments and manage them for individual, national and international development” (KIE, 2002, p. 144).

It is clear that Kenya’s natural science syllabi also acknowledge the importance of natural science education in achieving desired social goals. The agriculture syllabus aims to “Promote health consciousness” through the use of agricultural activities and implores teachers to present farming as respectable and profitable, while also warning school leaders that “Agricultural and other related activities must not be used as punishment for wrong doers” (p. 97). Likewise, the study of biology “Enables the learner to appreciate humans as part of the broader community of living organisms” (p. 79). Aside from the desired outcomes concerning the economic well-being, social consciousness, and responsibility of individuals, the Kenyan government also seeks to promote the study of science through the natural science coursework mandated in the national syllabi—agriculture, biology, and geography students should “[a]cquire a firm foundation of relevant knowledge, skills and attitudes for further education and for training in related scientific fields” (KIE, 2002, p. 80).

The fundamental objectives and specific goals listed in the natural science syllabi, of which those listed above are only a sample, address a wide spectrum of issues,
including numerous subject-related skills, overarching conceptual understandings, issues of social justice and inequality, and general attitudes towards individual subjects and schooling. When the goals of natural science education, as defined by the KIE, are looked at more broadly, it is clear that the Kenyan government views the study of agriculture, biology, and geography as important in terms of the economic and social development of the country—and, therefore, defines the official knowledge of these subjects. (For more comprehensive discussions of the interplay of official knowledge and education policy, see Apple [1995] and Apple [2000].)

While studies that consider the impact of state-propagated policies on natural science instruction and learning in Kenya are limited in number, there are some analyses that aim to examine conflicts between state policies and school practices. For example, Gitari’s (2003) inquiry into types and characteristics of knowledge held by rural communities and the secondary biology curriculum in Kenya furnishes an analysis of the theoretical and practical relations between government education policies and the natural science education that is practiced in schools. Gitari argues that, despite stated government intentions to indigenize the secondary science curriculum, knowledge and principles of local communities, particularly in the area of health and healing, are not accounted for in the science education that students receive in a rural area of Kenya. Her critique illuminates a rift between the national curriculum and the rural knowledge and skills of health and healing that community members practice. Gitari concludes that unless the knowledge and skills practiced at local sites are integrated into formal schooling, many Kenyan secondary students who do not advance to post-secondary education will be unable to make “positive epistemological contributions to the rural community” (p. 195).

Some studies have examined the nexus of government language policy and science instruction in Kenyan schools. For example, in their research on primary school education, Cleghorn, Merritt, and Abagi (1989) probe the difficulties encountered by teachers and students in regard to the national policy advocating English-Swahili bilingualism in science education. According to Kenyan government directives, the emphasis on English instruction is intended to unify instruction in primary-level sciences and prepare students for the system’s English language national tests. However, the study suggests that variations in individual schools and student populations alter the conceptual and linguistic input from students during instruction and that the policy, in general, disadvantages rural students who benefit from increased opportunities for “mother tongue science instruction” (p. 38).

The hindrance of conflict between state policies and everyday local practices is ubiquitous in African contexts. Take for example, the work of Sanders and Ngxola (2009), which is applicable to the study of Kenyan natural science education. Their research offers insight into the disjuncture between science-related policies prescribed by the state and the effects of such policies on teaching and learning in classrooms through a salient critique of the “radical, new” (p. 122) Life Sciences (biology) curriculum (finalized in South Africa in 2008). This particular curriculum initiative entails the comprehensive teaching of evolution in secondary biology, a
significant departure from the previous official stance on the topic. Although these authors approach their analysis of this reform from a viewpoint of curriculum change (p. 123), their examination also considers the systemic change from a critical perspective. In doing so, it details a number of issues related to the conflict between government-sanctioned curricular knowledge and the practice of education in classrooms, including the controversy generated by the topic of evolution, teacher apprehension due to personal belief systems, and student resistance to the subject.

Difficulties in the practical implementation of education policy are clearly illustrated by Engida (2002), who discusses teacher reaction and sentiment concerning an Ethiopian curriculum amendment that initiated chemistry instruction in grade seven, when students are approximately 13 years old. Research with primary school chemistry teachers in Addis Abba indicates that serious difficulties arise in classrooms due to the inclusion of highly abstract concepts in the new curriculum, contradictory suggestions in the chemistry curriculum guide, and a lack of adequate representation of advanced chemistry concepts in textbooks. Probyn (2006) also describes the challenges that South Africa’s Language-in-Education Policy (LiEP) produces for teachers and students as they attempt to meet the policy goals of bilingualism with English as the language of learning and teaching despite rural and township students’ lack of interaction with English speakers or English-language materials outside of school.

The studies discussed above clearly suggest that educational policies of the state that target the content, organization, and implementation of natural science curricula in Kenya and other African countries—while they might be well conceived and intended—result in conflicts and consequences at the classroom level that are often unaccounted for by such initiatives. The studies, however, seem to overlook the possibility that dominant cultural practices of curriculum and pedagogy in schools can invite struggles (perhaps between schools/teachers and students). In other words, a part of the problem facing Kenyan natural science education may well be one of “cultural hegemony” (e.g., Apple, 1978), rather than the sheer imposition of state power over official knowledge. Here, it is useful to review works in the area of science education in the United States, as they have approached the issues of science teaching and learning in schools from diversity and social justice perspectives. We would refer to such approaches as “multiculturalist,” borrowing the term from other subject areas such as literacy and social science education.

