Environmental Education for Secondary Students in the United States: A Grounded Theory Systematic Review

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ABSTRACT

Environmental educators work to create an environmentally literate citizenry that is willing and able to tackle complex environmental problems such as climate change, potable water availability, and biodiversity loss. Environmental education (EE) research is a robust field that links practice and research, but lacks a comprehensive model connecting practices and outcomes. The goal of this grounded theory systematic review (GT-SR) was to create a model that identifies the context, strategies, outcomes, and core category associated with EE for secondary students in the United States (U.S.).

Systematic review methods were used to locate and screen relevant, peer-reviewed research indexed in academic databases. The first search term, "environmental education," identified studies about EE. To narrow results to those focused on secondary education (grades 6–12), twelve search terms related to middle school and high school were used. After limiting the search to studies published between 2011 and 2018 and in English, 1,009 unique citation records were identified. A screening process for relevancy and quality excluded 982 records leaving 27 studies in the initial final sample. Theoretical sampling identified an additional 12 studies through a second database search and ancestry searching.

Data from the 39 studies were analyzed through initial, focused, and theoretical coding using the constant comparative method. During initial coding, descriptive and In Vivo codes were used to organize the data into meaningful chunks. Focused and theoretical coding were used to further abstraction and identify categories. "Authenticity" emerged as the core category

suggesting that, in order to be effective, EE for secondary students in the U.S. must be viewed as authentic in the eyes of the participants.

The coding process informed the development of the Implementation of Authentic Environmental Education Programs (IAEEP) model. Although not designed to be applicable to all contexts, the model will aid EE practitioners in developing and implementing EE programs for secondary students in the U.S. and guide researchers as they evaluate EE programs. The development of the model also supports the use of a GT-SR as an appropriate and useful method for identifying, screening, and analyzing existing research to create a theoretical model.

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GENERAL AUDIENCE ABSTRACT

Environmental educators work to create an environmentally literate citizenry that is willing and able to tackle complex environmental problems such as climate change, lack of potable water, and loss of biodiversity. Environmental education research is a robust field that links practice and research, but lacks a comprehensive model that connects practices with agreed-upon outcomes. This systematic review used a grounded theory approach to create a grounded theory model that identifies the strategies, context, conditions, core category, and outcomes associated with environmental education for secondary students in the United States. Systematic review methods and theoretical sampling were used to locate and screen relevant, peer-reviewed environmental education research. Data from the primary studies were analyzed using initial, focused, and theoretical coding using the constant comparison method. Integration of data from the systematic review and theoretical sampling informed the development of the Implementation of Authentic Environmental Education Programs (IAEEP) model. This model will aid practitioners in developing and implementing environmental education programs for secondary students and guide researchers as they further evaluate environmental education programs.

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Chapter 1: Introduction

Popular media coverage details a litany of environmental issues across the globe. Scientists report that 2016 was the hottest year on record and attribute much of this warming to anthropogenic climate change (NASA, 2017). Predicted results of climate change, some of which are already manifesting, include more intense and frequent precipitation and storms (e.g., flooding and hurricanes; Dinan, 2017; U.S. Climate Change Science Program, 2008); increased wildfires (Harvey, 2017); and sea level rise (Intergovernmental Panel on Climate Change, 2014). Loss of biodiversity is another major environmental issue with scientists referring to the current rate of species extinction as a "biological annihilation" (Schlossberg, 2017, p. A5). The United Nations warns that unsustainable use of groundwater will lead to subsidence of major metropolitan areas by 2030 and deadly conflicts prompted by water shortages (Parker, 2016). The common factor across these and other recent environmental phenomena is the direct influence of humans. Human actions, on large and small scales, are leading to changes in the environment that will affect every country and every person around the world.

To protect the environment, a cohesive environmental movement in the United States (U.S.) began to emerge and strengthen in the 1960s. The movement enjoyed a string of successes in the 1970s: the first Earth Day was celebrated on April 22, 1970; the U.S. Environmental Protection Agency was established in 1970; and major federal legislation addressing environmental issues (e.g., the Clean Air Act and Clean Water Act) was significantly strengthened and expanded (Dunlap & Mertig, 2014). In the 1980s and 1990s, the environmental movement began to delve into social issues as proponents of environmental justice advocated for increased attention to the role of gender, race, and class in environmental problems (Gottlieb,

2005). Despite early successes, environmental issues continue to exist and intensify in the twenty-first century.

By the early 2000s, some people suggested that the environmental movement was faltering, even referring to the death of environmentalism (Shellenberger & Nordhaus, 2007). Critics of the environmental movement attribute this failure to a focus on science and technology rather than a focus on creating an environmentally literate citizenry who is able to understand and support environmental issues (Shellenberger & Nordhaus, 2007; Speth, 2008). Environmental problems are no longer only issues of science; they have become entrenched in the political, social, and economic spheres. No issue more clearly illustrates this than climate change (Dryzek, Norgaard, & Schlosberg, 2011). Despite a consensus from scientists that human actions are causing global warming, a small number of vocal climate change deniers in the U.S. have made climate change a contested political issue and have managed to defeat federal efforts to reduce greenhouse gas emissions (Popovich, 2017).

Successfully addressing the world's environmental problems will require an informed and motivated public to find realistic, evidence-based solutions (Hollweg, Taylor, Bybee, Marcinkowski, McBeth, & Zoiso, 2011). Everyday citizens must be made aware of and be able to understand complex environmental problems. They must also possess the necessary skills to take action, such as knowing how to become civically engaged to produce societal change, and how to undertake individual actions, such as conserving energy and recycling. In addition to environmental knowledge and skills, the public must develop attitudes that will motivate and inspire them to care about the environment. It is a combination of knowledge, skills, and attitudes that will result in individual behaviors on a large scale that will lead to progress in tackling environmental issues (Kollmuss & Agyeman, 2002).

In this chapter, environmental education is introduced as one strategy for creating an informed, educated, and motivated citizenry. I first present the study's purpose and research questions. Next, I define and describe environmental education and briefly discuss environmental education research. Additionally, I highlight environmental education with middle school and high school students in the U.S as an important context. I conclude the chapter with an introduction to systematic reviews and grounded theory as appropriate methods to explore theoretical underpinnings of environmental education.

Purpose Statement

Our world faces a range of environmental problems directly linked to or exacerbated by human actions and choices. Environmental education is one tool that can create a more environmentally literate citizenry. Environmental education research contains numerous studies examining whether or not environmental education programs are achieving certain outcomes, yet *how* and *why* and under what circumstances environmental education works remains unclear. The purpose of this grounded theory systematic review was to explore and understand how environmental education works. This research was designed to develop a grounded theory model that synthesizes the strategies that lead to desired outcomes in environmental education programs for middle school and high school students in the U.S. First, an initial, traditional literature review of the broader field of environmental education (not specific to secondary environmental education in the U.S.) was conducted to develop a preliminary grounded theory model of environmental education. Next, peer-reviewed studies that examine environmental education with middle school and high school students in the U.S. were located and reviewed using systematic review protocols. Extracted data from the reviewed studies and the preliminary grounded theory model informed the development of a grounded theory model of environmental

education. Theoretical sampling of peer-reviewed research was used to further refine the grounded theory model.

Research Questions

1. How does environmental education lead to positive outcomes for middle school and high school students in the U.S.?

A grounded theory model was developed that addressed the following additional research questions:

   a. What are the intended and unanticipated outcomes of environmental education programs for middle school and high school students in the U.S.?
   b. What strategies do educators use in environmental education programs for middle school and high school students in the U.S. to achieve the desired outcomes?
   c. How do individual and contextual conditions impact the outcomes of environmental education programs for middle school and high school students in the U.S.?
   d. What core category explains why and how environmental education programs works in the specific context involving middle school and high school students in the U.S.?

Defining Environmental Education

Environmental education is one tool available to spur a more active and environmentally literate citizenry. Environmental education in the U.S. traces its roots to the merging of conservationism with related education movements of the early 1900s, namely nature study, outdoor education, and conservation education (Disinger, 1985). A definitional debate has at times plagued the field of environmental education (Disinger, 1985; Jickling, 2007) and a

number of related terms (e.g., conservation education, education for sustainability, ecological education) has frequently compounded this identity crisis. The North American Association for Environmental Education (NAAEE, n.d., para. 1) defines environmental education as "a process that helps individuals, communities, and organizations learn more about the environment, and develop skills and understanding about how to address global challenges." The U.S. Environmental Protection Agency (EPA) offers a similar definition of environmental education: "Environmental education increases public awareness and knowledge about environmental issues or problems. In doing so, it provides the public with the necessary skills to make informed decisions and take responsible action" (EPA, 2018, para. 1). In addition to awareness, knowledge, and skills, recent reviews of environmental behavior have emphasized the importance of positive environmental attitudes (Bamberg & Möser, 2007; Heimlich & Ardoin, 2008; Kollmuss & Agyeman, 2002; Steg & Vlek, 2009). In this study, I define environmental education as educational programs focused on environmentally related topics presented to positively impact the knowledge, attitudes, skills, behaviors, and actions of participants with the ultimate goal of creating an environmentally literate citizenry.

The term, environmental education, is used to describe a range of programs conducted in a variety of settings with diverse audiences (Ardoin, Bowers, Roth, & Holthuis, 2018). A typical environmental education program involves some kind of opportunity to interact with nature. Often environmental education programs include an outdoor component where participants go into a natural environment, such as a national park or local preserve (Farmer, Knapp, & Benton, 2007; Mcphie & Clarke, 2015); a zoo (Pringle, Hakverdi, Cronin-Jones, & Johnson, 2003); a public beach (James & Bixler, 2008); a butterfly garden or vegetable garden (Blair, 2009); or school playground that has trees and plants (Bell & Dyment, 2008). If access to a natural area is

not available or practical, environmental educators often bring natural materials, such as plants, rocks, seashells, or live animals into a classroom (Tarr, 2008). Environmental educators are also exploring the use of virtual reality and web-based tools to support virtual field trips and field experiences when travelling to a natural area is not feasible (Hirsch & Lloyd, 2005; Kamarainen et al., 2013; Poland, Baggott la Velle, & Nichol, 2003). Most environmental education programs combine an outdoor experience (real or simulated) with classroom activities that can include collaborative group work, class discussions, educational films, action projects, lab investigations, and traditional lectures. Environmental education programs can occur as part of formal education in schools, or in nonformal educational settings such as museums and science centers.

In many environmental education programs, classroom teachers take the lead in planning and implementing activities and experiences. Teachers are often supported by staff from non-profit environmental education programs that include, in the U.S., national programs like Project Learning Tree and Project WET and local programs based at zoos, science centers, nature centers, and parks (Powers, 2004). Government agencies at the federal and state level often have education specialists who provide programming or can work with teachers to develop and implement environmental education programming. For example, the USDA Forest Service and National Fish and Wildlife Service have environmental educators as part of their staff. State departments of forestry and natural resources also offer environmental education programs. Many of these programs can be completed in a school setting but may also involve field trips to natural areas.

Environmental education programs vary tremendously in duration. Some programs are one-time events such as when a representative of the local water district makes a presentation to a class about water conservation (Miller, Davis, Boyd, & Danby, 2014). Many classroom

teachers incorporate environmental education by integrating an environmentally themed unit into their standard science or social studies curriculum to address educational standards around topics such as climate, plants, animals, land use, and sustainability. These programs may occur over several weeks during the school year (e.g., Cetin & Nisanci, 2010; Dimick, 2012). There are also schools with an environmental focus where environmental themes and activities are an integral part of the everyday curriculum. These include environmental charter schools, nature kindergartens, and forest schools (e.g., Grayson, 2011; Jeronen, Jeronen, & Raustia, 2009; Maynard, 2007).

Environmental education can occur throughout a person's lifespan. In the field of early childhood, for example, nature centers manage preschool programs that use a nature-based curriculum incorporating unstructured play outside (Bailie, 2012). Farmer, Knapp, and Benton (2007) described the experience of fourth-graders during a one-day field trip to Great Smokey Mountains National Park involving hands-on activities and interaction with park staff. In an environmental education program in an urban high school, students created documentaries focused on environmental issues (Harness & Drossman, 2011). Undergraduate students in an environmental sociology course explored student use of water bottles and worked to change the culture of consumption on campus (Bywater, 2014). Environmental education is not just for children and young people. Merenlender, Crall, Drill, Prysby, and Ballard (2016) described the Virginia Naturalist Program that provides training for adults in biogeography, environmental science, and environmental issues. Graduates of the program volunteer to work with scientists to collect environmental data and educate the public about environmental issues.

Need for a Grounded Theory Model in Environmental Education Research

Compared to other education fields such as science education and math education, environmental education is relatively new, yet has already developed a significant research base and community of scholars (Stevenson, Brody, Dillon, & Wals, 2012). One of the major environmental education research journals, *Journal of Environmental Education*, began publishing in 1969, just as environmental education began to emerge as a distinct field of study (Taylor & Francis Online, 2018). Since that time, environmental education researchers have consistently produced reviews of research to both synthesize past research trends and suggest future research directions (e.g., Ardoin, Clark, & Kelsey, 2013; Hart & Nolan, 1999; Iozzi, 1981; Marcinkowski & Mrazek, 1996; Rickinson, 2001; Stern, Powell, & Hill, 2014). In book chapters, articles, editorials, blog posts, conference presentations, and keynote addresses, researchers have participated in ongoing reflection and debates about environmental education research to further shape and improve the field (e.g., Jickling, 2009; Reid, 2013; Scott, 2009).

This tremendous amount of research and reflection has not yielded a definitive model of environmental education that looks at how, when, and why environmental education programs work. Environmental education research and practice consistently draw upon existing theories coopted from other fields, such as psychology, education, and health (Brownlee, Powell, & Hallo, 2013; Jacobson, McDuff, & Monroe, 2015; Levy & Zint, 2013). Additionally, much of environmental education research is practitioner oriented and focuses on practical tips and strategies for conducting environmental education. Research with a more theoretical bent tends to examine a single program with any conclusions drawn based on the single experience under study. While there are a number of research reviews that have examined primary studies, the

results of these syntheses are frequently narrative summaries or lengthy lists of compiled strategies and outcomes.

What is lacking in environmental education research is a comprehensive model of environmental education that the field can call its own. In trying to create an environmentally literate citizenry through education, environmental education is doing something unique and surely this warrants its own theory. Recent reviews (Ardoin et al., 2018; Stern et al., 2014) have done an excellent job of identifying and aggregating environmental education research but have stopped short of a high-level synthesis that would demonstrate how, when, and why environmental education is effective. In this study, I will address this need by developing a grounded theory model of environmental education. A grounded theory model is the organization of related concepts inductively derived from data. The focus of a grounded theory model is on understanding not on explanation and prediction (Charmaz, 2014). While the model is situated in a defined context, it is not necessarily tested in different settings. I situated my grounded theory model in the context of middle school and high school environmental education in the U.S.

Environmental Education with Middle School and High School Students

A basic tenet of education is that the program or curriculum should fit the developmental stage and age of the participants. In the North American Association for Environmental Education's guidelines for creating and evaluating environmental education materials, Simmons et al. (2010) called for content and activities that are suitable and appropriate for the target grade level. As a result, while there are common underpinnings of all environmental education programs, an early childhood environmental education program, for example, will look very different from a high school environmental education program. In this study, I focused on

environmental programs for middle school and high school students (defined in this study as students ages 11 to 19).

Middle school and high school students are frequent participants in environmental education, with many environmental educators viewing these years as an ideal time to influence future environmental actions and behavior (Ardoin et al., 2018). Environmental educators know that students currently in middle school and high school are the decision makers of the future and therefore represent a crucial audience (Meinhold & Malkus, 2005). A number of researchers have interviewed adult environmental activists to explore what experiences shaped their pro-environmental work; the adults consistently described influential experiences in their middle and high school years (Arnold, Cohen, & Warner, 2009; Chawla, 2006, 2009). Other research has corroborated the importance of youth experiences in nature by examining environmental beliefs of the general adult population (Berns & Simpson, 2009; Ewert, Place, & Sibthorp, 2005; Wells & Lekies, 2012). This suggests that environmental education during the middle and high school years can play a pivotal role in shaping future environmentally literate adults.

Students in middle school and high school are also a highly appropriate audience for environmental education when considering the cognitive and affective development of this age group. Compared to children in elementary school, environmental educators view students in middle school and high school as having an increased capacity for understanding the complexities of contemporary environmental issues (DiEnno & Hilton, 2005; Parkin, Shackleton, & Schudel, 2006; Stevenson, Peterson, Bondell, Mertig, & Moore, 2013). It is during these middle school and high school years that affective dispositions such as environmental attitudes, environmental sensitivity, and connection to the natural world begin to

solidify (Kellert, 2002; Sivek, 2002). These developmental milestones make adolescence a prime time to involve students in environmental education programs.