SCIENCE EDUCATION AND MULTICULTURALIST APPROACHES IN THE UNITED STATES: THE ISSUES OF DIVERSITY AND SOCIAL JUSTICE

In the United States, the passage of the National Defense Education Act in 1958 marked a noteworthy government-led effort to increase funding for, and participation in, science-related subjects at all levels of schooling. While the motivations behind
this particular piece of legislation were couched in the Cold War and the changes
to the college-bound demography in the United States, the added emphasis on
the development of science-related knowledge and skills reflected the idea that
science education is important for national defense as well as economic and social
development (Anderson, 2007; Harris & Miller, 2005). Since the National Defense
Education Act of 1958, the rationale for promoting science education has often
been coupled with economic arguments concerning the preparation of workers for
participation in the competitive world economy and international business—(Carter,

In recent decades, some critics have attempted to rethink science education
critically, suggesting social justice goals, such as equitable educational
opportunities for diverse populations of students (Barton, 2002; Lee & Fradd, 1998), and making
arguments that consider science education in terms of broader human concerns that
occur in everyday life and culture (Aikenhead, 2005; Varelas, Becker, Luster, &
Wenzel, 2002). We should note that the major concern here—especially among
critical educators and scholars—has often been the persistent science achievement
gaps between the majority, mainstream (i.e., White) students and minority students.
In other words, the problem of science education is the disarticulation of science
education in schools and students’ experiences at home. A number of studies have
suggested that science curricula and pedagogy in schools be made responsive
and relevant to the social and cultural contexts and experiences of urban students
(i.e., minority students in general and African American and Latino/a students in
particular).

For example, in a study of a “low performing” urban elementary school,
Buxton (2006) investigates the ways minority youth employ a student-centered
model of scientific inquiry that values their lines of reasoning and helps to create
contextually authentic science. Through the use of this model, a collaborative
approach to inquiry is utilized that resonates with the cultures and experiences of
urban students outside the classroom, but also taps into the strengths of canonically
authentic science inquiry. Buxton argues that this approach helps authenticate
scientific learning for these urban children because it begins with their interests,
perspectives, and needs, suggesting that youth empowerment must be advocated
and valued if schooling should promote social justice as well as the content of
science education.

Research on science education from diversity and social justice perspectives
also focuses on teaching and learning strategies that teachers and students can use
to merge their social lives and experiences from outside the school with the content
and practices of science education that they encounter in the science classroom
and laboratory. For example, through their research with African American and
Latina girls in three low-income, urban middle schools, Barton, Tan, and Rivet
(2008) demonstrate the ways students create “hybrid spaces” that allow them to
“reshape the landscape of science education, rendering it less foreign” (p. 99). To
create such spaces, students and teachers forge creative interactions in the science classroom that connect the spaces of science education and the home to open the hybrid space that contains aspects of both school and home. Such emerging science practices and hybrid spaces also serve to welcome students who are not fluent in the school-acknowledged language and views of the science classroom and help to redefine student participation and the role of the teacher in science instruction. Through this research, these authors look beyond the abundantly studied issue of the achievement gap in sciences for minority students to focus on the responsiveness of formal science instruction to students’ lives and cultures outside the schools.8

Another example of research that interrogates science education using diversity and social justice perspectives can be found in Gilbert’s (2002) work in a predominantly Hispanic urban high school in the southwestern United States. In this research, Gilbert suggests that the use of “non-traditional” approaches (including the use of pedagogical approaches informed by multicultural, feminist, indigenous, or non-traditional science)9 by science instructors increases student participation in science and allows them to recognize the importance of science in their daily lives.10 In addition, Verma’s (2001) research with White and African American seventh graders in an urban setting shows the impact of a “contextualized science curriculum (an alternate science curriculum)” on student acquisition of, and attitudes toward, scientific content in the classroom (p. 5). These and other studies (e.g., Seiler, 2001; Zuniga, Olson, & Winter, 2005) concerning the science education of various student populations demonstrate that science education in schools fails to make its content (whether it be natural, life, or physical science information) relevant or responsive to the life experiences, perspectives, and cultures of students outside schools.11

The studies discussed above suggest that an examination of natural science education in rural and urban areas of Kenya may also need to raise questions of engagement and relevance for secondary students in these locations. Such an investigation should identify lines of inquiry that problematize and examine the disarticulation of students’ community experiences and schools’ teaching practices. Research on Kenyan education has pointed out the top-down, prescriptive national syllabi and standardized assessment process that is followed by each and every public secondary school in the country; however, it has not fully explored the (possible) conflicts between teachers and students in terms of their views on the legitimate knowledge to be taught in schools.

Indeed, these studies suggest that tremendous challenges exist for educators and those interested in promoting scientific literacy among youth to remake science education responsive and relevant to students’ experiences, views, and interests. Part of the challenges may not only be cultural in nature, but may also involve political aspects as well. Thus, critical examinations of such challenges can help teachers conceive and develop new approaches to curricula and pedagogies for education in general, and natural science education in particular, for sustainability in Kenya.
Here, we would argue, critical perspectives are more than helpful, as they provide us with theoretical tools to stir the debate over the relations between the kind of knowledge that is taught—and should be taught—in schools and the maintenance of existing social, cultural, and economic structure(s) that enable certain groups within society to subjugate and marginalize others.

NATURAL SCIENCE EDUCATION AND CRITICAL PERSPECTIVES

Critical Practice of Education: Pedagogy of the Oppressed and Counter-hegemonic Curriculum Making

Paulo Freire (1970), envisioning a critical, transformative role for education, argues that schooling should not seek to “integrate” students into a structure of oppression, but to transform the structure so that they can become “beings for themselves” (p. 74). Freire fundamentally opposes the prevailing form of education that involves interactions between teachers and students that are dominated by a “banking” concept of education. This concept, which positions students as containers into which the knowledge of the teacher can be deposited on a daily basis, is completely insufficient and will “never propose to students that they critically consider reality” (p. 74). The banking concept of education, which Freire sees as mechanistic and alienating, enables certain groups in society to more easily dominate other groups by regarding them as marginal or on the outside.