Environmental Education in the U.S.

While environmental education occurs in settings throughout the world, national policies and attitudes often influence the form and function of environmental education in individual countries (Barraza & Walford, 2002; Boeve-de Pauw & Van Petegem, 2010; Breiting & Wickenberg, 2010). The link between environmental education and country of setting suggests that focusing on a single country would facilitate the development of a grounded theory model of environmental education. In this study, I focused on environmental education in the U.S. While in some nations, like Taiwan and Finland, environmental education is a mandated and standardized part of a national school curriculum (Chang, n.d.; Jeronen, Jeronen, & Raustia, 2009), in the U.S., many education-related policies and decisions are made at the state or local level (McDonnell, 2005; Thomas & Brady, 2005). For environmental education, this means that how environmental education programs are implemented and managed varies from state to state (Clark & Whitford, 2010; Crouch & Abbot, 2009). Some states have a rich history of supporting environmental education and have integrated environmental education into their state education standards and curriculum; in other states, environmental education has received less funding and attention (Braus et al., 2014). Even in states with strong environmental education support, environmental education in the U.S. is most frequently viewed as an add-on to existing curriculum; whether environmental education is implemented, as well as the type of environmental education undertaken, is usually dependent on the individual teacher (Cole, 2007; Powers, 2004).

In addition to a lack of a national, comprehensive approach to environmental education, environmental educators in the U.S. must also contend with a backlash against environmental education. Some groups in the U.S., largely those aligned with the conservative right, argue that environmental education is liberal propaganda that brainwashes young students to be environmental activists (Crouch & Abbot, 2009). In the U.S., environmental issues have become political issues, best exemplified by the politicization of climate change (McCright & Dunlap, 2011). There are more climate change deniers in the U.S. than any other country in the world, with U.S. President Donald Trump publicly referring to climate change as an elaborate hoax to trick the Chinese (Erikson, 2017). With such vocal support denying scientifically supported anthropogenic climate change and open feelings of hostility towards educators and youth working to protect the environment, it is not surprising that environmental education has been called a failure in the U.S. (Blumstein & Saylan, 2007).

Using A Research Review to Develop A Grounded Theory Model

The combination of pressing environmental problems and doubt among some members of American society about environmental education suggests now is a good time to examine environmental education to develop a grounded theory model of environmental education. The field of environmental education research provides an immense amount of published studies that examine environmental education and the associated contexts, strategies, and outcomes. These existing studies are the data that I used to inductively develop a grounded theory model of environmental education for middle school and high school students in the U.S. To create a manageable dataset, I focused on studies published after 2010. I chose this time range because a recent systematic review conducted by Stern et al. (2014) and focused on strategies and outcomes, reviewed environmental education studies published from 1999 through 2010.

Additionally, a review that focuses on the most recent research is warranted because environmental education researchers have acknowledged that environmental education in practice is highly responsive to contemporary social and environmental conditions, resulting in a fluid field subject to constant change (Biedenweg, Monroe, & Wojcik, 2013; DuBois, Krasny, & Smith, 2017).

Even after limiting the data to research published after 2010, the quantity of research to collect and analyze was sizeable. The field of knowledge synthesis has developed to help researchers, practitioners, and policy-makers in their quest to remain informed about research. Dicks et al. (2017, p. 4) defined knowledge synthesis as "a set of methods used to review, collate and communicate the best available knowledge on a specific topic or question." Knowledge synthesists have identified numerous types of research reviews (e.g., Grant & Booth, 2009; Kastner et al., 2012). For this study, I used a systematic review with a grounded theory approach. In the following paragraphs, I provide information about this specific review type that was developed to meet the needs of this study.

Systematic Reviews of Research

In a traditional literature review, the researcher is not overly concerned with transparency and rigor. Searching for relevant literature can proceed haphazardly, may be reliant on serendipitous search methods, and may revolve around a broad or nebulous topic. The reasons for choosing to focus on certain literature, and ignoring others, are often not addressed in traditional literature reviews. In contrast, a systematic review involves explicit, systematic methods to search, identify, screen, appraise, and analyze a collection of research studies. The researcher begins with a focused question or topic, systematically searches and analyzes the relevant literature, and keeps detailed records throughout the process.

Systematic reviews have been described as a young, developing field (Gough, Oliver, & Thomas, 2017) but they have a long history grounded in medicine and science. Systematic reviews grew from early meta-analyses completed by physicians and medical researchers to determine the efficacy of interventions such as vaccinations and new medicines (Cooper, 2010). Some critics view systematic reviews as "illegal imports from the world of medicine" (Gough et al., 2017, p. xiii; see also Evans & Benefield, 2001), but the social sciences enjoy their own history of systematic reviews. In the 1970s, researchers in psychology, sociology, and education began publishing more and more high quality meta-analyses, which are research reviews that use statistical procedures to combine results from similar studies (Gough et al., 2017). In the social sciences, these quantitative-focused reviews eventually evolved into systematic reviews as researchers emphasized the methods involved in synthesizing research; these early systematic reviews often included a meta-analytical component but also began incorporating narrative synthesis (Cooper, 2010). Educational research now includes many systematic reviews on diverse topics. For example, a scan of recent table of contents of two high-impact educational research journals (*Educational Research Review* and *Review of Educational Research*) revealed systematic reviews of research on principal turnover (Rangel, 2018), blended learning (Boelens, De Wever, & Voet, 2017), sexuality education (Gegenfurtner & Gebhardt, 2017), and social skills interventions (Ke, Whalon, & Yun, 2018).

Grounded Theory in a Systematic Review

Most systematic reviews follow commonly agreed upon, basic steps to identify, screen, and analyze research studies relevant to a review question or topic (Cooper, 2010; Gough et al., 2017). Within each step of the review, there are many specific methods that can be used and many systematic reviews appear to lack justification for why certain methods were chosen. To

improve the rigor in this systematic review, I used a grounded theory approach throughout the review process. Grounded theory methodology and associated grounded theory methods guided decision-making and practice during the review process. Rather than using a hodgepodge of potentially unrelated methods and design, using a grounded theory approach created a coherent structure that supported transparency and systematicity—defining characteristics of quality systematic reviews.

As a methodology, grounded theory provides a framework for conducting a systematic review in a way that develops a grounded theory—a set of related constructs about a phenomenon. The constructs are derived inductively from a coding process that involves iterative data collection and analysis (Charmaz, 2014). This study most closely aligns with constructivist grounded theory (Charmaz, 2014), as the grounded theory model that emerged from the data is viewed as one interpretation of environmental education based on research studies identified in the systematic review.

Grounded theory is an appropriate methodology for studying environmental education because environmental education is a complex, multi-layer, temporal phenomenon that is strongly influenced by context such as setting, participants, facilitator, topic, and teaching strategies (Charmaz, 2014). In addition to adopting an approach emphasizing grounded theory methodology, throughout the study I used grounded theory methods during data collection and analysis. Grounded theory methods are tools and techniques associated with the grounded theory methodology and include constant comparison, theoretical sampling, and analytical memos and matrices.

Chapter 2: Literature Review

Complex environmental issues, such as climate change, biodiversity loss, and availability of potable water, represent serious challenges to maintaining a sustainable human population. Since the 1960s, environmental education has offered a powerful tool to create environmentally literate citizens willing to take action to address environmental problems. Robust research and practitioner-oriented materials provide support for environmental education, but few, if any, comprehensive models exist that connect practices with agreed-upon outcomes. The goal of this study was to develop a grounded theory model of secondary environmental education based on a systematic review of environmental education research published in peer-reviewed journals or as peer-reviewed conference papers. A grounded theory model will aid researchers as they evaluate and study environmental education programs and practitioners as they develop and improve environmental education programs.

Environmental education in practice is versatile and fluid as educators constantly adapt to changing social and environmental conditions (Biedenweg, Monroe, & Wojcik, 2013; DuBois, Krasny, & Smith, 2017; Fraser, Gupta, & Krasny, 2015). Changing practices, strategies, objectives, goals, and definitions can present a challenge to environmental education researchers who are attempting to offer recommendations for improved policy and practice. As such, this study's systematic review focused on recent environmental education research published between 2011 and 2018 to ensure results and findings are relevant and cutting-edge. Additionally, I chose 2011 as the cut-off date because a recent systematic review of K–12 environmental education research (Stern et al., 2014) included studies published between 1999 and 2010.

This chapter describes a traditional literature review that targeted research not part of this

study's systematic review corpus due to delimitations of the search process, namely that the systematic review did not include research published prior to 2011 and focused on secondary environmental education in the U.S.

Conducting a literature review prior to data collection and analysis in this study was necessary to confirm the need for a grounded theory model of environmental education. Additionally, I sought to identify and synthesize previously conducted systematic reviews. The literature review presented in this chapter informed the creation of a preliminary grounded theory model of environmental education (see Figure 1). The creation of a grounded theory model based on a literature review is not new. In her study of the concept of integration in nursing, Whittemore (2005) presented a grounded theory model of integration based on an integrative review of 56 published journal articles and reports.

Literature Reviews in Grounded Theory

In support of pure induction, proponents of classical grounded theory methodology have suggested delaying a literature review until the end of data analysis (Andrew, 2006; Charmaz, 2014; Dunne, 2010; Nathaniel, 2006). This aspect of grounded theory has been the subject of ongoing discussion with many grounded theorists supporting a literature review prior to and concurrent with grounded theory data collection and analysis (Charmaz, 2014; Corbin & Strauss, 2015; Dunne, 2010; Thornberg, 2012). Even Glaser, one of the originators of grounded theory and a staunch believer in delaying the literature review, acknowledged that there were practical reasons, such as pleasing dissertation committee members and funders, for doing a literature review prior to data collection and analysis (McCallin, 2003). By reviewing past research

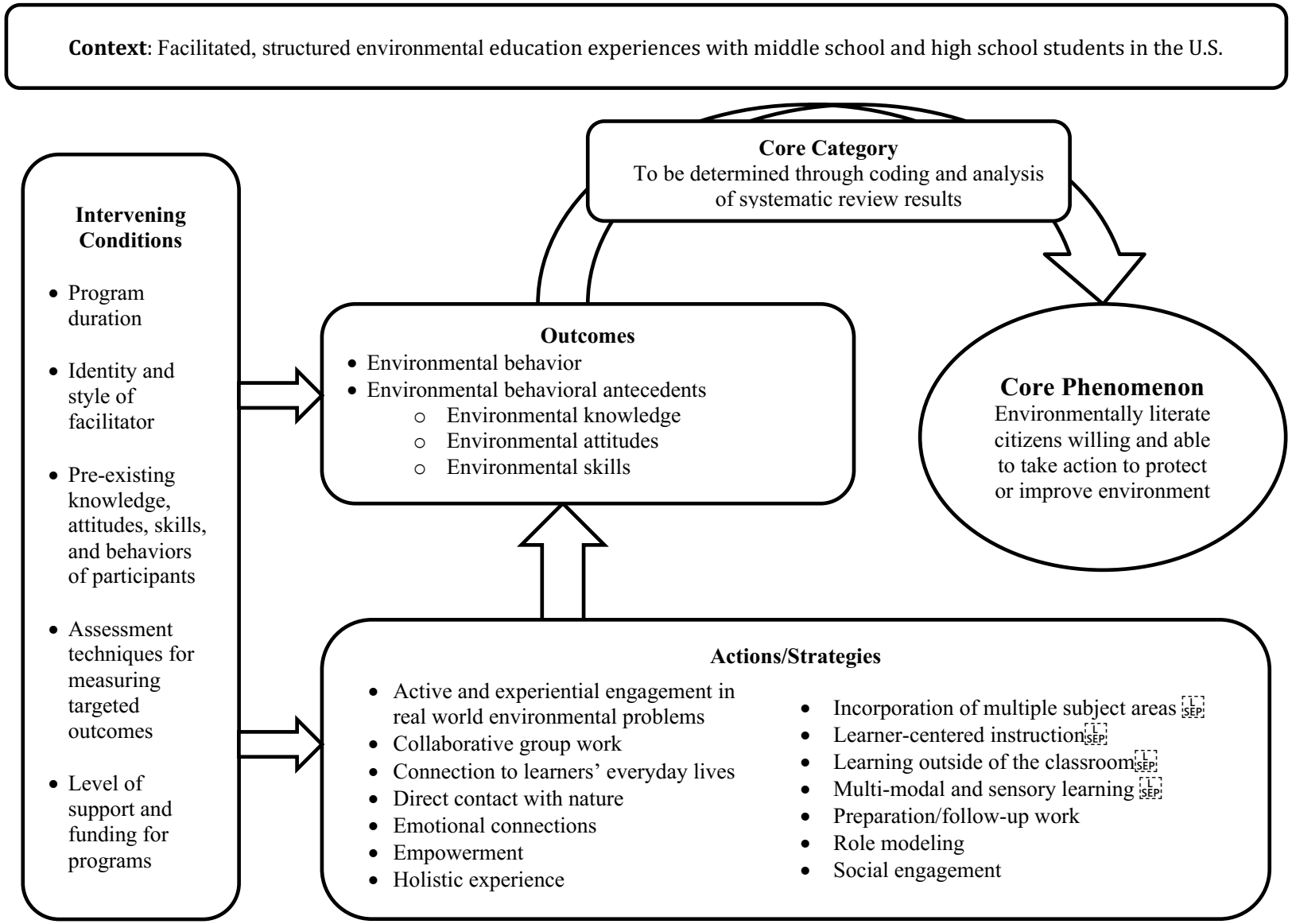

Figure 1. Preliminary grounded theory model addressing the effectiveness of environmental education programs.

reviews and related primary studies in environmental education, I was able to confirm the lack of a model of environmental education. Additionally, conducting a literature review served as a vehicle for identifying sensitizing concepts, which I discuss in Chapter 3.

Components of the Preliminary Grounded Theory Model

In this study, the literature review described in this chapter informed a preliminary grounded theory model using the components aligned with categories from Strauss and Corbin's approach to grounded theory: core phenomenon, context, actions/strategies, consequences/outcomes, intervening conditions, and core category (Corbin & Strauss, 2015; Creswell & Poth, 2018). This chapter is organized around these model components, where each model component is presented in its own chapter section.

Environmental Education (Core Phenomenon and Context)

In grounded theory, the core phenomenon is the main issue that is being theorized about (Creswell & Poth, 2018). For this study, the core phenomenon is environmental education. A review of current definitions of environmental education suggest a core phenomenon that emphasizes action and behavior. The North American Association for Environmental Education (NAAEE) defines environmental education as "a process that helps individuals, communities, and organizations learn more about the environment, and develop skills and understanding about how to address global challenges" (NAAEE, n.d., para. 1). The U.S. Environmental Protection Agency (EPA) offers this definition of environmental education: "Environmental education increases public awareness and knowledge about environmental issues or problems. In doing so, it provides the public with the necessary skills to make informed decisions and take responsible action" (EPA, 2018, para. 1). Both the NAAEE and EPA definitions make a clear connection between environmental learning and taking action and this focus on actions and behaviors

receives further support from environmental education researchers (Chawla & Cushing, 2007; Heimlich & Ardoin, 2008; Kollmuss & Agyeman, 2002). Thus, for this study, environmental education is education that results in environmentally literate participants undertaking an action or behavior to help protect or improve the environment.

Context refers to a specific set of conditions surrounding the strategies and actions under study (Creswell & Poth, 2018). This focus on context is a defining feature of grounded theory studies. Charmaz (2014) described a grounded theory as "an abstract theoretical understanding of the studied experience" (p. 4). Grounded theory is not aiming for an all-encompassing theory that explains every, single experience, rather the "studied experience" involves specific context, some of which may be known prior to data collection and analysis, and some of which may emerge from the data itself (Charmaz, 2014). For this study, I focused on environmental education with middle school and high school students in the U.S. Secondary students represent a primary audience for environmental education, with significant resources, efforts, and research being expended to support environmental education (Ardoin et al., 2018; Stevenson, Peterson, Bondell, Mertig, & Moore, 2013). The middle school and high school years have been noted as an important window of opportunity to positively influence pro-environmental behaviors and actions later in life (Berns & Simpson, 2009; Chawla, 2015; Ewert, Place, & Sibthorp, 2005; Wells & Lekies, 2012).

The environmental education programs under study provide additional context as they represent a facilitated, structured educational experience that differentiates them from youth simply spending time in nature. There is a tremendous amount of research, interest, and support associated with getting children outside (Chawla, 2015; Louv, 2008) and environmental educators view this movement as corroboration for environmental education, but environmental

education involves more than children playing in nature. Having an adult plan and implement environmental education activities is a defining feature of environmental education. Although environmental education programs may vary in form and function, each environmental education program should follow commonly agreed upon best practices in education. NAAEE has developed a set of standards for environmental education programs that delineates six guidelines for excellence: fairness and accuracy, depth, emphasis on skill building, action orientation, instructional soundness, and usability (Simmons et al., 2004). While not every environmental education program conforms to the guidelines, these basic standards serve as initial context that most environmental education programs strive to achieve.

Environmental Education Practices (Strategies)

In the grounded theory model, the strategies are the actions taken as part of the core phenomenon (Creswell & Poth, 2018). For this model, the strategies are the educational practices that the facilitator of the environmental education program uses to achieve the desired outcomes. The reviewed literature did not yield a consensus about a few, select strategies; rather, the reviewed literature suggested a list of potentially important strategies. This may be due to the fact that the majority of research studies that empirically examine environmental education focus on a single program resulting in lots of research about specific strategies but little discussion that compares the effectiveness of these strategies. For example, Kinslow, Sadler, and Nguyen (2018) explored changes in environmental literacy in one field ecology course for high school students that used a socio-scientific issue-based teaching approach. Bergman (2016) investigated the effects of a single environmental service-learning project on the attitudes, awareness, and intentions of fourth through eighth grade students. Like most empirical research in environmental education that highlights strategies, these two studies provide support for the

strategy they are promoting but provide little guidance about how the strategy might compare to other environmental education practices.

Less common in environmental education are reviews that look across multiple studies to identify the most effective educational practices and strategies. This section reviews three documents that have provided compilations of environmental education best practices based either on research reviews (Rickinson, 2001; Stern et al., 2014) or recommendations from a team of environmental education experts (Simmons et al., 2004). Using a historical perspective, Rickinson (2001) is discussed first as his findings are based on a review of studies published between 1993 and 1999. Stern et al. (2014) is discussed next as they reported that their review built on Rickinson's work and involved a review of studies published from 2000 to 2010. To conclude this section on strategies, I review the recommended practices developed by the NAAEE (Simmons et al., 2004) that have received support from both practitioners and researchers.

Rickinson (2001) reviewed 110 studies and noted that these studies, published prior to 2000, had not produced many notable findings about which environmental educational strategies had been the most effective in achieving program outcomes. Instead, Rickinson reported that most of the reviewed empirical studies were singularly focused on providing evidence about whether a specific outcome had been successfully achieved. From the few studies that did attempt to connect strategies to positive outcomes, Rickinson identified the following four program strategies: (1) role modeling; (2) direct contact with nature; (3) collaborative group work; and (4) preparation/follow-up work.

In contrast to Rickinson (2001), Stern et al. (2014) conducted preliminary work in an attempt to connect effective practices and achieved outcomes. In their review of evaluations and

research studies of K–12 environmental education programs, Stern et al. (2014) identified numerous best practices using two avenues of discovery. First, they synthesized existing literature on best practices in environmental education (with a self-reported emphasis on NAAEE guidelines) to create a list of consensus-based best practices. Second, Stern et al. used authors' discussions and claims collected during the review of 86 K–12 environmental education programs to identify influential program strategies and characteristics. In addition to identifying program characteristics that can be viewed as best practices, Stern et al. provided data about the level of findings (i.e., null, mixed, or positive) associated with the different practices. The analysis of how practices were associated with findings led Stern et al. to identify six effective broad program strategies: (1) active and experiential engagement in real world environmental problems; (2) empowerment; (3) student-centered learning; (4) social engagement; (5) emotional connections; and (6) holistic experience.

The NAAEE's *Environmental Education Materials*: *Guidelines for Excellence* (Simmons et al., 2004) outlined six key characteristics of high-quality environmental education materials. A team of environmental education professionals identified these characteristics and repeatedly revised them based on input from over a thousand environmental education practitioners and researchers. Some of these characteristics, such as fairness and accuracy and usability, were designed to help curriculum designers create high-quality environmental education materials. One of the six key characteristics—instructional soundness—directly addresses what the guideline developers felt were effective environmental education strategies. Five strategies to support instructional soundness were recommended: (1) learner-centered instruction; (2) multi-modal and sensory learning; (3) connection to learners' everyday lives; (4) learning outside the classroom; and (5) incorporation of multiple subject areas.

Reviewing the findings from Rickinson (2001), Stern et al. (2014), and Simmons et al. (2004) did not reveal a lot of overlap, suggesting that there is not a general consensus about what strategies in environmental education are the most effective. The only strategy supported by more than one of the researchers is learning-centered instruction. As such, a list of potentially effective strategies was created by combining the findings from Rickinson, Stern et al., and Simmons et al. I added this combined list to the preliminary grounded theory model in Figure 1 with the hopes that the systematic review would help trim the model by identifying the effective strategies with the most recent empirical support.

Environmental Education Outcomes (Consequences)

In a grounded theory model, the consequences are the outcomes associated with using the strategies (Creswell & Poth, 2018). For the model developed in this study, the consequences refer to the desired outcomes measured and observed in the environmental education programs under study. To create an environmentally literate citizenry that is willing and able to take action to protect and improve the environment, the reviewed literature demonstrated common support for the idea that environmental educators most frequently target behavioral and behavioral antecedent outcomes (Ardoin et al., 2018; Rickinson, 2001; Stern et al., 2014), which are discussed in this section. Less common outcomes of environmental education include community level outcomes such as capacity-building and community resilience (Schusler, Krasny, Peters, & Decker, 2009) as well as direct environmental outcomes such as change in air quality or water quality (Johnson, Duffin, & Murphy, 2012). While these are also important environmental education outcomes, this study focuses on behavior-related outcomes in individual participants, as these are the most studied outcomes in environmental education and most applicable in a secondary school setting.

Environmental behavior refers to behavior consciously undertaken by a person to minimize the negative impact of their actions and lifestyle on the environment (Kollmuss & Agyeman, 2002). Common environmental behaviors include conserving energy by turning off lights, conserving water by monitoring and adjusting water use, recycling, buying organic foods, eating less meat, and using public transportation (Cleveland, Kalamas, & Laroche, 2005; Gatersleben, Steg, & Vlek, 2002). Despite difficulties in measuring changes in environmental behaviors (Milfont, 2009; Olli, Grendstad, & Wollebaek, 2001; Steg & Vlek, 2009), numerous reviews of environmental education research have identified behavioral outcomes as a major outcome under study (Ardoin et al., 2018; Rickinson, 2001; Stern et al., 2014; Zelezny, 1999).

Environmental education researchers and environmental psychologists have extensively explored environmental behavior in the hopes of identifying the most efficient and effective ways to create and sustain positive environmental behavioral changes (Heimlich & Ardoin, 2008; Kollmus & Agyemon, 2002). Environmental behavior models have identified environmental behavior antecedents—determinant variables associated with positive changes in environmental behavior (Bamberg & Möser, 2007). Early environmental behavior models used in environmental education proposed a simple, linear process that linked knowledge and behavior; the idea was that increased knowledge would lead to positive changes in environmental behaviors (Bamberg & Möser, 2007; Hines, Hungerford, & Tomera, 1987). Recent thinking about environmental education has acknowledged that creating behavior is more complex than a simple, linear process and involves more than just environmental knowledge (Heimlich & Ardoin, 2008; Kollmus & Agyemon, 2002). In addition to environmental knowledge, environmental attitudes and environmental skills (e.g., critical thinking and systems thinking) have received increased attention as important environmental behavioral antecedents

(Casaló & Escario, 2018; Ernst & Monroe, 2006; Husted, Russo, Meza, & Tilleman, 2014; Molderez & Ceulemans, 2018; Sapci & Considine, 2014). Environmental education researchers and practitioners often use the environmental behavioral antecedents as the measurable outcomes of environmental education programs (Ardoin et al., 2018; Rickinson, 2001; Stern et al., 2014).

Looking across the environmental education literature that examines outcomes being targeted and measured in environmental education programs revealed a consensus for the primacy of four broad outcomes: environmental behavior and three antecedents of environmental behavior (environmental knowledge, environmental attitudes, and environmental skills). These four identified outcomes were added to the preliminary grounded theory model (see Figure 1) as the consequences associated with the strategies. The systematic review results served to confirm if these outcomes remained the dominant outcomes in recent empirical studies of environmental education.

Environmental Education Barriers and Supports (Intervening Conditions)

Situational factors that have been identified as affecting the strategies and outcomes in a grounded theory model are called intervening conditions (Creswell & Poth, 2018). In a grounded theory model of effective environmental education, intervening conditions include program and participant characteristics. Intervening conditions have not been an explicit focus of past environmental education research but the reviewed research reviews suggested program duration, facilitator and participant characteristics, and assessment techniques as possible influential conditions. In this section, I discuss the scant information offered by existing research reviews in environmental education concerning possible influential conditions and present Ernst's (2007) work regarding barriers to environmental education as a potential source for ideas about intervening conditions in environmental education.

Previous reviews of environmental education research have largely focused on outcomes and practices (e.g., Ardoin et al., 2018; Rickinson, 2001; Stern et al., 2014). The reviewers have alluded to intervening conditions as they discussed program and participant characteristics that they believe may have been influencing the measured outcomes. Several researchers have suggested the length of the environmental education program (program duration) as an important program characteristic with longer programs, such as one- to three-day residential programs or semester or yearlong projects, suggested to be more effective than short, one-time programs that last an hour (Ardoin et al., 2018; Rickinson, 2001; Stern et al., 2014).

Rickinson (2001) and Stern et al. (2014) presented the identity and style of the program facilitator as an instrumental program feature. Stern et al. talked about several studies that described the need for an enthusiastic, caring, and engaging teacher who guides students along a journey of environmental learning. Rickinson and Stern et al. also commented on specific characteristics of program participants that appeared to have affected program outcomes. Rickinson reviewed research that suggested students with an interest in environmental topics were more likely to demonstrate gains in environmental knowledge. Stern et al. suggested that students who possess already high levels of positive environmental knowledge, skills, attitudes, and behaviors will not be able to demonstrate increases in those areas after participating in an effective environmental education program; this is referred to as the 'ceiling effect.' While the exact nature of how participants' prior environmental knowledge, skills, attitudes, and behaviors affects program outcomes is unknown, findings from Rickinson and Stern et al. suggest that this factor may play an important role in achieving desired outcomes. Additionally, the possible existence of a ceiling effect hints at a final program characteristic of interest—assessment and evaluation conditions that may make measuring targeted outcomes difficult. Rickinson, Stern et

al., and Ardoin et al. (2018) discussed the known difficulties when measuring certain outcomes such as attitudes and behaviors. These measurement issues associated with environmental education program outcomes could also be an intervening condition worthy of further investigation.

In her study that examined K–12 teachers' use of environmental education, Ernst (2007) uncovered a number of variables that teachers reported as affecting their implementation of environmental education. Many of these variables had to do with the level of support that teachers felt they received when implementing environmental education. This support included monetary funding for programs as well as perceived support from administration, parents, and the community. The implication of Ernst's work is that level of support and funding can impact the environmental education program, which can then impact eventual program outcomes. This perceived barrier represents another possible intervening condition.

Based on the reviewed literature in this section, I added five possible intervening conditions to the preliminary grounded theory model in Figure 1. The five conditions are: (1) program duration; (2) identity and style of facilitator; (3) pre-existing participant knowledge, attitudes, skills, and behaviors; (4) assessment used for measuring targeted outcomes; and (5) level of support and funding for programs.

Core Category

The core category is the overarching theme with greatest explanatory power that links other categories (Corbin & Strauss, 2015). This part of the grounded theory model of environmental education has received the least amount of attention in the environmental education literature. While several reviews (e.g., Ardoin et al., 2018; Rickinson, 2001; Stern et al., 2014) have presented excellent syntheses of information about outcomes and strategies from

reviewed empirical studies, what is missing is an identification of the process that integrates the strategies, outcomes, conditions, and context surrounding environmental education. The preliminary model for this study, presented in Figure 1, shows a placeholder box for the core category but lacks suggested text. The systematic review and associated coding and analysis were used to complete this box in the final grounded theory model.

Process

While the core category box in Figure 1 is not completed, the placeholder box serves as a reminder that the core category was to be identified in the final grounded theory model. There is no corresponding placeholder for process, which some grounded theorists believe is central to the methodology. Charmaz (2014) described process as a sequence of events occurring over time that lead to change. While environmental education can be studied as a process, much of the empirical research on environmental education has focused on the more easily observed strategies and outcomes. A systematic review of the research can only examine what has been reported on; thus, both the preliminary grounded theory model and the final grounded theory model did not address the process that environmental education participants go through, but rather both models maintain a focus on strategies and outcomes. While Corbin and Strauss (2015) acknowledge that some grounded theory studies may emphasize process, they do not suggest that all grounded theory work must study a temporal process.

Conclusion

This chapter reviewed environmental education literature that contributed to the development of a preliminary grounded theory model of environmental education. Since a separate systematic review of a defined body of literature was used to inform final model

development, this narrative review focused on literature not likely to be identified in the systematic review. In this way, I worked to create an informed grounded theory approach that views existing literature as part of the data from which a grounded theory model can emerge (Thornberg, 2012). As a form of additional data, the review of literature in this chapter serves as a humble acknowledgement of previous high-quality research that has examined environmental education. By incorporating findings from this past work into a preliminary grounded theory model, I was able to integrate sound, older work with the identified findings of more recent research uncovered in the systematic review.

In addition to informing a preliminary grounded theory model, this literature review also offered support for the need of a grounded theory model in environmental education. The review highlighted the emphasis on outcome and strategy research in environmental education and the lack of substantial work on context, conditions, and process. Review of research reviews in the field revealed a lack of a comprehensive model that links outcomes, strategies, context, and conditions. To address this need, I developed a grounded theory model of environmental education using a grounded theory systematic review as described in the next chapter.

Chapter 3: Research Methods

The major trade association for academic publishing estimated that 2.5 million peer-reviewed journal articles were published in 2014 and that the rate of publication was growing by 3 to 3.5% (Ware & Mabe, 2015). For researchers trying to remain up to date with current and innovative research, research reviews have become important tools. Researchers have identified numerous types of research reviews (Grant & Booth, 2009; Kastner et al., 2012), many of which incorporate systematic review methods. Although there are numerous variations to the systematic review process, in general, a systematic review involves defining the question, searching the literature, appraising the quality of reviewed studies, extracting data from reviewed studies, analyzing the data, and sharing findings (Cooper, 2010; Gough et al., 2017; Petticrew & Roberts 2006). Researchers who use systematic review methods are endeavoring to be transparent and rigorous in order to present updateable and useful results.

In this chapter, I first briefly outline the study components and review the purpose of this study and associated research questions. Then I more fully describe the study phases as I discuss the methods that supported a grounded theory systematic review of recent peer-reviewed environmental education research to develop a grounded theory model of environmental education. I conclude this chapter with discussions of transparency and trustworthiness, and delimitations and limitations of the study.

Study Phases

Given the ultimate study goal of development of a grounded theory model, the study was divided into phases based on stage of model development. As shown in Figure 2, data collection and analysis were ongoing and occurred at multiple points during the study. The study involved the following phases:

- In the preliminary grounded theory model phase, a model was developed based on a traditional literature review targeting relevant research that would not be captured in the formal systematic review given the pre-determined review constraints and limitations. The preliminary grounded theory model was also informed by research identified during the systematic review but that failed to meet the inclusion criteria. I used data-driven thematic analysis (Braun & Clarke, 2006; Dixon-Woods et al., 2005) to synthesize categories to inform the components of a formal grounded theory model (i.e., strategies, outcomes, intervening conditions, context, and core category).
- The systematic review phase consisted of distinct stages of the systematic review process to locate, retrieve, screen, appraise, and analyze primary, peer-reviewed studies that examined environmental education for middle school and high school students in the U.S. and were published between 2011 and 2018. To analyze the data, I used grounded theory methods that incorporated initial, focused, theoretical coding and context-mechanism-outcome coding (Jackson & Kolla, 2012). The results of this phase's review process along with the preliminary grounded theory model from the first phase informed the development of a working (but not yet final) grounded theory model of environmental education.
- In the theoretical sampling phase, I conducted theoretical sampling to refine the newly developed grounded theory model. A theoretical sample was retrieved from primary, peer-reviewed studies that examined environmental education with secondary students in the U.S. and were published or made available after the initial systematic search was conducted. Additional studies were located using ancestry searching (Conn, et al., 2003), which involved reviewing the reference lists of studies in the original sample.