Freire also envisions knowing not merely as an individual process, but as a social, collective process. According to his theory, education needs to be a series of conscious acts in which educational content can be analyzed and understood by both the teacher and student, thus overcoming the conflict, or dichotomy, that exists between the two parties and their epistemologies. Freire’s pedagogy calls for the transformational relationship between teacher and student to be accompanied by collective consciousness-raising that taps personal and communal situations and daily lives to provide powerful knowing processes and growth.

In Freire’s view, it is not necessary to reference exotic spaces in order to generate opportunities for study; instead, topics for learning can be found in the reality that surrounds oppressed groups. In using such resources, the epistemological curiosity and interest of the oppressed will allow them to construct their own knowledge using their lived experiences. In other words, Freire proposes a powerful bottom-up approach to education that starts with the knowledge produced by students and teachers through the examination of their immediate conditions of existence.

R. W. Connell, in *Schools and Social Justice* (1993), further develops critical theories and perspectives for education of socially and culturally disadvantaged students. Connell’s arguments regarding curricular organization, presentation, and assessment suggest that the very process of formalized schooling creates the potential for broad social consequences that are, in the end, divisive. Connell contends that once social divisions are well established in society and schools (through numerous
other mechanisms aside from the process of schooling), then “academic splitting” drives a wedge between work deemed “academic” and work that is seen as practical or vocational. He states:

The latter (learning that occurs in an engineering shop, a bakery, or a steno pool) comes to be treated as a subordinated or inferior kind of curriculum, associated with the education of subordinated social classes. (1993, p. 33)

Connell argues for counter-hegemonic curriculum making. As he puts it, “the position of those who carry the burdens of social inequality” serves as “a better starting-point” for the construction of knowledge about society than “the position of those who enjoy its advantages” (p. 39). “At its simplest,” he argues, the standpoint(s) of the socially subordinate “[yield] experiences and information not normally available to the dominant groups, and therefore overlooked or marginalized in their constructions of knowledge” (p. 39). In other words, the traditional mainstream curriculum excludes the knowledge of the socially subordinate groups, whereas a counter-hegemonic curriculum inverting hegemony brings out that knowledge. In Connell’s view, the latter is at least better than the former in being “more comprehensive, truer to life ‘as it really happened’” (p. 40). For example, a school history curriculum that includes histories of socially subordinate groups (e.g., ordinary people and women) is more comprehensive than the traditional school history curriculum centering on the deeds of famous men.

Connell points to the assembly and dispersal of curricula that appropriate “bits of hierarchically-organized abstract knowledge” as being intricately linked to schisms between social classes within society and in schools (1993, p. 34). Couple such curricula with forms of assessment that are exclusively measured through individualized and competitive testing, and the resulting “hegemonic curriculum . . . helps generate and reinforce class hierarchy in society as a whole” (p. 34). Although Connell discusses this point in terms of social class, his theory of building a counter-hegemonic curriculum can be applied to other socially subordinate groups (Nozaki, 2006), including, we argue, the rural population in Kenya.

Possibilities of Critical Educational Studies and Practices in Kenya

As we have discussed, the Kenyan government exerts significant, unitary control over education in general, and natural science education in particular, in classrooms across the nation. While the state creates a uniform education for students, neoliberal economic policies transcend international boundaries and processes associated with globalization in the current era appear to widen the rural-urban divisions. In this context, an examination of educational practices that take place in Kenyan schools and classrooms becomes important to the nation’s sustainable future.

Critical educational theories problematize the relationships between and among the knowledge sanctioned for, or taught in, natural science education in schools, the standpoints and epistemologies of the teachers, and those of the students in
Kenya. These theories present a paradigm of educational research to assist in the exploration of the social and economic elements of educational action in natural science classrooms in rural and urban Kenya. Critical educational theories offer a framework for conceptualizing an education for all Kenyan students, leading to a more transformative and sustainable society. And envisioning such an education requires research that generates critical and empirical insights into system- and school-level education policy and practices and the nature of natural science education itself. Such insights—while often opaque at best—must seek to clarify the processes through which natural science syllabi are constructed, how individuals or groups are charged with the organization and content of syllabi, and how formal natural science syllabi treat the knowledge and practices of individuals and groups that are often seen as marginalized.

For example, practical, indigenous knowledge about nature, the environment, and sustainability may be seen by dominant groups as belonging to members of a lower-class, or subordinate group—e.g., those residing in rural areas—and thus unworthy of inclusion in the formal curriculum. The critical point here is that educational research must examine whether the curricular content taught in schools and the knowledge gained through out-of-school contexts are tagged to specific groups who, through their ascent or stagnation in the educational system, are separated into social strata.

As Apple (e.g., 1995) also reminds us, school knowledge and curriculum in their stated and practiced forms cannot be considered neutral. On the contrary, knowledge that is deemed legitimate results from complex power relations and struggles among identifiable groups in society. Hence, following Apple, a series of questions can be raised to explore, including: Whose individual or societal goals are represented by the stated objectives for natural science education? Whose interests are being met through the current content and form of natural science education in Kenya? Is it the interests of students? Is it the interests of a particular segment of Kenyan society (e.g., those who live in urban areas) and are in positions whereby they can form policy and draft syllabi? Or, are both of these groups’ (or others’) interests being met?

Critical theories in education also provide guiding principles for ways to (re)organize the curriculum and pedagogy of Kenyan natural science education and put them into practice. For example, Freire insists that critical communal knowledge and local understandings—or what we may call “indigenous knowledge”—are essential to the education of the oppressed. Gadotti relates Freire’s position on mathematics and natural science education. As Freire states:

What is called today surveying the local environment should also be made by the pupils, with the help of their teachers. I can’t see how mathematics can fail to be taught by examining the environment. I can’t see how biology and natural sciences can fail to be taught by observing the environment. (Gadotti, 1994, p. 117)
Connell (1993) suggests that curriculum making should be undertaken using the “inverting hegemony” approach, which “seeks a way of organizing content and method that builds on the experience of the disadvantaged, but generalizes that to the whole system, rather than confining it to an enclave” (p. 38). According to this strategy, utilization of the experiences and knowledge of the subordinate (e.g., rural students in Kenya and the practitioners of indigenous knowledge) will provide a path toward the reconstruction of curriculum and pedagogy in schools, including natural science education. Through such a reconstruction, the socially and culturally disadvantaged students would not be granted advantages; instead, this process would initiate grassroots approaches toward the epistemological transformation of curriculum and pedagogy that would benefit all students.