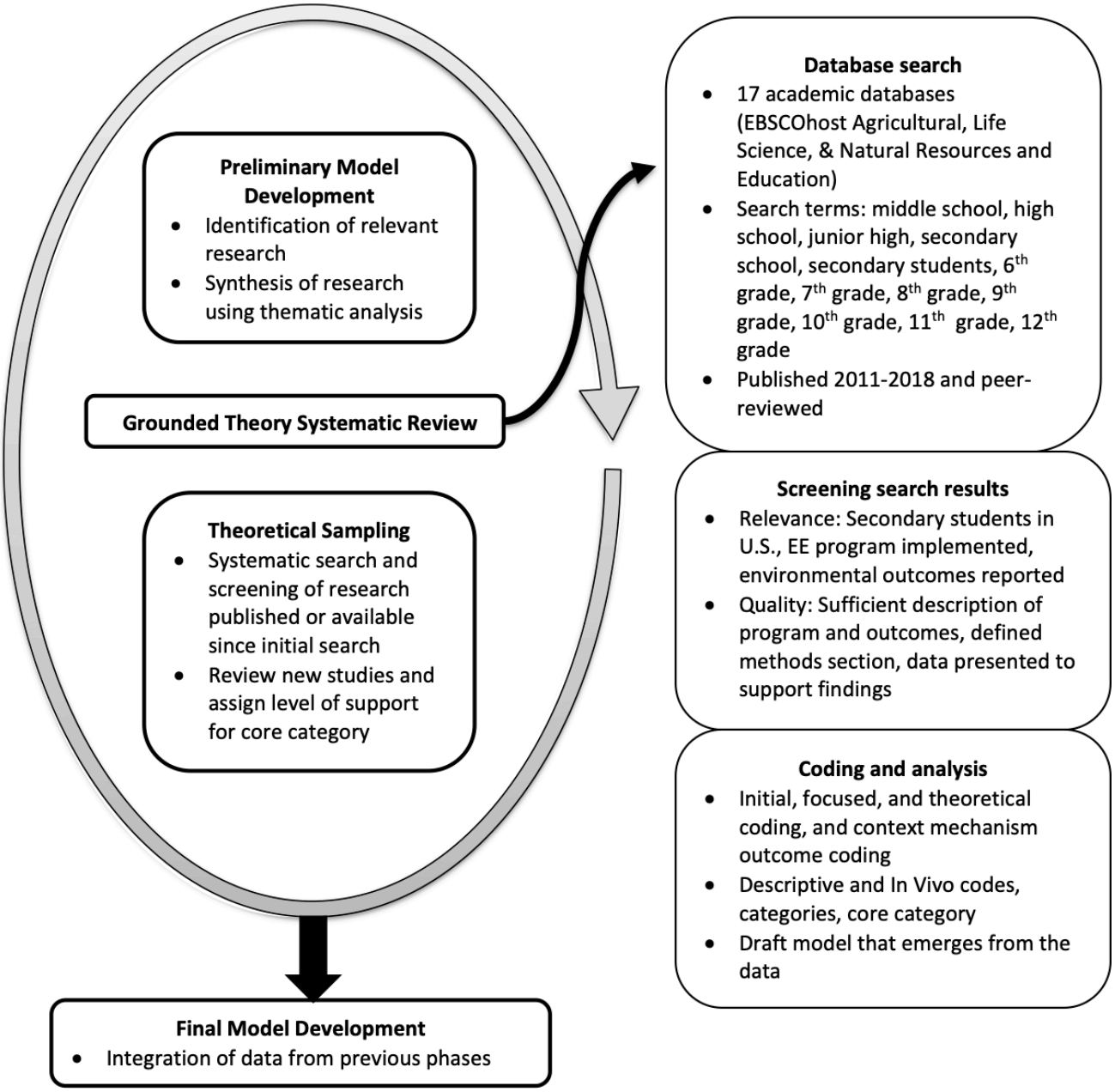

Figure 2. Study flowchart.

- In the culminating phase of final model development, I revised and finalized the grounded theory model by integrating data from all previous phases.

Purpose Statement

Our world faces a range of environmental problems directly linked to or exacerbated by human actions and choices. Environmental education is one tool that can create a more environmentally literate citizenry. Environmental education research contains numerous studies examining whether or not environmental education programs are achieving certain outcomes, yet *how* and *why* and under what circumstances environmental education works remains unclear. The purpose of this grounded theory systematic review was to explore and understand what makes environmental education work. This research was designed to develop a grounded theory model that synthesizes the strategies that lead to desired outcomes in environmental education programs for middle school and high school students in the U.S. First, an initial, traditional literature review of the broader field of environmental education (not specific to secondary environmental education in the U.S.) was conducted to develop a preliminary grounded theory model of environmental education. Next, peer-reviewed studies that examine environmental education with middle school and high school students in the U.S. were located and reviewed using systematic review protocols. Extracted data from the reviewed studies and the preliminary grounded theory model informed the development of a grounded theory model of environmental education. Theoretical sampling of peer-reviewed research was used to further refine the grounded theory model.

Research Questions

1. How does environmental education lead to positive outcomes for middle school and high school students in the U.S.?

A grounded theory model was developed that addressed the following additional research questions:

a. What are the intended and unanticipated outcomes of environmental education programs for middle school and high school students in the U.S.?
b. What strategies do educators use in environmental education programs for middle school and high school students in the U.S. to achieve the desired outcomes?
c. How do individual and contextual conditions impact the outcomes of environmental education programs for middle school and high school students in the U.S.?
d. What core category explains why and how environmental education programs work in the specific context involving middle school and high school students in the U.S.?

Selection of Data Source

In educational research, data typically come from research participants such as students, educators, parents, and administrators, via methods such as observation, interviews, focus groups, and surveys. When conducting research reviews, data are usually found in the written texts describing such studies, which are referred to in systematic reviews as primary-level studies or more commonly as reviewed studies (Gough et al., 2017; Heyvaert et al., 2017). These primary-level studies comprise the review sample. Using published studies, rather than participants, circumvents many of the ethical problems that result from having actual participants. Given the nature of the data for this study, Institutional Review Board (IRB) approval was not needed.

Preliminary Model Development Phase

The ultimate goal of this study was the development of a grounded theory model of environmental education. After conducting searches for and speaking with environmental education experts about existing theoretical models, I was unable to find models that link strategies and outcomes. Instead, a picture emerged of a multi-disciplinary field that draws from many existing, established theories (Jacobson, McDuff, & Monroe, 2015).

The main systematic review phase of this study was focused on a specific subset of environmental education research—peer-reviewed research published between 2011 and 2018 that focused on middle school and high school students in the U.S. The constraints of the main systematic review were chosen for specific reasons but it would be foolish to fail to acknowledge that there is relevant research outside of that subset that can inform grounded theory model development. To capture research that would likely be missed in a systematic review, a traditional narrative literature review was conducted. A traditional narrative review, not bounded by systematic review protocols, allowed for a broad sweep of environmental education research to capture research published prior to 2011, research not limited to environmental education for middle school and high school students in the U.S., and gray literature (sources such as program evaluations and reports from government agencies and non-profit organizations) found outside the peer-reviewed realm.

The development of a preliminary model also served as a tool to assist in identifying sensitizing concepts. Charmaz (2014) defined sensitizing concepts as tentative ideas and questions that can guide initial grounded theory data collection and analysis. Grounded theory researchers use sensitizing concepts to suggest directions for inquiry and to ascertain important aspects of the phenomenon under study (Bowen, 2006). Blumer (1954), credited with originating

the idea of sensitizing concepts, described how, as a study progresses, sensitizing concepts are transformed into definitive concepts. This process of moving towards more definitive ideas aligns with this study as the ideas developed in the preliminary grounded theory model served as a foundation for the final grounded theory model that emerged from the systematic review. The components of the preliminary grounded theory model (the sensitizing concepts) also guided data collection and analysis, as they suggested categories for coding. In the end, some of the strategies, outcomes, conditions, and other concepts identified through the initial literature review were retained in the final model and others were modified based on data gathered during the systematic review. If no further support for strategies, outcomes, conditions, and other concepts in the preliminary model was uncovered in the systematic review, those concepts were removed from the final model.

Identification of Relevant Literature for Preliminary Model Development

The literature review of this phase focused on prior reviews or other documents that had compiled information about the components of the planned grounded theory model: strategies, outcomes, intervening conditions, context, core category, and core phenomenon (Corbin & Strauss, 2015; Creswell & Poth, 2018). The focus was not on individual primary-level research studies, but rather past research that had synthesized or reflected on primary-level studies. Publications geared towards environmental education practitioners were also sought out. Search procedures were not entirely systematic but relied more on serendipitous searching and consultation with subject area experts—two forms of searching not often prioritized in systematic reviews in education where reviewers frequently rely solely on database and ancestry searching (Campos & Figueiredo, 2001; Greenhalgh & Peacock, 2005). Additional sources were

identified during the formal systematic review when relevant research was located in the academic databases but failed to meet the inclusion criteria used in the screening process.

Synthesis of Sources for Preliminary Model Development

To identify data in the sources discovered in this phase to inform a preliminary model, I used iterative, data-driven thematic analysis (Dixon-Woods, Agarwal, Jones, Young, & Sutton, 2005) combined with vote-counting (Heyvaert, et al., 2017). This involved reviewing each source to identify goals, strategies, outcomes, and intervening conditions associated with effective environmental education. This information was recorded tabularly and continuously reviewed for emerging patterns to develop categorizations of strategies, outcomes, and intervening conditions and additional details regarding the core phenomena. After I reviewed all sources, extracted data, and created categories based on extracted data, I used vote-counting to determine which categories had the strongest support in the discovered literature. Finally, I drafted a preliminary grounded theory model using the emergent categories with the most support in the reviewed literature.

Grounded Theory Systematic Review Phase

Systematic reviews generally involve a similar sequence of steps: define the question; search the literature; screen the results for relevancy and quality; extract, analyze, and synthesize data; and share findings. Within each step, there are several areas open to variation in terms of how to conduct each step. One of the primary areas that offers many methodological options is the retrieval and use of the data from the reviewed studies. Historically, systematic reviews tended to focus on either quantitative or qualitative data, and the options used to analyze and synthesize each data type were limited. Reviewers of quantitative findings frequently used meta-analysis and reviewers of qualitative data frequently used meta-synthesis. As systematic reviews

evolved to consider a mix of data types, the options for analysis techniques appears to have grown tremendously. Dixon-Woods et al. (2005) detailed eleven methods for the synthesis of quantitative and qualitative data. In this study, I chose a grounded theory approach because my goal was to develop a grounded theory model of a process that occurs in stages (Creswell & Poth, 2018). The sections below outline the stages of this second phase: the systematic review and the use of the systematic review results to develop a grounded theory model.

Systematic search and screening

As the interest in systematic reviews has increased, so have the suggested ways to conduct them. For this study, I used protocols based on guidelines offered by Gough et al. (2017) and Cooper (2010), both of whom write about systematic reviews specifically in the social sciences. I also incorporated guidelines outlined in the PRISMA statement (2015) that are supported by the high impact educational review journal, *Review of Educational Research* (2018).

Literature search. I used academic databases, specifically those on the EBSCOhost platform, to search the environmental education research literature. EBSCOhost is a widely used search tool capable of searching across multiple databases. It offers users a tool to select subject areas that are associated with relevant databases. I used two EBSCOhost subject areas—(1) Education and (2) Agricultural, Life Science, & Natural Resources—that I accessed through the EBSCOhost platform via a Virginia Tech Library subscription. An EBSCOhost search that combined these two areas searched across seventeen separate databases (see Table 1). Immediately prior to conducting the official database search, I verified that the major environmental education journals (*Applied Environmental Education and Communication, Australian Journal of Environmental Education, Canadian Journal of Environmental Education,*

Environmental Education Research, International Journal of Geographical and Environmental Education, and *Journal of Environmental Education*) were indexed at that time by the selected EBSCOhost databases.

Table 1

Selected EBSCOhost Subjects and Associated Databases

EBSCOhost subject	Databases searched
Agricultural, Life Science, & Natural Resources (10 databases)	Academic Search Complete; Fish, Fisheries & Aquatic Biodiversity Worldwide; FSTA - Food Science and Technology Abstracts; GreenFILE; MasterFILE Premier; Psychology and Behavioral Sciences Collection; Wildlife & Ecology Studies Worldwide; Environments Complete; Applied Science & Business Periodicals Retrospective: 1913–1983 (H. W. Wilson); and Garden Landscape & Horticultural Index
Education (7 databases)	ERIC; Teacher Reference Center; SocINDEX with Full Text; Women's Studies International; Education Research Complete; E-book Collection (EBSCOhost); and Children's Core Collection (H.W. Wilson).

Note. Information based on Virginia Tech Library subscription as of March 2018.

EBSCOhost databases use limiters, expanders, and Boolean operators in their search processes. Selecting the right search terms is a crucial step as search term selection determines which publications in the databases will be identified. Selecting search terms is both an art and

science. Search terms need to be broad enough to capture relevant literature but narrow enough to exclude irrelevant literature.

For this study, two sets of search terms were used. The first search term, “environmental education”, identified all database records that addressed environmental education. To narrow the results to only those that focus on middle school and high school, I used a set of search terms: “middle school”, “high school”, “junior high”, “secondary school”, “secondary students”, “sixth grade”, “seventh grade”, “eighth grade”, “ninth grade”, “tenth grade”, “eleventh grade”, “twelfth grade”. These terms were separated by the Boolean operator “OR”.

I used a set of limiters to further constrain the search results. I limited to peer-reviewed sources and English language only. I set the date range to exclude studies published prior to 2011. A total of 1,956 records were returned and exported from EBSCOhost into Zotero, a bibliographic management program. I used the duplicate feature of EBSCOhost and Zotero to identify and remove 947 duplicate records, leaving 1,009 records to be screened. See Figure 3 for a flow diagram that illustrates the identification and screening process.

Screening of search results. After locating and retrieving potentially relevant citation records and abstracts, the next step was an intensive vetting process to screen for relevancy to the research questions and to appraise quality to insure a consistent level of evidence. The screening process occurred over multiple rounds of review.

Prior to any screening, I developed a decision tree of exclusion/inclusion criteria to ascertain relevancy to the research questions of this study (see Table 2). In the first round, I read the title and abstract for each citation record and applied the Relevancy Decision Tree to each abstract. Citation records were flagged in Zotero as either “1_Exclude” or “1_Include”. Next, I located the full text for all records marked as “1_Include” in the first review round. During the

second review round, I reviewed the full text for each included citation record. I re-applied the Relevancy Decision Tree to the full text and marked each record as "2_Exclude" or "2_Include" based on the results of second Relevancy Decision Tree application. The Relevancy Decision Tree was applied twice during screening because some records appear to meet the inclusion criteria based on a review of their abstract, but when the full text is reviewed, more details emerge to indicate that inclusion criteria are not met.

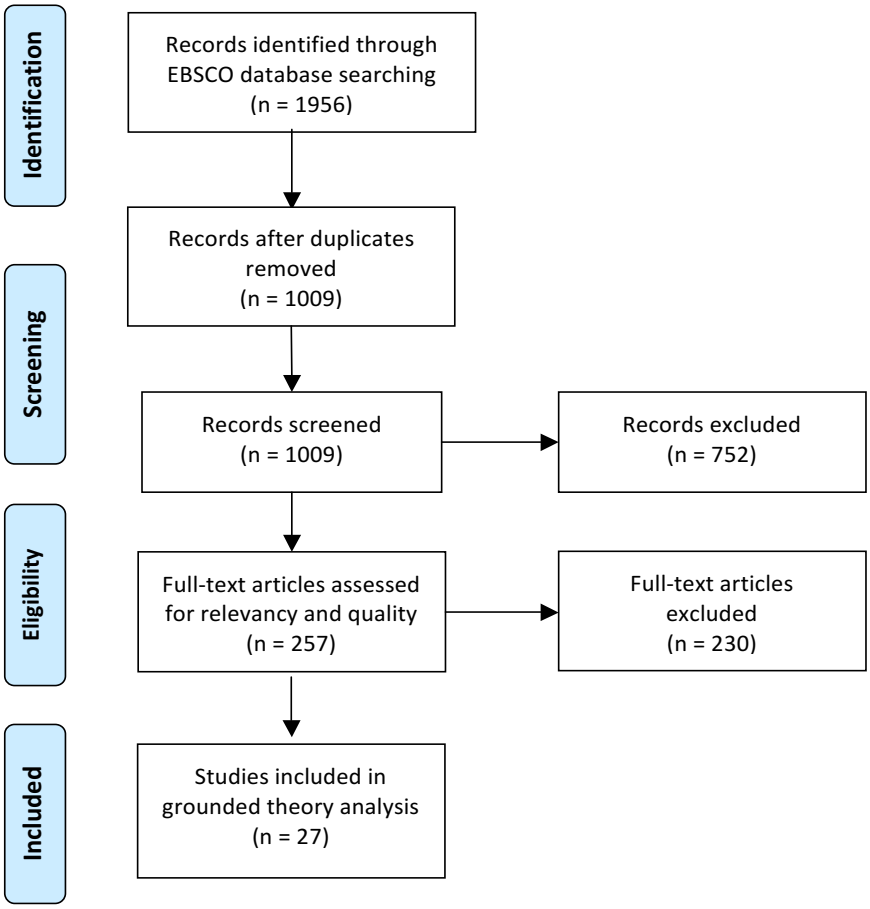

Figure 3. Flow diagram of the initial sample search and screening process. Adapted from PRISMA 2009 Flow Diagram by Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Table 2

Relevancy Decision Tree

Prompt	Response
1. Does the publication focus on students in middle school or high school (ages 11–19) in the U.S.?	• If no, exclude. • If yes, move to #2.
2. Is some type of environmental education program implemented?	• If no, exclude. • If yes, move to #3.
3. Are environmental outcomes of the environmental education program measured or described?	• If no, exclude. • If yes, include.