There are, however, some issues that merit further consideration. First, critical educational theories, challenging the vertical dialogue of society’s elite and the relationship between the knowledge of the dominant and that of the subordinate, use examples and references drawn from specific cultural and scholarly contexts. For example, Freire’s theory suggests that it is possible to reconstruct natural science education of Kenyan secondary school students based on the knowledge and skills the students acquire in their local communities. It is still an open question to what extent the aspects of Freire’s theory—or other critical analyses for that matter—translate to the situations surrounding Kenyan state control of curricular content, pedagogical practice, and the image of indigenous knowledge that we uncover in agriculture, biology, and geography in both rural and urban classrooms.

Second, and perhaps more problematic, is the retention, however nuanced, of epistemological dichotomization between the oppressor and the oppressed, or the colonizer and the colonized. Freire’s replacement of oppressive education with education that is liberating begins with a critical theory of knowledge that is seeded with the interests of the oppressed and grants them the opportunity to reorder their knowledge and therefore acquire new knowledge. Such substitution is also clear in Connell’s arguments for the liberating and socially-empowering nature of counter-hegemonic curriculum making and implementation. In this picture, the knowledge of the oppressor, or that of the socially subordinate, is seen as more coherent than it actually is. Two bodies of knowledge are represented as mutually exclusive categories.

However, the critical theories in education discussed above do not seem to direct adequate attention to the dilemmas and contradictions—or, say, “epistemological tensions”—that exist within the experiences and knowledge of the socially and culturally subordinate (Nozaki, 2006). This is not to suggest that it is unimportant to ask whose knowledge is—and should be—taught in schools; however, it is to question if a dichotomy lurks in that question; if so, such a question can be misleading. Postcolonial perspectives, by making us aware of heterogeneity, hybridity, inauthenticity, and incoherence of histories, cultures, and experiences of the colonized (e.g., Bhabha, 1994; Said, 1979, 1993), urge us to critically examine the dichotomy. In order to propose the future of natural science
education in diverse school settings, it seems essential to examine the interplay of these issues and tensions and how students and teachers in science classrooms talk about them.

Note that the dichotomization of knowledge also can exist between separate classifications of knowledge, such as Western scientific knowledge and indigenous knowledge. This particular rift is vital to the discussion of natural science education in Kenya (and elsewhere by implication). Below, we closely examine the notions of Western scientific knowledge and several important notions of non-Western knowledge, since the focus of this volume is the epistemological tensions between, and dichotomization of, the two kinds of knowledge in the context of Kenyan secondary schools. By investigating these tensions, we seek to unearth their manifestations in policy documents, school curricula and pedagogies, and the voices of teachers and students in regard to natural science education.14

WESTERN SCIENCE, COLONIAL POWER, AND INDIGENOUS KNOWLEDGE

Western Scientific Knowledge and Colonial Power

Over the past thirty years, discussions on the formation of (Western) science disciplines have proliferated in the anthropological, educational, and international development literature. Although reviewing this literature in its entirety is beyond the scope of the present study, it is helpful to discuss prevailing conceptions of Western scientific knowledge and how research regarding science education in developing countries interacts with critical discussions of knowledge, power, and the subordination, or colonization, of non-Western peoples.

Park and Daston (2006) trace the history of the Aristotelian framework and its influence on the rise of mechanical philosophies, natural philosophies, and the Newtonian experience and summarize the significant advances in what is often termed “scientific knowledge” during the scientific revolution of the Sixteenth and Seventeenth Centuries. Other studies explore the histories of particular disciplines during the early stages of the scientific revolution, such as medicine (e.g., Siraisi, 2007). These works provide a foundational understanding of the scientific knowledge that shaped the development of Western civilization.

Western scientific knowledge is described as the product of centuries-old traditions of analytical thought emphasizing literate, didactic communication and an objective, reductionist view of natural phenomena and processes (Sillitoe, 2002). The production of such knowledge is argued to be “self-contained, self-sustaining, handy, convenient, and even tinged with a sense of righteousness” (Rains, 1999, p. 317). Furthermore, the development of Western knowledge is thought to occur more or less independently of the ongoing production of more contextually specific types of knowledge of local, non-Western people (Maurial, 1999).15 Through its insular production, authoritative claims, and positivistic foundations, Western scientific knowledge positions locally-, culturally-, and
environmentally-bound knowledge of non-Western people and communities as substantively and functionally inferior. 16

Several studies in Kenya (e.g., Lillis & Lowe, 1987; Merryfield, 1986) that specifically tackle the topic of Western knowledge’s influence on educational content and practice in schools do not concentrate on kinds of knowledge in natural science per se. Researchers also associate the predominance of generalized Western perspectives in schools with numerous characteristics of the education system itself, such as variable enrollment rates (e.g., Buchmann, 2000) and diminished participation by girls (e.g., Ndunda & Munby, 1991).

In recent years, relations between the concepts and principles that are represented in formal science education curricula in schools—which may be termed “school science” 17—and Western scientific knowledge have been explored in great detail, with numerous analyses concentrating on science education in developing nations (e.g., Agrawal, 1995; Cobern & Loving, 2001; George, 1999). Analyses of Western science and schooling in the context of the developing world typically evoke discussions regarding the role schools played when large swaths of Central and South America, Africa, and Asia were colonized by European powers. In particular, critical studies such as Linda Tuhiwai Smith’s (1999) help to uncover the ways that various Western disciplines, transmitted through the formal colonial system of schooling, not only subvert existing knowledge systems of the colonized but also serve to assimilate their cultural practices and languages into the colonial system.