For the third round of the screening process, I used a second decision tree to evaluate each full-text article for quality. Table 3 lists the questions that were asked during the application of the Quality Decision Tree, which was done during a second review of the full text. Citation records that met the inclusion criteria found in the Quality Decision Tree were marked as "3_Include" in Zotero. This final subset of included studies comprised the final review sample.

Table 3

Quality Decision Tree

Prompt	Response
I. Quality of author-provided description of the environmental education program under study	
1. Does the publication contain sufficient description of outcomes of the environmental education program?	• If no, exclude. • If yes, move to #2.
2. Does the publication contain sufficient description of the environmental education program implemented, including description of the instructional strategies and program characteristics?	• If no, exclude. • If yes, move to #3.
II. Quality of reported research	
3. Is there a defined methods section that describes the research methods used to collect and analyze data?	• If no, exclude. • If yes, move to #4.
4. Are data presented to support the findings and conclusions?	• If no, exclude. • If yes, include.

In this systematic review, study quality had two components. The first component was quality in relation to this study's research questions. These quality questions addressed whether the reviewed study provided sufficient information about the outcomes, strategies, and conditions of the environmental education program that was reported on in each reviewed study. Each study needed to contain enough description of the outcomes, strategies, and conditions of the environmental education program in order to be coded for analysis in later review steps.

The second component of quality appraised during screening had to do with overall quality of the research presented in each study. Appraising quality of reviewed studies is complicated because prior research has suggested that even impartial reviewers often disagree on how to define a high-quality study (Cooper, 2010). Difficulty in quality appraisal is further exacerbated when reviewing studies of different research designs as many existing quality rubrics are created specifically with a particular research design in mind. This study only reviewed peer-reviewed research and this choice was made partly because peer-reviewed research is often more readily available and searchable than non-peer-reviewed research, but also because peer-reviewed research has undergone some form of expert review and appraisal prior to publication. There is tremendous variation in the peer-review process but appearing in a peer-reviewed journal suggests some level of prior review. With this in mind, the questions in the second section of the Quality Decision Tree were kept general and basic with the main purpose of excluding studies geared towards practitioners and lacking a research focus, and excluding occasional low quality studies that managed to emerge from the peer review process. Low quality studies were defined as lacking a clearly defined and developed methods section or lacking data to support presented findings and conclusions. These indicators of low-quality studies were based on discussions with researchers during my experiences in prior systematic

reviews in environmental education (Ardoin et al., 2018; Ardoin & Bowers, in progress; Ardoin, Bowers, Gaillard, 2019).

A total of 982 records were excluded during the screening process. In the review of abstracts, 752 records were excluded and an additional 230 were excluded during a full-text review. Twenty-seven studies were included in this initial final sample.

Coding and Analysis

All 27 of the full-text publications marked as "3_Include" were exported from Zotero into NVivo, a qualitative software analysis program. In this phase, I used grounded theory techniques to extract and code data from the studies in the final review sample. Because my "participants" were the reviewed studies, I was able to easily revisit the participants and collect data any time after the publications had been identified and screened. This facilitated constant comparison, a key feature of grounded theory, where data collection and analysis occur concurrently and iteratively as the researcher makes comparisons and builds relationships among data, codes, categories, and concepts (Charmaz, 2014; Creswell & Poth, 2018).

Initial coding. Once the full-text publications were in NVivo, I used a combination of an inductive and deductive approach to initial coding to formally explore the data for the first time as I allowed ideas and codes to emerge to guide further data collection and analysis. Initial coding involved close reading of the full texts and the breaking of text into discrete parts (Corbin & Strauss, 2015). The goal for this first round of coding was to remain open to all potential theoretical directions (Charmaz, 2014). Other forms of coding can be incorporated into initial coding to give the process more structure and direction; I used context-mechanism-outcome (CMO) coding, which originated in the field of realist synthesis and evaluation (Jackson & Kolla, 2012). In their work with parenting programs, Jackson and Kolla (2012) used CMO

coding to develop theory from data from interviews with practitioners. CMO coding involves first coding for discrete units of context, mechanisms, and outcomes, and then coding for hierarchies that link context, mechanisms, and outcomes. In this study, CMO coding helped identify what strategies (mechanisms) and conditions (context) the researchers believed were contributing to positive outcomes of environmental education. For initial coding, I used a hybrid deductive-inductive approach (Brixey et al., 2007; Fereday & Muir-Cochrane, 2006) since I knew the broad categories of data I was looking for (strategies, conditions, and outcomes), and used the preliminary grounded theory model to suggest possible codes and categories. At the same time, I remained open to new codes and hierarchies (combinations of context, mechanism, and outcome), which emerged inductively from the data.

Focused coding. With the emergence of an increasing amount of initial codes, I was then able to start focused coding where I identified the initial codes and CMO hierarchies that appeared to have the most support in the data. I continually revisited the full-text publications to verify the salience of initial codes. Focused coding identified the outcomes and strategies that researchers appeared to think were leading to effective environmental education with a middle school or high school audience.

Theoretical coding. In this final coding stage, I further abstracted the codes that emerged from initial and focused coding by reflecting on the placement and organization of all codes in the grounded theory model (Glaser & Strauss, 1967). It is during this stage, that the grounded theory model began to firm up as connections among hierarchies and codes persisted. As Charmaz (2014) noted, it is theoretical coding that provides a framework for analysis as long as the researcher lets the theoretical codes "breathe through the analysis, not be applied to it" (p. 155).

Theoretical Sampling Phase

In theoretical sampling, researchers seek out new participants, events, or information to further investigate how the theoretical categories and model hold up in light of new data. Theoretical sampling also offers researchers the chance to explore surprising findings and ideas that have emerged during coding (Charmaz, 2014). To use theoretical sampling in this study, I launched a search of research focused on middle school and high school environmental education in the U.S. that had been published since the initial search was conducted for the systematic review in the previous phase. Additionally, I used ancestry searching (Conn et al., 2003), which involved reviewing the reference lists of the 27 studies identified in the initial search.

For the database search, I replicated the search procedures used in the initial search with the only difference being the expanded date range. This second search included a search of studies published or made available between April 2018 (when the initial search was conducted) and January 2019 (when the second search was conducted). A total of 210 records were identified in EBSCOhost and exported to Zotero. Twelve records were identified in the ancestry search of the reference lists from the initial sample of 27 studies. After duplicates were removed, 146 studies were screened for relevancy and quality using the decision trees described previously. A review of the abstracts excluded 123 records and a review of full-text articles excluded 11 studies. As a result of the second search and screening process, 12 additional studies were identified. See Figure 4 for a summary of the search and screening process for the theoretical sample.

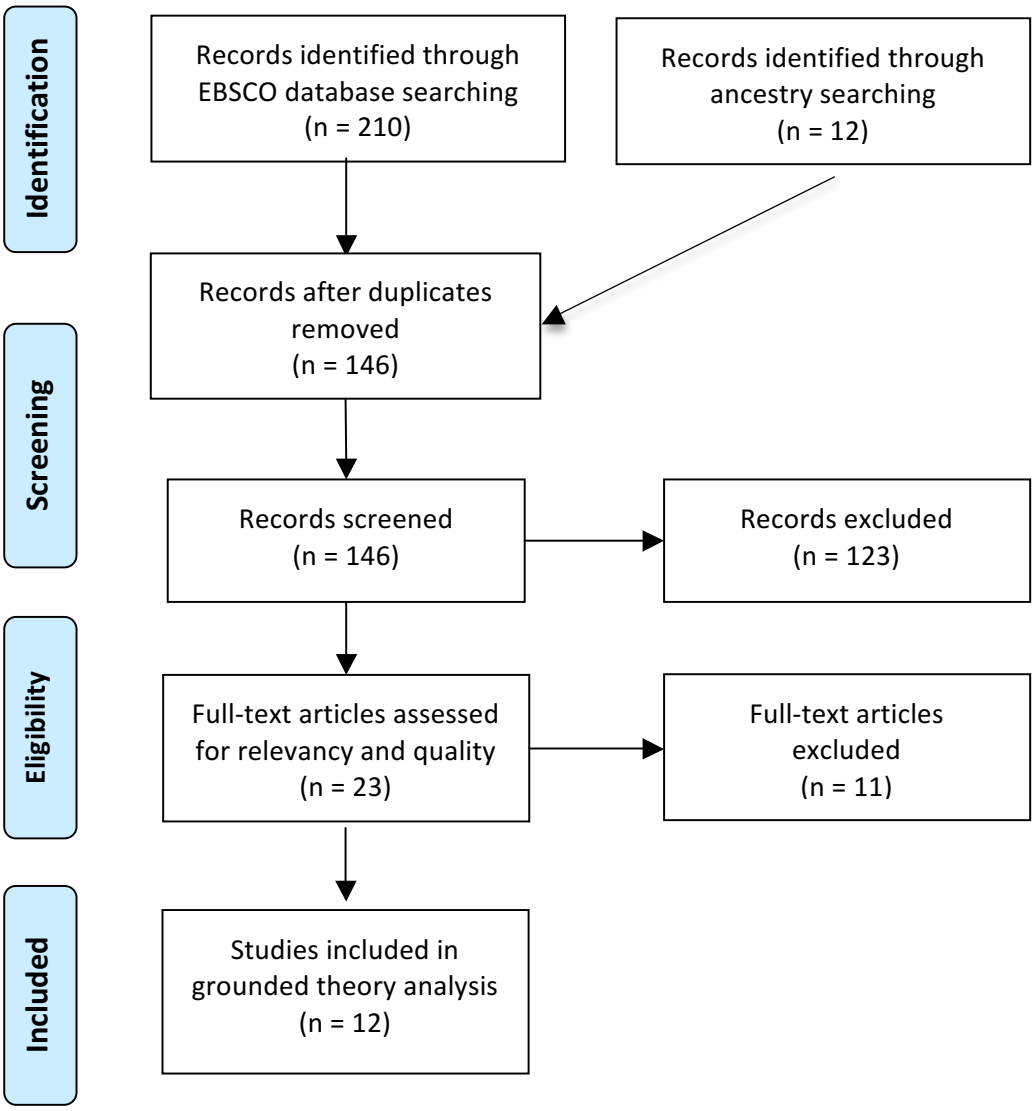

Figure 4. Flow diagram of the theoretical sample search and screening process. Adapted from PRISMA 2009 Flow Diagram by Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Since the goal of this theoretical sample was to explore the level of support for the developing grounded theory model, I reviewed the newly identified 12 studies and assigned a

code to indicate the level of support for the grounded theory model, with an emphasis on support for the core category. The 12 studies were also coded following the coding process described above.

Transparency and Trustworthiness

A hallmark of high-quality systematic reviews is transparency of methods; initially this was required based on the idea that reviews should be updateable. Being transparent about methods also allows others to evaluate how search and screening processes were conducted, and if these processes were done in a way to maximize comprehensiveness and usefulness of the review. When conducting the review, I kept detailed records of the literature search and screening process including information such as dates searches were conducted, exact search terms used, databases accessed, and which records were eliminated at which stage.

Analytical memos are a frequently used tool in grounded theory research and, in addition to serving as analytical tools, can be viewed as records of analysis (Corbin & Strauss, 2015). In a systematic review, these grounded theory tools can be used to support transparency, a key feature in systematic reviews (Gough et al., 2017), as they detail both the thought processes of the researcher and the connections among data that lead to the development of the grounded theory model. In this study, I used a particular kind of analytical memo, a case dynamics matrix, which is useful for studies focused on processes and outcomes (Miles, Huberman, & Saldaña, 2014). For each coded study, I developed a corresponding matrix that named the outcomes coded in that study and delineated the associated contexts and strategies. These visual displays of data helped me see the relationships among the CMO hierarchies and facilitated the process of sharing my analysis with my peer reviewer, who I discuss in the next paragraph.

Another qualitative tool that can support transparency and trustworthiness is peer debriefing where a person, besides the researcher, reviews the research at different stages (Creswell, 2014). I relied on regular conversations and email check-ins with colleagues in the environmental education field for ongoing verification that coding and model development were progressing appropriately. Similarly, systematic reviews also benefit from outside review. I worked with a library specialist to confirm the choices I made regarding the search engines, search terms, and search parameters.

Delimitations and Limitations

Despite idealized calls to be exhaustive in the search process, systematic reviews, due to time and resource constraints, often involve decisions to narrow and limit the search process to capture a manageable and practical amount of research to review. This guarantees that not all relevant literature will be identified and this was certainly the case for this review as well. I attempted to keep the search broad and analyzed data with this delimitation in mind.

Even before conducting the search, based on the search limiters, I knew this review would not capture much of the grey literature that addresses environmental education. The field of environmental education does not currently have a good system for compiling and making available evaluation reports, grant reports, conference presentations, and other non-peer-reviewed materials that could contribute to the building of a grounded theory model of environmental education. When writing the results and findings from this study, I acknowledged that the model was primarily based on peer-reviewed publications. Since I do not fluently speak another language, the reviewed publications had to be written in English and this posed another delimitation to consider as context.

Finally, a common limitation of systematic reviews is publication bias, the tendency of researchers to publish only positive results. Other systematic reviews in environmental education have reported the possibility of publication bias (Ardoin et al., 2018; Stern et al., 2014). For this study, the implication of publication bias is that the grounded theory model may lack information on what to avoid when trying to achieve effective environmental education.

Conclusion

The goal of this grounded theory systematic review was to develop a grounded theory model of environmental education for middle school and high school students in the U.S. In this chapter, I outlined the variety of methods and approaches that combined to capture, extract, code, and integrate existing data in the form of published environmental education research. Each method uniquely contributed to the overall study by allowing the final model to emerge from, yet remain grounded, in the data. The combination of grounded theory with a systematic review created an innovative use of tools offered by each method to synthesize data from a range of reviewed studies.

Chapter 4: A Grounded Theory Systematic Review of Environmental Education for Secondary Students in the United States

Abstract

Our world faces a range of environmental problems directly linked to or exacerbated by human actions and choices. Environmental education (EE) is one tool that can create a more environmentally literate citizenry. EE research contains numerous studies examining whether or not EE programs are achieving certain outcomes, yet *how*, *why* and *under what circumstances* EE works remains unclear. The purpose of this grounded theory systematic review was to explore and understand what makes EE effective when used with secondary students in the U.S. This research was designed to develop a grounded theory model that synthesizes the strategies and outcomes associated with EE for this specific context. A systematic search identified 39 studies published between 2011 and 2018 that examined EE for secondary students in the U.S. Grounded theory coding and theoretical sampling informed the development of the Implementation of Authentic Environmental Education Programs (IAEEP) model, which posits program authenticity as the core category underlying the process of EE with secondary students in the U.S. The resultant theoretical model can help guide secondary school educators and EE practitioners in the development and implementation of EE for middle and high school students.

Introduction

Popular media coverage details a litany of environmental issues across the globe. Scientists report that 2016 was the hottest year on record and attribute much of this warming to anthropogenic climate change (NASA, 2017). Predicted results of climate change, some of which are already manifesting, include more intense and frequent precipitation and storms (e.g., flooding and hurricanes; Dinan, 2017; U.S. Climate Change Science Program, 2008); increased

wildfires (Harvey, 2017); and sea level rise (Intergovernmental Panel on Climate Change, 2014). Loss of biodiversity is another major environmental issue with scientists referring to the current rate of species extinction as a "biological annihilation" (Schlossberg, 2017, p. A5). The United Nations warns that unsustainable use of groundwater will lead to subsidence of major metropolitan areas by 2030 and deadly conflicts prompted by water shortages (Parker, 2016). The common factor across these and other recent environmental phenomena is the direct influence of humans. Human actions, on large and small scales, are leading to changes in the environment that will affect every country and every person around the world.

Successfully addressing the world's environmental problems will require an informed and motivated public to find realistic, evidence-based solutions (Hollweg et al., 2011). Everyday citizens must be made aware of and be able to understand complex environmental problems. They must also possess the necessary skills to take action, such as knowing how to become civically engaged to produce societal change, and how to undertake individual actions, such as conserving energy and recycling. In addition to environmental knowledge and skills, the public must develop attitudes that will motivate and inspire them to care about the environment. It is a combination of knowledge, skills, and attitudes that will result in individual behaviors on a large scale that will lead to progress in tackling environmental issues (Kollmuss & Agyeman, 2002).

Environmental education (EE) is one available tool to spur a more active and environmentally literate citizenry. Compared to other education fields such as science education and math education, EE is relatively new, yet has already developed a significant research base and community of scholars (Stevenson, Brody, Dillon, & Wals, 2012). EE researchers have consistently produced reviews of research to synthesize past research trends and suggest future research directions, often in the form of narrative summaries and compilations of strategies and

outcomes, but these reviews have not resulted in development of a theoretical model or framework that connects EE strategies, outcomes, and contexts (e.g., Ardoin, Clark, & Kelsey, 2013; Ardoin, Bowers, Roth, & Holthuis, 2018; Hart & Nolan, 1999; Iozzi, 1981; Marcinkowski & Mrazek, 1996; Rickinson, 2001; Stern, Powell, & Hill, 2014). A model showing the connections among strategies and outcomes would aid EE practitioners and researchers as they develop, evaluate, and improve EE programs.

In this study, we developed a grounded theory model of EE based on the results of a systematic review of the literature. A grounded theory model is the organization of related concepts inductively derived from data focused on the understanding of a complex phenomenon, not on explanation and prediction (Charmaz, 2014). While the model is situated in a defined context, it is not necessarily tested in different settings. We situated our grounded theory model in the context of middle school and high school (ages 11 to 19) EE in the U.S. Our primary research question was: How does EE lead to positive environmental outcomes for middle school and high school students in the U.S.?

A grounded theory model is comprised of multiple components: core category, consequences/outcomes, contextual conditions, intervening conditions, and actions/strategies (Creamer, 2018). In addition to our primary research question, our review was guided by supporting research questions based on the grounded theory model components as they related to our topic:

- What are the reported environmental outcomes of EE programs for middle school and high school students in the U.S.?
- What strategies do educators use in EE programs for middle school and high school students in the U.S. to achieve the desired environmental outcomes?

- How do individual and contextual conditions impact the environmental outcomes of EE programs for middle school and high school students in the U.S.?
- What core category explains why and how EE programs work in the specific context involving middle school and high school students in the U.S.?

Defining EE

EE in the U.S. traces its roots to the merging of conservationism with related education movements of the early 1900s, namely nature study, outdoor education, and conservation education (Disinger, 1985). A definitional debate has at times plagued the field of EE (Disinger, 1985; Jickling, 2007) and a number of related terms (e.g., conservation education, education for sustainability, ecological education) have frequently compounded this identity crisis. The North American Association for Environmental Education (NAAEE, n.d., para. 1) defines EE as "a process that helps individuals, communities, and organizations learn more about the environment, and develop skills and understanding about how to address global challenges." In addition to awareness, knowledge, and skills, reviews of environmental behavior have emphasized the importance of positive environmental attitudes (Bamberg & Möser, 2007; Heimlich & Ardoin, 2008; Kollmuss & Agyeman, 2002; Steg & Vlek, 2009). Environmental educators frequently try to address environmental attitudes and related dispositions, such as environmental sensitivity, sense of place, and nature connectedness, alongside environmental awareness, knowledge, and skills (Ardoin et al., 2018). In this study, we define EE as educational programs focused on environmentally related topics presented to positively impact the environmental knowledge, attitudes, skills, and behaviors of participants.

EE with Middle School and High School Students

In this study, we focused on environmental programs for middle school and high school students, which we defined as students ages 11 to 19. Middle school and high school students are frequent participants in EE, with many environmental educators viewing these years as an ideal time to influence future environmental actions and behavior (Ardoin et al., 2018). Students currently in middle school and high school are the decision makers of the future and therefore represent a crucial audience (Meinhold & Malkus, 2005). A number of researchers have interviewed adult environmental activists to explore what experiences shaped their pro-environmental work; the adults consistently described influential experiences in their middle and high school years (Arnold, Cohen, & Warner, 2009; Chawla, 2006, 2009). Other research has corroborated the importance of youth experiences in nature by examining environmental beliefs of the general adult population (Berns & Simpson, 2009; Ewert, Place, & Sibthorp, 2005; Wells & Lekies, 2012). This suggests that EE during the middle and high school years can play a pivotal role in shaping future environmentally literate and active adults.

Methods

We conducted a grounded theory systematic review (GT-SR) using procedures outlined in the Preferred Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher, Liberati, Tetzlaff, & Altman, 2009) and in systematic review texts (Cooper, 2010; Gough, Oliver, & Thomas, 2017). Throughout the review process, we used a grounded theory approach that created a coherent structure to support transparency and systematicity—defining characteristics of systematic reviews (Cooper, 2010; Gough, et al., 2017). Grounded theory is an appropriate methodology for studying EE as EE is a complex, multi-layer, temporal phenomenon that is strongly influenced by context such as setting, participants, facilitator, topic, and teaching

strategies (Charmaz, 2014). We used a number of grounded theory tools including theoretical coding, constant comparison, theoretical sampling, and memoing (Bowes & Creamer, in progress). While not a common approach in systematic reviews, other studies have employed grounded theory methods in systematic reviews (Kearney, 2001; Sawyer, 2017; Wolfswinkel, Furtmueller, & Wilderom, 2013).

Search Process

We used academic databases on the EBSCOhost platform to search the EE research literature. We used two EBSCOhost subject areas— (1) Education and (2) Agricultural, Life Science, & Natural Resources—to search across seventeen databases (see Table 4). We verified that major EE journals were indexed at the time of the search by at least one of the selected EBSCOhost databases.

For this study, two sets of search terms were chosen after consultation with a library specialist in the field of education to ensure the terms were appropriate and optimized for efficient and relevant results. The first search term, “environmental education”, identified database records that addressed EE. To narrow the results to only those that focused on middle school and high school, we used a set of search terms: “middle school”, “high school”, “junior high”, “secondary school”, “secondary students”, “sixth grade”, “seventh grade”, “eighth grade”, “ninth grade”, “tenth grade”, “eleventh grade”, “twelfth grade”. These terms were separated by the Boolean operator “OR”.

We employed a set of limiters to further constrain the search results, first limiting results to peer-reviewed sources and English language. We set the date range to search for studies published from 2011 through 2018. This date range was chosen partly because a recent systematic review that focused on strategies and outcomes (Stern et al., 2014) included studies

Table 4

Selected EBSCOhost Subjects and Associated Databases

EBSCOhost subject	Databases searched
Agricultural, Life Science, & Natural Resources (10 databases)	Academic Search Complete; Fish, Fisheries & Aquatic Biodiversity Worldwide; FSTA - Food Science and Technology Abstracts; GreenFILE; MasterFILE Premier; Psychology and Behavioral Sciences Collection; Wildlife & Ecology Studies Worldwide; Environments Complete; Applied Science & Business Periodicals Retrospective: 1913–1983 (H. W. Wilson); and Garden Landscape & Horticultural Index
Education (7 databases)	ERIC; Teacher Reference Center; SocINDEX with Full Text; Women's Studies International; Education Research Complete; E-book Collection (EBSCOhost); and Children's Core Collection (H.W. Wilson).

Note. Information based on Virginia Tech Library subscription as of March 2018.

published from 1999 through 2010. Additionally, we felt a review of the most recent research was warranted because EE researchers have acknowledged that EE in practice is highly responsive to contemporary social and environmental conditions, resulting in a fluid field undergoing constant change (Biedenweg, Monroe, & Wojcik, 2013; DuBois, Krasny, & Smith,

2017). All returned records, including full citation information and abstract, were exported from the EBSCOhost database to Zotero, a bibliographic management program that removed duplicate records.

Screening of Search Results

An initial search was conducted in May 2018 that identified 1,956 citation records. After duplicates were removed, 1,009 records and their associated abstracts were available for screening. Figure 5 provides a flow diagram of the search and screening process. To screen for relevancy to the research questions, we developed a decision tree of exclusion/inclusion criteria (see Table 5) and applied it to each abstract. Of the 1,009 records, 752 were excluded because the study involved a program that took place outside the U.S., did not focus on secondary students, did not target environmental behavior, or did not measure or describe program outcomes.

For the remaining 257 records, we located and reviewed the full text. We excluded an additional 210 studies that failed to meet the inclusion/exclusion criteria upon a full review. We then appraised the remaining 47 studies for quality using the *Quality Decision Tree* found in Table 6. Twenty studies were excluded after applying the *Quality Decision Tree*, leaving 27 studies in the final initial sample for coding and analysis.

Coding and Analysis

We imported the 27 studies from the final sample into NVivo, a qualitative software analysis program. We used constant comparison, a key feature of grounded theory, that dictates that data collection and analysis occur concurrently and iteratively as the researcher makes comparisons and builds relationships among data, codes, categories, and concepts (Charmaz, 2014; Creswell & Poth, 2018). We followed three stages of coding (initial, focused, and

theoretical) to move progressively through levels of abstraction (Charmaz, 2014; Glaser & Strauss, 1967).

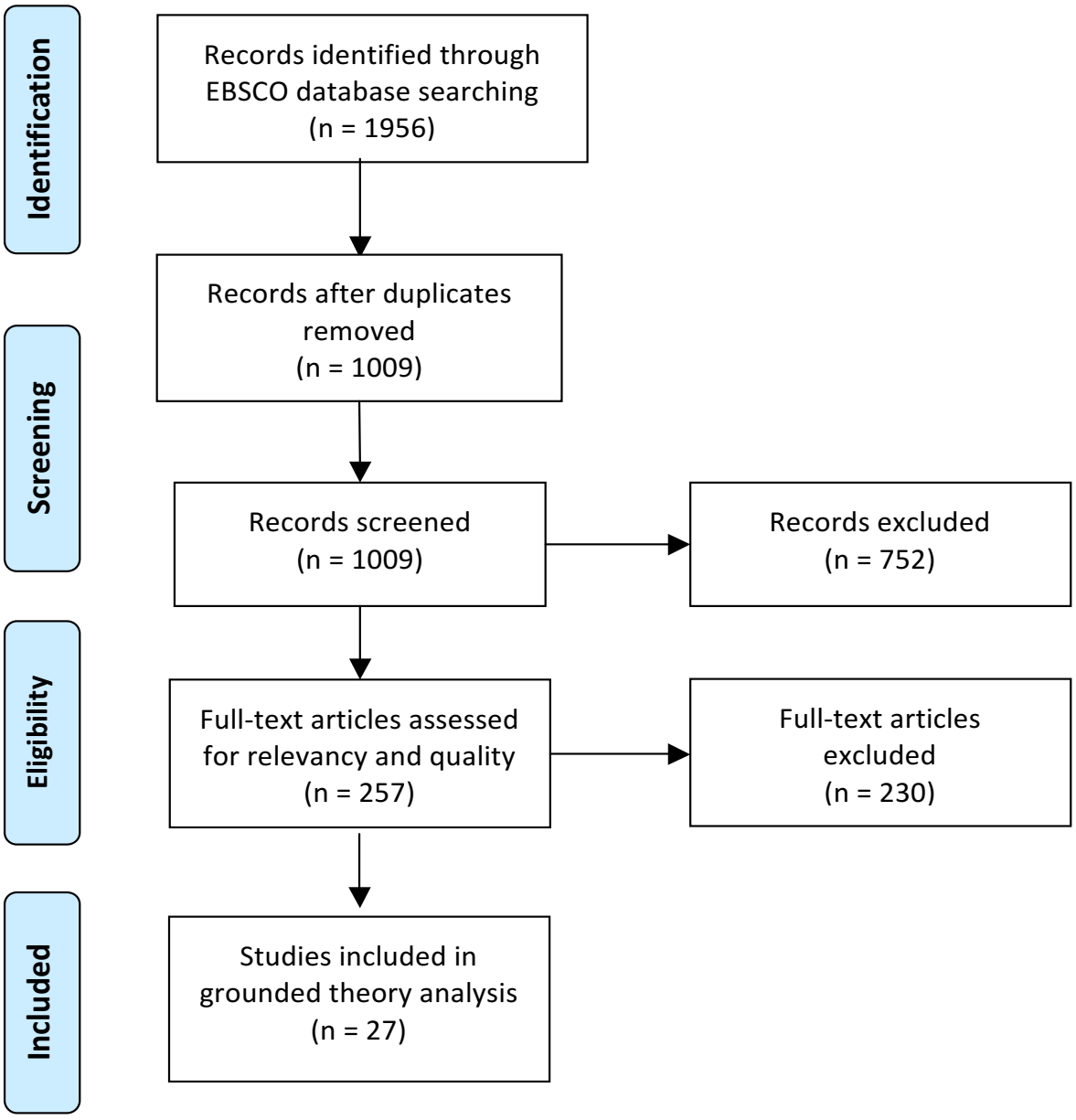

Figure 5. Flow diagram of the initial systematic review and screening process. Adapted from PRISMA 2009 Flow Diagram (Moher et al., 2009).

Table 5

Relevancy Decision Tree

Prompt	Response
4. Is the study a peer-reviewed research publication written in English and published in 2011 or later?	• If no, exclude. • If yes, move to #2.
5. Does the publication focus on students in middle school or high school (ages 11–19) in the U.S.?	• If no, exclude. • If yes, move to #3.
6. Is an EE program implemented that focuses on creating change in environmental behavior?	• If no, exclude. • If yes, move to #4.
7. Are outcomes of the EE program measured or described?	• If no, exclude. • If yes, include.

Table 6

Quality Decision Tree

Prompt	Response
I. Quality of author-provided description of the EE program under study	
5. Does the publication contain sufficient description of outcomes of the EE program?	• If no, exclude. • If yes, move to #2.
6. Does the publication contain sufficient description of the EE program implemented, including description of the instructional strategies and program characteristics?	• If no, exclude. • If yes, move to #3.
II. Quality of reported research	
7. Is there a defined methods section that describes the research methods used to collect and analyze data?	• If no, exclude. • If yes, move to #4.
8. Are data presented to support the findings and conclusions?	• If no, exclude. • If yes, include.

Initial coding involved close reading of the full texts and the breaking of text into discrete parts while remaining open to all potential theoretical directions (Charmaz, 2014; Corbin & Strauss, 2015). We used descriptive and In Vivo codes (Saldaña, 2016) to identify codes related to EE strategies, outcomes, and context. Focused coding was used to crystallize and clarify the relationships among the emerging codes and organize codes into categories (Creswell & Poth, 2018). We used the categories developed during focused coding to create preliminary versions of the theoretical model. Finally, in theoretical coding, we further abstracted the categorical hierarchies and codes that emerged from initial and focused coding and firmed up the theoretical model (Glaser & Strauss, 1967).

Theoretical Sampling

In a grounded theory study, theoretical sampling takes place after initial sampling to guide additional data collection once preliminary coding has identified emerging categories (Bryant, 2017; Charmaz, 2014). During the theoretical sampling, we launched a search for studies focused on middle school and high school EE in the U.S. that had been published since the initial search had been conducted. Additionally, we used ancestry searching (Conn et al., 2003), which involved reviewing the reference lists of the 27 studies identified in the initial search, to identify additional studies that may not have been captured in the database searches.

For the theoretical sampling database search, we replicated the search procedures used in the initial search with the only difference being the expanded date range. This second search focused on studies published or made available between April 2018 (when the initial search was conducted) and January 2019 (when the second search was conducted). A total of 210 records were identified in EBSCOhost and exported to Zotero. Twelve records were identified in the ancestry search of the reference lists from the initial sample of 27 studies. After duplicates were

removed, 146 studies were screened for relevancy and quality using the decision trees described previously. A review of the abstracts excluded 123 records and a review of full-text articles excluded 11 studies. As a result of the second search and screening process, 12 additional studies were identified. Figure 6 provides a flow diagram of the theoretical sample search and screening process.