Smith (1999) argues that the colonized nations must “de-colonize” the ways—“methodologies” in her words—they produce knowledge in order to become truly liberated. But how should we conceptualize and define such knowledge produced and used locally—especially in a country such as Kenya?

Primitive, Local, and Indigenous Knowledge

Questions regarding the delineation of specific kinds of knowledge and the means by which such kinds of knowledge are produced have been deliberated for centuries. During the second half of the twentieth century, numerous debates addressed, among other topics, the epistemological differences between Western scientific knowledge and its alternatives. To discuss all the nuances of every epistemological debate is not our intention here; however, we would like to examine three major conceptions that emerge from such debates—“primitive,” “local,” and “indigenous.”

The Savage Mind (Levi-Strauss, 1966) juxtaposes the knowledge systems of so-called “primitive” and modern cultures by suggesting that primitive societies are more intimately bound with their environments and surroundings than modern societies are. Levi-Strauss’ usage of the term “primitive” is not synonymous with inferior or backwards. On the contrary, the kinds of knowledge these societies generate and employ are advanced and valuable in their situated contexts. Yet, as he sees it, the epistemological foundations of such kinds of knowledge are complicated by the associations between primitive knowledge and magical thought (p. 11). Through his
theoretical comparison of the “bricoleur” (handyman or craftsman) and engineer, Levi-Strauss deliberates the nature of understanding and knowledge between the “savage mind” and the scientific mind. He posits that the knowledge constructed by the savage mind in primitive cultures is not easily detached from its context, but instead is given form and order mainly in accordance with the needs of the culture.

The Savage Mind legitimates primitive knowledge, positioning it as an independent, developed system of knowledge. Primitive knowledge is different from Western knowledge, but is equally valuable and worthy of consideration. The position here is a foundational and formative theoretical move to relativize Western and primitive knowledge systems. The Savage Mind has made enormous contributions to the field of anthropology (and other academic fields such as literature, sociology, political sciences, and education) and inspired numerous studies by focusing specifically on the separation of Western and non-Western knowledge systems. For example, Berkes (1993) provides detailed distinctions between ecological knowledge held by native people (in his words, “traditional knowledge”) and (Western) scientific ecological knowledge. Similarly, Maurial (1999) argues that non-Western people’s knowledge exists in everyday cultural practices, unlike the archived, tested, and manipulated disciplinary knowledge of the West.

Levi-Strauss’ arguments concerning the nature of knowledge produced and used by native people are followed by a series of analyses that explore how such knowledge systems are culturally bound and contextually constructed and reconstructed. For example, Geertz (1983) refers to it as “local knowledge” to argue for the need to draw upon the knowledge, beliefs, and ideas of a local culture when exploring its contextual practices. According to Geertz:

[T]he shapes of knowledge are always ineluctably local, indivisible from their instruments and their encasements. One may veil this fact with ecumenical rhetoric or blur it with strenuous theory, but one cannot really make it go away.

(p. 4)

If Geertz’s assertions constitute an accurate depiction of how knowledge is constructed across different cultural contexts, then the frameworks that people use to make sense of their world and construct their knowledge are local, specific, and highly valued and entangled with local histories and experiences. These local experiences, interpretations, and interactions—with people, objects, or natural processes—thus have greater merit to these groups than associations of abstracted or detached concepts, theories, or formulas. Hence, some critics (e.g., Hobart, 1993) argue that local knowledge appears to be more about “knowing how” than “knowing that” or “knowing as,” and may be more sensitive to particularities of place, occasion, and circumstance (Hobart, 1993, p. 4). Moreover, individuals and communities can perform certain practices without actually knowing the science that underlies or explains the practices.

For Geertz, universalist judgments and dense analyses of local knowledge cannot dislodge the local, situated nature of local knowledge and their importance
to those who develop and use them. Note that he made his argument in the context of anthropology in which Western scholars conduct research on non-Western cultures. Yet, in examining the origins, assembly, practice, and valuation of local knowledge and specific populations existing in a particular space and time, Geertz’s theorizing leads us to ask: Can we apply discussions about local knowledge to numerous contexts such as schools and communities in the West? Are deliberations regarding local knowledge in one culture even transferrable to another? Is the notion of local knowledge keen enough to point to the nexus of knowledge and colonial power?

“Indigenous knowledge” is another term that is prevalent in contemporary anthropological, sociological, and educational literature which refers to contextualized, situated, or experience-informed knowledge of native people (e.g., Bollig, 1999; Ogunniyi & Ogawa, 2008)—and is perhaps the best term to refer to such knowledge held by Kenyan people locally. Definitions of indigenous knowledge, in broad terms, often incorporate notions of groups of peoples creating knowledge-producing systems based on historical and cultural understandings of themselves in relation to their bio-physical surroundings for the purposes of long-term human adaptation (Purcell, 1998, p. 260) and the enhancement of their livelihood and existence (Semali & Kincheloe, 1999, p. 3). In other words, the nature of indigenous knowledge is more dynamic than is often assumed or acknowledged.

In recent years, indigenous knowledge has been associated with national or regional populations in postcolonial and less developed countries (e.g., Kassam, 2002; Whitt, 2009). However, as Purcell (1998) notes, the notion of indigenous knowledge can be (and has been) expanded to encompass “territorially non-indigenous communities and nations acting on their own behalf, in accordance with the dictates of their own history and political culture” (p. 260). Using this perspective, the notion of indigenous knowledge can be used beyond so-called “indigenous peoples” and instead can be more functionally tied to humans’ interactions with their surroundings and their social, political, economic, ideological, and religious practices. In this sense, it becomes similar to the notion of local knowledge as offered by Geertz (1983); however, the term evokes more political and critical meanings because of its origins in colonial and postcolonial struggles, which, indeed, fits into Kenyan contexts well.

Research on Indigenous Knowledge

The existence of indigenous knowledge systems, including locally-informed and contextually-appropriate ways of knowing, is well documented and established through the work of Brokensha, Warren, and Werner (1980), Hess (1995), and Sillitoe (1998). This topic is moderately dispersed through anthropological literature and predominantly focuses on the use of indigenous knowledge in science-related livelihood activities, such as agriculture (e.g., Dewalt, 1994), medicine (e.g., Sindiga, 1994), and nutrition (e.g., Mwadime, 1999). Deliberations of indigenous knowledge
Numerous publications consider historical and contemporary issues concerning indigenous knowledge in Africa. Harries’ (2007) book is a wide-ranging account of how European intellectuals categorized local African knowledge and how local Africans, in turn, incorporated foreign epistemologies and practices into their societies during the early colonial period. Falola’s (2000) text also investigates bodies of indigenous knowledge, and, like a number of other works, does so by tapping into locally-constructed narratives by adults and elders regarding African history and historical knowledge. Marchand and Kresse’s (2009) edited publication includes a variety of perspectives examining practical applications of accumulated knowledge in Sub-Saharan Africa using examples from traditional healers, community leaders, and artisans. Although historical accounts like Harries’ research (2007) thoroughly document the subjugation of peoples (and kinds of knowledge they held) during the colonization of the African continent, many volumes that trace the intersections of indigenous and Western cultures do little to dispel or interrupt the dichotomization of these epistemologies.

In the field of Kenyan studies, scholarly investigations of indigenous knowledge, although relatively few in number, yield thoughtful debates concerning various theoretical and practical issues surrounding the usage and maintenance of such ways of knowing and their applicability in diverse contexts. In most of these analyses, investigators focus on the indigenous knowledge of adults and typically confine their scope to specific geographies or ethnicities. Wane and Chandler’s (2002) work typifies this limited body of research. Through their exploration of the indigenous and cultural environmental knowledge of rural adult women in a specific location, they contend that such contextual knowledge, while complex and localized, can and should be used as an untapped resource for the broader teaching of environmental concepts within Kenyan society. In their view, indigenous knowledge can provide alternative, even oppositional, sets of knowledge to the Western scientific knowledge.

Some studies focus on the interactions of indigenous and Western knowledge systems in Kenyan contexts. These inquiries predominantly address two themes: the use of indigenous knowledge in modern agricultural-related activities and natural resource management (e.g., Wane & Chandler, 2002; Watson, Adams, & Mutiso, 1998) and indigenous botanical or herbal knowledge usage in the treatment and prevention of disease (e.g., Munguti, 1997; Sindiga, 1994).

Other studies examine practical issues surrounding the co-existing or complementary relationships of Western scientific and indigenous knowledge systems in practical contexts in Kenya and Africa. For example, Sibisi (2004) highlights examples from agricultural practices and healthcare initiatives in Africa that illustrate the richness of indigenous knowledge systems and their contributions to science and technology. O’Donoghue (2003) describes how game rangers in South Africa’s Umfolozi Game Reserve utilize both the practical experiences
of indigenous game guards and university-based ecological training to establish management practices for the fledgling reserve. In O’Donoghue’s (2003) example, the interplay between the Nguni (indigenous) “knowledge of the interconnected ways of the wild and game ranger scientist as interpretive mobilizer of ecological patterns that connect” help to create mutually enriching interactions for the reserve’s first game guards and rangers (p. 62).

In the field of educational research, Ogunniyi and Ogawa (2008) review bold attempts to reflect elements of indigenous knowledge in science classrooms in South Africa and Japan and discuss the challenges in the development and implementation of indigenized science curricula in both countries. Ogunniyi and Hewson (2008) analyze a teacher-training course in South Africa that seeks to enhance their understanding of indigenous knowledge systems (IKS) and improve their ability to integrate IKS into their science classrooms.19

Studies that specifically address the potential use of indigenous knowledge in Kenyan schools are extremely limited. Gitari’s (2003) research focuses on the theoretical compatibility of indigenous knowledge and science education, but is limited to the particular topic of health and healing, which is addressed in the form four biology syllabus. Her study, while helpful in interrogating the disparities between school offerings and everyday offerings regarding this topic, overlooks input from students and teachers regarding these epistemologies.

Kithinji’s study (2000), which focuses on views concerning health and healing through an analysis of retrospective accounts of formal science instruction from adults (mostly women) in Kenya’s Meru District, specifically suggests the integration of the non-Western knowledge produced and circulated among Kenyans into the secondary science curriculum. By using these and other sources, the study recounts how school science becomes the definitive knowledge of human health in Kenya, supplanting indigenous ways of healing which encompass an individual’s physical, spiritual, social, and emotional dimensions of life. Kithinji’s research demonstrates how externally-developed, Eurocentric changes to secondary science education fail to produce significant improvements in existing life conditions in Kenya.20 In her conclusion, she suggests that the secondary science curriculum “must aim to give adequate attention to the principles and processes that are used in everyday problem solving in rural areas” (p.250).

The academic works reviewed above have advanced the debates concerning the role of indigenous knowledge in the natural science education of youth in Kenya, as well as other African countries, by exploring ways of supplementing current science curricula with indigenous perspectives (e.g., Gitari, 2003; Kithinji, 2000; Ogunniyi & Ogawa, 2008). Indeed, their scholarly contributions go beyond the boundaries of education research, since the subject of Western scientific knowledge and indigenous knowledge is now woven through conversations and arguments of various scholarly fields that span the spectrum of anthropological and sociological thought and analysis. A question arises, however, from the perspectives of postcolonial theories (e.g. Said, 1979): While enormously helpful to rethink natural science education
in Kenya and, by implication, elsewhere, do the studies discussed above reify, consciously or unconsciously, the binary of Western scientific knowledge and indigenous knowledge? In this binary, Western scientific knowledge is viewed, rightly or wrongly, as authoritative (and reductionist) and indigenous knowledge is suggested as the (oppositional) alternative.