The goal of the theoretical sample was to explore the level of support for the developing grounded theory model; therefore, we reviewed the newly identified 12 studies and assigned a code to indicate the level of support for the grounded theory model. Additionally, the 12 studies were added to the initial sample of 27 studies in NVivo and coded using the same coding process (initial, focused, and theoretical coding) described above to create a final sample of 39 studies.

Descriptive Findings

Figure 7 provides a visual summary of selected descriptive characteristics of the 39 reviewed studies. The 39 articles were published throughout the targeted timeframe with 2011 and 2014 being the most popular years with 8 studies published in each of those years. Mixed methods, qualitative, and quantitative designs were well represented among the studies, with quantitative studies being the most prevalent type of study design (n = 15). Application of the regional classification system of the U.S. Census Bureau (2015) revealed that the study sites occurred throughout the U.S., with the Western region seeing the most studies (n = 9).

The 39 studies examined a wide range of EE programs. Both middle school (6^{th} to 8^{th} grades) and high school students (9^{th} to 12^{th} grades) were equally represented among the studies (see Figure 7). The program formats varied, although the majority of the programs occurred during school hours. We also coded for program length that ranged from brief, one-time programs to ongoing programs that lasted an entire year (see Figure 7).

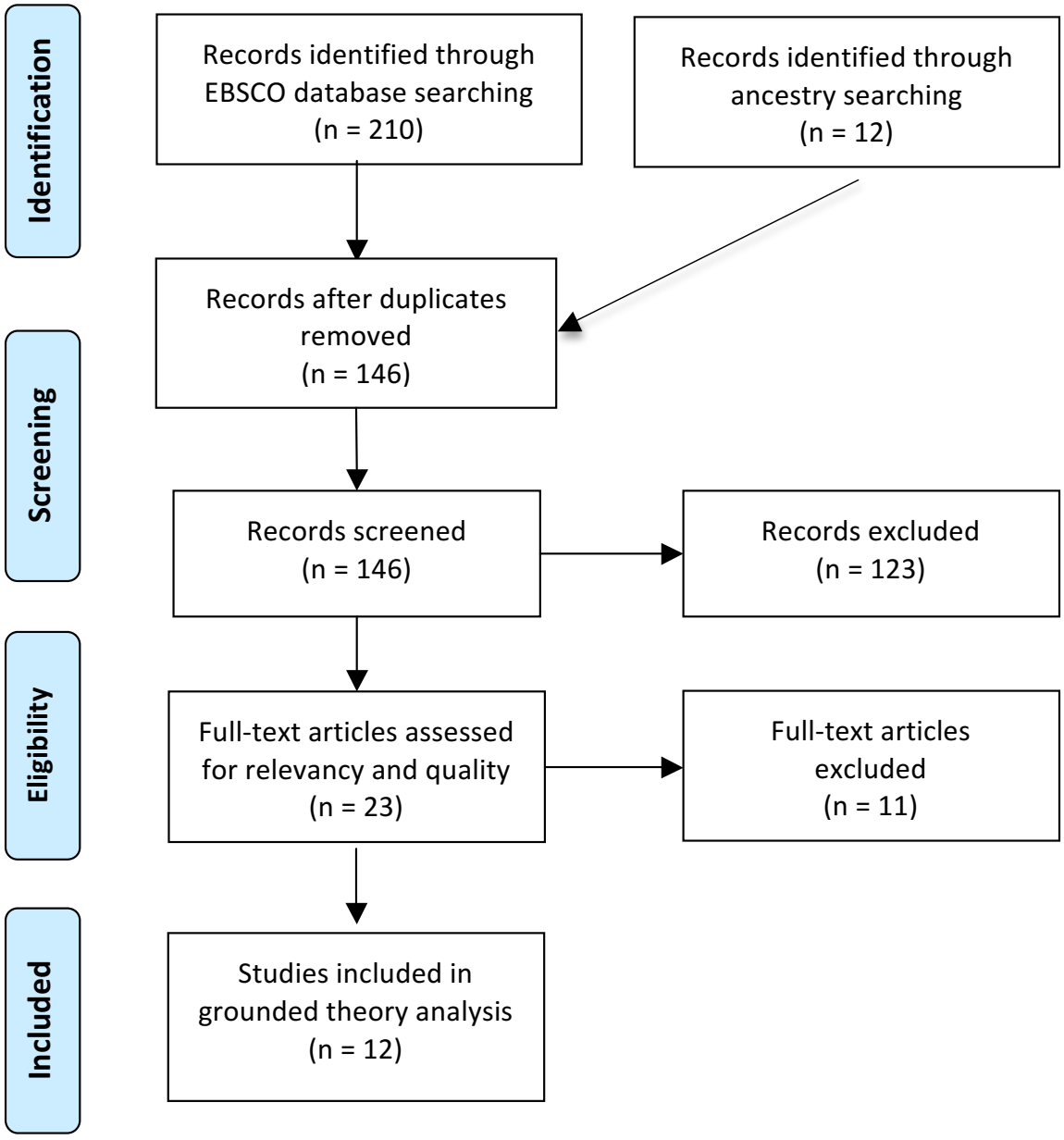

Figure 6. Flow diagram of the theoretical sample systematic review and screening process. Adapted from PRISMA 2009 Flow Diagram (Moher et al., 2009).

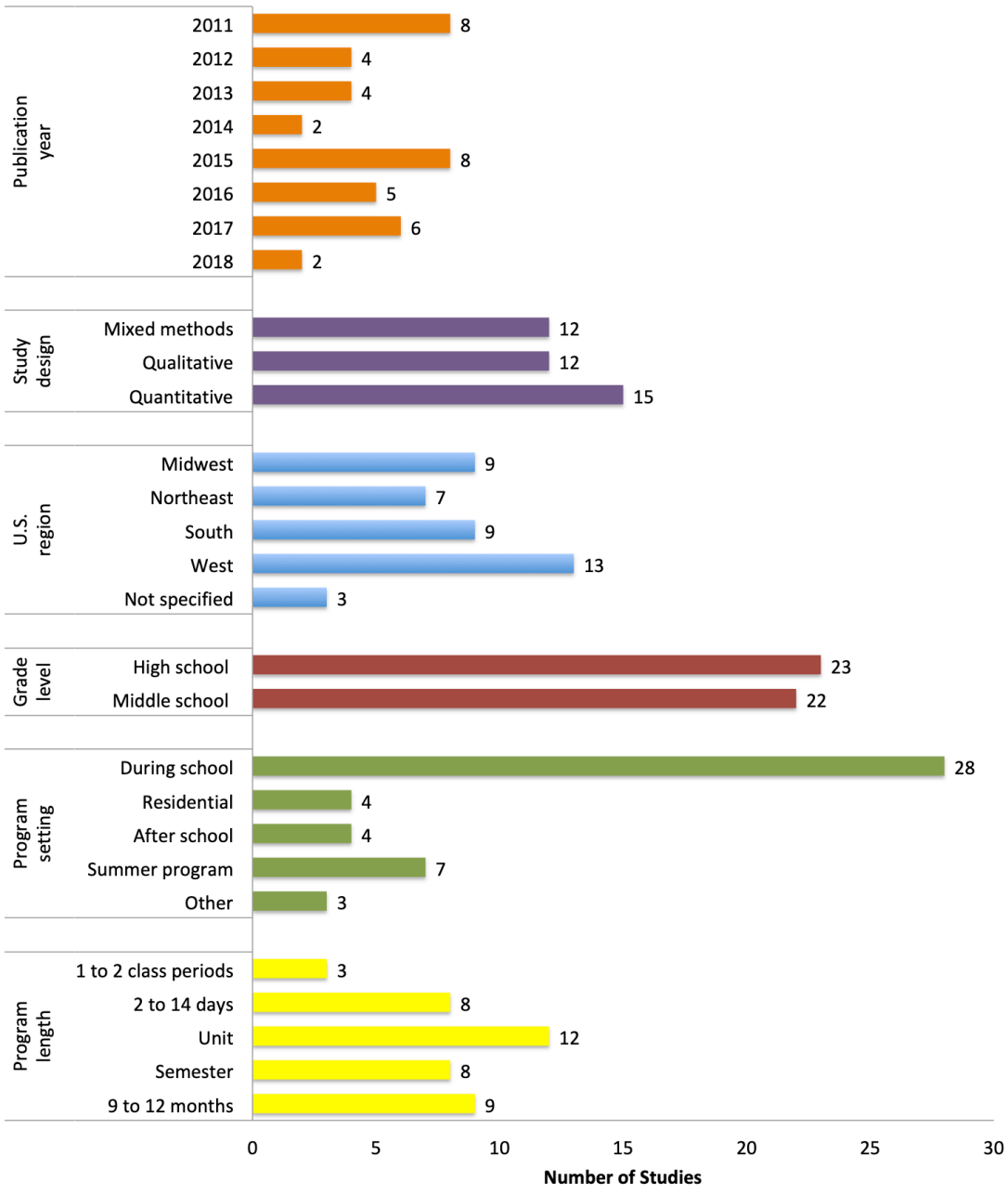

Figure 7. Summary of selected descriptive study characteristics (n = 39). With the exception of Publication Year, bar totals for each category may sum to greater than 39 because a single study may have been coded to more than one sub-category.

Grounded Theory Findings

From the coding of the 39 studies identified during the systematic review, we developed the Implementation of Authentic Environmental Education Programs (IAEEP) model that depicts the process of EE for secondary youth in the U.S. (see Figure 8). The model incorporates the main components of a grounded theory: strategies, outcomes, core category, contextual conditions, and intervening conditions (Corbin & Strauss, 2015).

Model Narrative Statement

The IAEEP model suggests that EE increases pro-environmental behavior by impacting an individual's environmental literacy, which is comprised of environmental awareness, knowledge, skills, and attitudes. For middle school and high school students in the U.S., this is achieved through the core category of creating and implementing programs that are viewed as authentic by participants. Secondary students are more likely to view programs as authentic when the programs move beyond conventional classroom learning by connecting with others, creating a safe space, demonstrating relevance, mitigating complexity, supporting self, and using technology. The EE process is influenced by contextual conditions that exist prior to program implementation (facilitator style and characteristics; participant characteristics; program settings; and program duration) and intervening conditions that occur after the program (level of support from family and friends and amount of exposure to other EE).

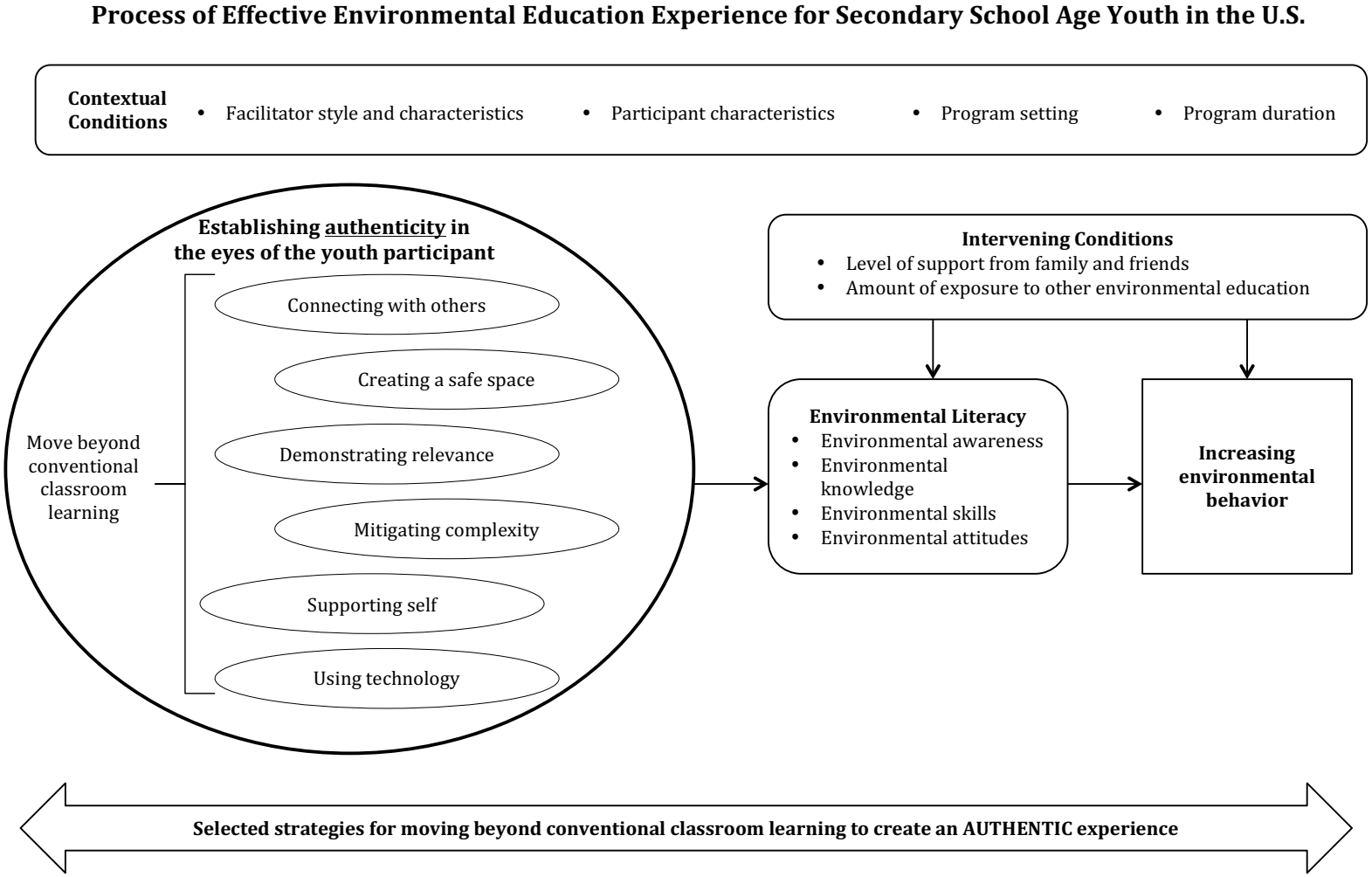

Figure 8. The Implementation of Authentic Environmental Education Programs (IAEEP) grounded theory model for middle school and high school students in the U.S.

Discussion

Components of the IAEEP Model

Model Outcomes

In the IAEEP model, the ultimate outcome of EE with secondary youth in the U.S. is an increase in environmental behavior. Environmental behavior occurs when people consciously act in a way to protect natural resources (Juárez-Nájera, Rivera-Martínez, & Hafkamp, 2010; Kollmuss & Agyeman, 2002). Behavior change has been part of the EE lexicon since the emergence of the field and has been codified in foundational documents (e.g., UNESCO, 1978; UNESCO-UNEP, 1976). Many, but not all, contemporary definitions of EE reference behavior change and action as an important goal (Eilam & Trop, 2012; EPA, 2019; Heimlich & Ardoin, 2008; NAAEE, n.d.). This emphasis on behavior change is what differentiates EE from related fields like environmental science, ecological education, and science education, which aim to impart knowledge and understanding of environmental concepts and systems, without explicitly influencing environmental behavior. This ultimate goal of EE, impacting environmental behavior, is acknowledged in the model as the endpoint for the entire process.

One of the inclusion criteria for our systematic review required that the reviewed study include a focus on environmental behavior change, yet not all of the studies measured or described a behavior change despite behavior change being their ultimate goal. Due to the complexity of environmental behavior and the associated difficulties in measuring changes in environmental behavior (Heimlich, 2010; Heimlich & Ardoin, 2008; Kollmuss & Agyeman, 2002), environmental educators frequently target one or more behavioral antecedents, the factors or predictors of behavior (Ernst, Blood, & Beery, 2017; McGuire, 2015). Our coding revealed an array of behavioral antecedents that we categorized as environmental awareness, knowledge,

skills, or attitudes and refer to collectively as environmental literacy. Environmental literacy in EE is "the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems" (Roth, 1992, p. 10). As such, environmental literacy involves knowledge about the environment; awareness of environmental issues; environmental dispositions such as environmental sensitivity, motivation, and pro-environmental attitudes; knowledge of socio-political systems; cognitive skills such as problem-solving and critical thinking; and citizenship and action skills (Goldman, Pe'er, & Yavetz, 2017; Lloyd-Strovas, Moseley, & Arsuffi, 2018; McBride, Brewer, Berkowitz, & Borrie, 2013). Even in studies that did not directly reference environmental literacy, the reported outcomes we coded as behavioral antecedents easily grouped under the umbrella term of environmental literacy. In the IAEEP model, we show how environmental educators target a range of behavioral antecedents (environmental awareness, knowledge, skills, and attitudes), grouped under environmental literacy, to impact an individual's environmental behavior.