In other words, one may wonder if, in their arguments, many studies reviewed above adopt theoretical positions that tend to dichotomize Western scientific knowledge and indigenous knowledge. Is the binary of Western versus indigenous the only perspective that can be employed when discussing the relationships and roles of these epistemologies? How can we overcome the dichotomy of indigenous and Western knowledge systems? To what extent do critical theories in education, such as those offered by Freire and Connell, help us transcend the binary of the two epistemologies prevalent in natural science education in Kenya? How can we develop a discussion of curriculum theories that provides a framework for linking (as opposed to adding to or substituting) Western scientific knowledge and indigenous knowledge?

It is important to note that there also seems to be a vacuum in educational research on the subject of the dichotomization of the indigenous and Western bodies of knowledge. In particular, scant empirical attention has been paid to the perspectives of youth and their teachers concerning their views on, and experiences with, the two systems of knowledge discussed above. To be sure, the dichotomy between Western scientific knowledge and indigenous knowledge has been, to some extent, questioned in anthropological and educational debates for decades; however, the focus of much of the literature on this topic is theoretical in nature. It is here that we argue that there is considerable merit in the (re)conceptualization of bottom-up approaches to natural science education and the exploration—with a critical lens—of students’ and teachers’ interaction with, and perceptions of, Western scientific knowledge and/or indigenous knowledge.

The investigation of student and teacher interactions with, and perspectives on, indigenous knowledge—when viewed with a critical lens—can yield a reconceptualization of natural science education in Kenya (and beyond). Such exploration involves a series of essential questions: What are students’ and teachers’ views on indigenous knowledge? How do individuals within these groups articulate the relationship between indigenous knowledge and knowledge taught through formal schooling? Do discussions of indigenous knowledge within the context of specific subjects, such as those in natural science education, create enhanced possibilities for framing the interactions with or of indigenous knowledge and school knowledge? Do individuals from different socioeconomic groups and different geographic locations such as those located in rural or urban areas have similar or different perspectives of indigenous knowledge and those practicing such knowledge?

With these (and other related) questions in mind, it is worthwhile to examine the relationship between indigenous knowledge and school curriculum of a specific subject or group of related subjects in diverse locations within a particular country,
such as Kenya. In the next chapter, we detail the historical development of formal schooling in Kenya and discuss the strong role of the state in the natural science education of secondary students in modern Kenya.

NOTES

1 For example, Lawson (1985) reviews the research on science education to explore the role of formal reasoning in the teaching of science, while Bowen (1992) analyzes the predominant themes in science education literature to examine the usage of scientific practices in solving educational problems (e.g., questions about curricular content or instructional practices). Critical questions can be raised regarding the entanglement of indigenous and Western knowledge and their (co)production, representations, engagement, and usage. For example, Bang and Medin (2010) question the lack of cultural orientation of education in science, technology, engineering, and mathematics (STEM), and Jegede and Aikenhead (1999) examine contemporary goals of science education through cognitive understanding of the cross-cultural experiences students encounter. While we must acknowledge the importance of understanding how students come to know such knowledge, how they construct it, or how they store and access it, the present study focuses on the ways in which students view and conceptualize indigenous and Western systems of science knowledge vis-à-vis their formal schooling in agricultural, biological, and geographical sciences.

2 There is a substantial body of scholarly work that investigates various topics surrounding science education in other Western contexts, such as Lithuanian teens’ attitudes towards species protection (e.g., Lamanuskas, Gailien, & Vilkonis, 2006), the work of environmental non-governmental organizations in education initiatives in southeastern Europe (e.g., Turnock, 2004), and innovations in science education that target stale pedagogies and disengaged teachers (e.g., Willingale-Theune, Manaia, Gebhardt, De Lorenzi, & Haury, 2009). Despite this excellent body of work, we highlight critical analyses of science education in the United States not only because of their theoretical perspectives, but also due to their utility in drawing parallels between the perceived incompatibilities of science education for some (mostly urban) students in the United States and the similar incompatibilities that were observed in Kenya.

3 The body of literature that focuses on “science education” is voluminous given the differentiation of sciences into broad categories (such as natural, physical, or social) and individual disciplines (such as biology, chemistry, or geology). However, it is important to note that researchers have investigated myriad policy and practical issues in relation to science subjects, such as physics and chemistry, in numerous national contexts, such as England (e.g., Franco & Taber, 2009), Spain (e.g., Solbes & Traver, 2003), and the Czech Republic (e.g., Škoda & Doulik, 2007).

4 To be sure, a number of notable studies have also examined conflict in education in African contexts, however not specifically between state and local entities or actors. Some of these studies have addressed, critically or otherwise, points of contention related to issues of colonization, de-colonization, and Western influence upon, or westernization of, education. For example, Ottevanger, Akker, and Feiter (2007) examine a group of academic disciplines, namely science, mathematics, and information and communication technology (ICT) in secondary schools located in ten Sub-Saharan African countries. Bassey’s (1999) book investigates the ways that Western education has been used by Africa’s political and economic elite to marginalize and dominate Africa’s poor. While both of these publications offer in-depth critiques and critical analyses of education in various African contexts, they do so broadly, focusing on multiple disciplines in national education systems and wider social processes, such as socialization and the accumulation of political and economic capital.

5 Sanders and Nngxola (2009) note that, prior to 1994, South Africa’s government implemented a Christian National Education policy that disallowed the teaching of subjects that were viewed as either anti-Christian or unchristian. Such a national policy could have produced a generation of teachers that now struggle to reconcile their Christian-influenced upbringing and education with the evolutionary principles that they are required to teach (a conflict that, these authors suggest, is fed by misconceptions between the two and the portrayal of evolution and religion as being mutually-exclusive). In fact, these authors note that many of their study’s participants would skip or omit
entire sections dealing with genetics or evolution; this behavior was not only due to their personal beliefs about evolution, but also their lack of understanding of the topics prior to (and after) the implementation of the new curriculum and their uncertainty about how to teach the topics. Griffith and Brem (2004) and Downie and Barron (2000) also address issues and controversies surrounding the teaching of evolution in the United States and Scotland, respectively.

As we see it, this position suggests that science education curricula be made from broader, critical perspectives of societal transformations, rather than its knowledge and skills being offered simply as technical tools for economic success of the nation and individuals. Furthermore, such critical science education curricula should be offered to all students. As such, this position is, indeed, close to the notion of science education for sustainability, as both attempt to deal with such issues as equality, justice, and peace. It is interesting (and important) to realize the recent shift of language here from “transformation” to “sustainability.”

Buxton (2006) refers to contextually authentic science as approaches to science that begin with the interests and needs of learners and seek to discover “ways that science learning can be taken up and negotiated within and against the canonical world of science, but rarely within the setting of school science” (p. 702). In using such an inclusive approach, science instruction can de-center the “expert” paradigms that characterize canonically authentic science and provide learning in science that is collaboratively constructed and uniformly stresses “both the relevant science learning experiences themselves and the social issues/actions that are embedded in those science experiences” (p. 719).

“Culturally relevant or responsive pedagogy” has been one of the key theories of multiculturalist education for some time (e.g., Ladson-Billings, 2009), and the studies discussed here suggest that the theory applies to science education also. For a useful and concise review of the theory, see Sleeter and Combleth (2011, pp. 2-5).

In Gilbert’s (2002) research, he defines indigenous science as “a philosophical orientation of science knowledge which values responsibility, care, and respect concerning the rights of all living things, the earth, the universe, and all matter within it” (p. 21). He continues: “My use of this term represents an effort to broaden the notion of what science should be as opposed to what has been accepted and forwarded by western mindsets” (p. 21).

The studies referred to in this section typify many of the science education-related analyses, in that they tend to concentrate on specific aspects of science education, such as achievement, attainment, or teaching practices, in or with individual communities. Broader investigations of science education in the United States and elsewhere that use a critical perspective are scarce; however, notable exceptions are Kincheloe (1997), Kincheloe (2001), and Lee and Luykx (2006).

It is critically important to consider the ways that science education connects not only with students’ lives outside classrooms, but also with different groups of students themselves. Research that investigates the ways that formal, curricular-based science knowledge contributes to the positioning of individuals from different backgrounds, locations, and ethnicities into socioeconomic groupings in Kenya needs to be one of the important foci of future studies. Many thanks to Lois Weis and Robert Stevenson for their comments on this point.

For a more thorough analysis of Connell’s work as it relates to the nexus of curricula development and power, knowledge, and ideology, see Nozaki’s (2006) chapter in Weis, McCarthy, and Dimitriadis’ (2006) edited volume.

Another perspective used to evaluate the nature of natural science education in rural and urban Kenyan secondary schools is derived from Michael Apple’s (1995, 2000) critical work on relationships between knowledge, power, and society. From Apple’s perspective, the knowledge of a subject that is deemed of the most worth or legitimacy is the official knowledge that is embodied in the formal curriculum of that subject. In the exploration of official knowledge, one may reveal not only the types of knowledge that find their way into curricula and schools, but also the processes through which knowledge and values are legitimated by individuals or groups in positions of power in society. Through the definition, legitimization, and dissemination of this knowledge by the social and economic elite, societal inequality can be maintained. In the Kenyan context, the predominance of knowledge aligned with the Western scientific tradition in the agriculture, biology, and geography curricula raises questions concerning the ascension and marginalization of certain types of knowledge and the power granted to specific groups to select school knowledge.
CHAPTER 2

14 This chapter examines the bodies of knowledge that are most commonly referred to as “indigenous” knowledge. As demonstrated during the course of the literature review, various names have been used to address various types of knowledge, including “primitive,” “local,” and “non-Western.” For the purposes of theoretical clarity, this volume uses the term indigenous, as it is the most popular term used to refer to such knowledge in the literature. It should be noted, however, that the term “traditional knowledge” was used in the data collection (i.e., interviews and discussions primarily with rural and urban students) in order to tack such knowledge to the practices and traditions of elders in their families and the community. Yet, for the remainder of the present study, the term indigenous is used when discussing this kind of knowledge.

15 The concept of indigenous knowledge will be discussed later in this chapter.

16 “Western science” is actually the product of knowledge contributions from many non-Western cultures (see Bernal [1987] and Turnbull [1997]). Le Grange (2008) argued that by considering all kinds of knowledge to be local in nature, Western science is de-centered and, therefore, more conceptually comparable to indigenous knowledge. In leveling the two epistemologies, Western science’s claims of objectivity, rationality, and universality are weakened (p. 819).

17 The term “school science” is coined based upon Whitty’s (1985) notion of “school knowledge,” which he refers to as a selection of knowledge that is carved “from a much vaster range of knowledge” (p. 1). Accordingly, in this volume, the term is used to connote the natural science knowledge that is bound by the Kenyan national curriculum and that does not account for indigenous knowledge or indigenous natural science.

18 Kithinji (2000) and Gitari (2003) make similar arguments regarding the potential benefits of increased access and acceptance of indigenous knowledge, but also attempt to link the indigenous knowledge of a specific topic (health and healing) to the teaching of the topic in schools.

19 According to Ogunniyi and Ogawa (2008), Indigenous Knowledge Systems (IKS) refers to “a conglomeration of knowledge systems” that is “a redemptive, holistic, and transcendental view of human experience with the cosmos” (p. 178).

20 Gitari’s (2003) research findings were similar to Kithinji’s (2000) analysis. In essence, both researchers argued that the formal curriculum in health and healing did not incorporate indigenous concepts that, according to these authors, were vital to the health maintenance of the rural communities where their research occurred.