Model Strategies

The related outcomes of environmental literacy and environmental behavior are supported in the model by the interplay of various contributory strategies that emerged from the coding of the reviewed studies. In early rounds of our grounded theory coding, we identified countless strategies that varied tremendously in terms of specificity and structure, such as having students complete a personal energy audit to taking a field trip. As coding progressed, connections between different groups of strategies began to emerge that led to the creation of six categories of strategies presented in the IAEEP model: connecting with others, creating a safe space, demonstrating relevance, mitigating complexity, supporting self, and using technology.

Figure 9 provides an excerpt from the coding dictionary that details the individual codes associated with each category of strategies.

Connecting with others	Group activities, discussions Team building activities Share results Participants teach others Use social media Time to connect with facilitator Family activities
Creating a safe space	Develop trust Cultivate an inclusive space Identify and alleviate anxiety Action component Integrate facts and actions skills Create feelings of empowerment Move participants out of comfort zone
Demonstrating relevance	Citizen science Place-based education Local focus Local field trips Action projects Family involvement Connect to school curriculum Connect to prior knowledge Interact with experts Time for reflection Chance to see direct impacts
Mitigating complexity	Increase knowledge Apply pedagogy and learning theory Elicit prior knowledge Identify and address misconceptions Systems based thinking Logical progression (simple to complex) Models and simulations Unifying theme, focus on a specific topic
Supporting self	Adventure activities Novel experiences Provide opportunities for creativity Coupling awareness with action skills Free-choice activities Problem-solving activities Action projects Identity building Increase knowledge and skills Vocational and college prep
Using technology	Computer simulation games Geographic information systems (GIS) Watch videos Make videos Social media Demonstrate technological tools Document work with photos

Figure 9. Coding dictionary excerpt presenting individual codes associated with each strategical concept.

During higher levels of coding, we determined that all six categories of strategies were tied conceptually through the idea that EE programs engage students in an educational experience that is different than conventional classroom teaching. Conventional instruction usually involves lecture-format, a top-down educational strategy where the educator fills the

student with knowledge and information. As we analyzed the extracted data from the 39 reviewed studies, we noted that students valued and appreciated the fact that EE was different than normal classroom instruction as EE often varies from the traditional lecture format. In the model, the six categories of strategies are shown as being connected by the idea that they move beyond conventional teaching and as such, contribute to the model's core category, which we describe next. The six strategies are probably not unique to EE. It is very likely that they overlap with educational best practices used in other fields as well.

Core Category

Corbin and Strauss (2015, p. 189) defined the core category of a grounded theory as the concept that has the "greatest explanatory power and the ability to link the other categories to it and to each other." For the data in our reviewed studies, this core category occurred when students viewed the EE program as authentic. Studies often referenced *authentic* learning, *authentic* setting, *authentic* experiences, *authentic* science, and similar phrases. These studies introduced us to the idea of authenticity in EE and as coding progressed and we wrote memos reflecting on the data and coding, the idea of authenticity persisted and grew in importance. In later stages of coding, the two dominant categories were authenticity and instruction that differed from conventional classroom learning (discussed above). When reflecting on the categories and data, we thought about what made EE different than other types of educational efforts. Music education and art education also can be viewed as offering an experience that contrasts with conventional classroom lectures, so while that category (moving beyond conventional classroom learning) was clearly an important part of EE, it was not something unique enough to create true and lasting changes in environmental behavior. Coding and data suggested that it was students viewing the EE experience as authentic that best explained what was happening during EE

programs and that this core category of authenticity was the overarching link among other codes and categories.

Model Context

The various strategies and outcomes presented in the model do not occur in a vacuum, rather they are continually influenced by context. We coded and analyzed the data for context throughout the study and included specific contexts in the model that were suggested by the data as being influential (see contextual conditions and intervening conditions in Figure 8).

In grounded theory, contextual conditions are the specific background circumstances of the phenomenon being studied and include time, duration, and place (Böhm, 2004; Corbin & Strauss, 2015; Watts, Ivankova, & Moss, 2017). Program duration and setting were two contexts that emerged as important in EE programs. In terms of program length, there was a general trend suggesting that a longer program allows for more positive outcomes.

Program setting also emerged as an influential context. Thirty-three of the 39 studies occurred mainly in a school setting, either during formal classes, as part of an after-school program, or as part of a residential experience where students attended as part of their school class. This emphasis on the school setting does not imply that students never left the classroom, the experiences within the school setting varied greatly and different settings appeared to have influenced program outcomes. Field trips to local natural areas received a lot of attention in the reviewed studies, as Kuwahara (2013, p. 202) wrote: "…field trips allowed them to gain experience with the place and develop positive associations with the local environment."

Study authors also described the characteristics of the facilitator (the person who leads the EE program, often a teacher, but not always) and the participants and these conditions seemed to influence outcomes. For example, Stern, Frensley, Powell, and Ardoin's (2018)

focused on role models in EE programs and wrote about the importance of having a diverse group of facilitators. Similarly, authors often provided information about participant characteristics such as the academic status of participants (e.g., at-risk students, academically promising, "invisible middle" students; Carlone et al., 2015; Harness & Drossman, 2011; Parsons, Bell, & Kim Swan-Sosky, 2011) or whether students were from urban, suburban, or rural areas. As we coded, we noted that authors often made connections between participant characteristics and outcomes. For example, Zimmerman, Toomey, and Weible (2017, p. 26) suggested rural students have an advantage when it comes to learning about environmental issues: "their experiences in rural places were assets to their meaning-making related to understanding the environmental problem and its causes."

Intervening conditions in grounded theory models are circumstances occurring during or after the phenomenon that alter or impact the outcome (Corbin & Strauss, 2015; Watts et al., 2017). Continued support from family and friends after the program was mentioned as an intervening condition that could extend the positive outcomes of EE. For example, Stapleton (2015, p. 108) described how students who become involved in environmental issues as a result of an EE program, may be viewed as family and friends as "environmental actors." Such recognition would support ongoing environmental activism.

Study authors also commented on the effect of the continual exposure to EE, both previous and follow-up exposure. This was often talked about in general terms of how environmentally aware students were prior to the program. For example, in their study exploring the effects of natural schoolyards, Nelson and Shaw (2013, p. 5) discussed the "ceiling effect" where measurable changes in attitudes due to participation in EE are not detected because students begin the program already with positive environmental attitudes.

Implications for Practice

While a number of models and frameworks populate the EE literature, these are often models attempting to explain the factors associated with environmental behavior (Heimlich & Ardoin, 2008; Kollmuss & Agyeman, 2002) or the components of environmental literacy (McBride et al., 2013). Less common are models that link EE practices and strategies, desired outcomes, and context. Stern et al. (2014) noted inherent difficulties in isolating agreed-upon strategies that constitute effective EE. When researchers do identify a set of effective strategies, what often emerges are lengthy lists of best practices (Jacobson, McDuff, & Monroe, 2015; NAAEE, 2009; Stern et al., 2014). This is unsurprising given that like all education (Jacobson, Levin, & Kapur, 2019), EE is a complex system involving collective and individual behaviors that must be addressed to achieve positive environmental change. Long lists of best practices may seem cumbersome but the multitude of practices illustrates two of EE's greatest strengths: versatility and interdisciplinarity.

The most salient aspect of our IAEEP model for practitioners is the identification of authenticity as the core category driving the process of EE with secondary students in the U.S. Discussion of authenticity is not unprecedented in the EE discourse. Uzzell (1999) decried a lack of authenticity in EE, and in his reimagining of EE in schools, Stevenson (2007) stressed making EE authentic and meaningful. Recent studies and essays have called for EE to incorporate authentic care (Delia & Krasny, 2018), authentic learning (Smeds, Jeronen, & Kurppa, 2015), authentic education (Bonnett, 2017), and personal authenticity (Lundegård, 2018). We add our support to these calls for authenticity in EE backed by a systematic review of evidence suggesting authenticity is the crucial component in EE with middle and high school students.

The idea of authenticity also emerges in discussions of classroom learning at various educational levels. Johnson and LaBelle (2017) reported that college students preferred and learned more from professors they viewed as authentic. Primary and secondary educators have acknowledged the need to make learning and assessment relevant to students' lives and to the real world using tools and strategies like authentic assessment and project-based learning ((Bell, 2010; Darling-Hammond, Ancess, & Falk, 1995; Frey, Schmitt, & Allen, 2012; Herrington, Reeves, & Oliver, 2014). Many of the key principles of authentic learning environments (e.g., real-world tasks, group work, exposure to multiple perspectives, time for reflection; Herrington & Oliver, 2000) overlap with characteristics of EE (North American Association for Environmental Education, 2009), highlighting a natural connection between EE programs and authenticity. The IAEEP model suggests that educators and EE practitioners wanting to develop and implement EE programs for secondary students in the U.S. need to insure both program facilitator and format be viewed as authentic by students. The IAEEP model offers six specific strategies to help do this by moving beyond traditional classroom teaching. Practitioners can also consult related existing research and guides on authenticity in the classroom (e.g., Chinn & Malhotra, 2002; Herrington, Reeves, & Oliver, 2014; Roth, 1995) to further support the development of EE for middle school and high school students in the U.S.

Recommendations for Future Research

Our review highlights a number of areas in need of future research. Our goal, in line with grounded theory methodology, was to develop a substantive theory suitable to the specified context (secondary students in the U.S.). A logical extension of this work would be to confirm the applicability of the model in other settings, such as other countries and with other age groups. Additionally, like many other areas of research, environmental education has benefited from

increasing discussions of how race, gender, sexuality, class, and other demographic characteristics may impact the environmental education experience (Maina-Okori, Koushik, & Wilson, 2018; Stapleton, 2019). Vulnerable populations, such as low-income and marginalized communities, are often the first people affected by environmental issues and may experience more intense repercussions, yet these populations are not the most likely participants of environmental education. While participant characteristics emerged as an important context in the IAEEP model, we noted a lack of consistent descriptive data about individual study samples that would have allowed us to identify links among identified strategies and positive outcomes for marginalized student populations. Another area of future could examine how the model and our other findings might be different if the sample studies had involved a variety of populations of middle and high school students.

Given its emergence as the core category, additional research into authenticity in EE is also warranted to confirm its importance to EE. The model context offers several interesting conditions that received significant support from the authors of the reviewed studies as potentially impactful aspects of EE. For example, while most authors indicated a belief that longer programs provide a more intense and meaningful EE experience, the authors of the two studies that investigated the shortest programs in the review sample also reported positive results and commented on the program length. Osbaldiston and Schmitz (2011, p. 169), who explored an energy conservation program spanning two class periods, stated: “In spite of this small investment, a simple program like the Energy Challenge can have a meaningful change on attitudes, motives, and behaviors.” Shorter programs, which might be easier and more efficient to implement, may play a key role in ongoing EE that a person can be exposed to throughout their life.

Review Limitations

As with all systematic reviews, a major limitation of this review is the failure to capture all relevant literature; however, given the grounded theory approach we used, this common limitation is less problematic in this review. In grounded theory, data collection is not about being comprehensive and capturing all data, but rather about gathering enough data to provide sufficient information about the topic under study and to saturate the emergent categories (Charmaz, 2014; McCrae & Purssell, 2016). One area of relevant literature that we did not explore at all, however, was dissertation work. A search and review of recent dissertations would likely yield new insights and thoughtful reflection on what contributes to effective EE. Similarly, a review of non-peer-reviewed work, such as program evaluations and grant reports, may produce relevant work but due to the difficulties in searching this "grey literature" in EE, we limited our search to peer-reviewed publications.

Conclusion

The goal of our review was to create a theoretical model of EE built upon observed commonalities among reported outcomes and strategies; we wanted to abstract the mechanism that underlies proven strategies in EE. Knowing that different strategies and outcomes are likely needed for different audiences (Eilam & Trop, 2012), we focused on middle and high school students in the U.S. and we used peer-reviewed research to provide a strong evidentiary base. We combined the tools and approaches of systematic reviews and grounded theory to locate relevant studies, extract and code pertinent data, and analyze the data to produce the IAEEP model that links strategies, outcomes, core category, and context.

Hage (1972, p.5; as cited by Corbin & Strauss, 2015) described the reward for the hard work associated with grounded theory construction as a "new vision of our social world." We

used a grounded theory approach in our review to hopefully accomplish just that—a fresh look at existing evidence in EE to create a new interpretation of what makes EE effective for secondary students in the U.S. We chose a systematic review because of its rigor and transparency. The field of EE has a tendency of "talking to itself" (Potter, 2009, p. 31), so the methods of a systematic review insured that we looked beyond the same oft-cited studies and included studies published in non-EE journals. By combining grounded theory with a systematic review, our in-depth review of 39 studies of EE with secondary students yielded rich data and emergent insights. We believe the idea of authenticity in EE with secondary students merits further attention. Any educator who has worked with middle school and high school students will likely not be surprised that authenticity plays an important role in EE with this age group. EE, firmly grounded in real world problems with direct effects on every citizen of Earth, is an ideal vehicle for bringing authenticity to middle and high school students.

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Note: An asterisk (*) denotes study was included in the final sample of reviewed studies.

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Chapter 5: Core Principles of Grounded Theory in a Grounded Theory Systematic Review of Environmental Education for Secondary-Age Youth

Abstract

As systematic reviews of research increase in number, the methods used to conduct the analyses are becoming more diversified. While named in the methodological literature as an analytical approach, grounded theory is not frequently used as an approach in systematic reviews; when it is, reviewers typically emphasize the use of grounded theory coding and constant comparative methods while ignoring other key components of grounded theory. In this article, we describe a systematic review of environmental education research that incorporated grounded theory methodology to produce a theoretical model. To contribute to emerging discussions about methodological integrity when combining distinct methods like systematic reviews and grounded theory, we outline how our review methods aligned with core principles of grounded theory and discuss implications of using grounded theory when conducting a systematic review.

Introduction

In 2018, an estimated three million peer-reviewed journal articles were published in 33,100 English language journals, with the rate of publication growing from 3.5% in 2014 to 4.0% in 2018 (Johnson, Watkinson, & Mabe, 2018). For researchers trying to remain up to date with current research, research reviews are crucial tools that provide summaries, identify trends, and illuminate gaps. Researchers have identified many types of research reviews (e.g., Grant & Booth, 2009; Kastner et al., 2012; Paré, Trudel, Jaana, & Kitsiou, 2015), which they differentiate based on the varying methods and type of evidence (qualitative, quantitative, or mixed) used in the review. Given the large amount of research review types and methods available, research reviewers must make numerous methodological decisions throughout the review process, including how to search the literature, which studies to include, how to extract and analyze data, and how to present results. Qualitative research, with its deep experience with textual data and tools designed to collect and analyze words, has a lot to contribute to the continuing evolution of research reviews (Bowers & Creamer, in progress; Whittemore, Chao, Jang, & Minges, 2014).

In this article, we share how a grounded theory systematic review (GT-SR) that we conducted incorporated the core principles of grounded theory methodology into the systematic review process. While this is a methodological article, the context is environmental education. Environmental education involves educational programs focused on environmentally related topics presented to positively impact the knowledge, attitudes, skills, behaviors, and actions of participants with the ultimate goal of creating an environmentally literate citizenry. We chose environmental education as a context as the first author has experience as an environmental

education practitioner and researcher and the environmental education field offers a robust evidentiary base appropriate for a systematic review.

The goal of our GT-SR was to develop a theoretical model of environmental education for secondary-age youth (grades 6–12) in the United States (U.S.). Environmental education research has many studies examining the effectiveness of environmental education with a range of audiences; yet, the field lacks a model that connects context, strategies, and outcomes for environmental education for middle school and high school students. Using procedures from grounded theory methods allowed us to draw upon the extensive literature about environmental education (using systematic review methods) to create a model of environmental education (using grounded theory methodology).

In the following sections, we first introduce systematic reviews and describe the common steps of systematic reviews. We then discuss various qualitative approaches to systematic reviews before focusing on using grounded theory in systematic reviews. We present the methods we used in our GT-SR to demonstrate how the core principles of grounded theory can be incorporated into a systematic review. Finally, we reflect on the process of combining grounded theory methodology with a systematic review and discuss the implications of using grounded theory in a systematic review.

Systematic Reviews

In literature reviews that are written for a brief section in academic papers or conducted to guide the framing for a study, the researcher is often not overly concerned with transparency and rigor. Searching for relevant literature may proceed haphazardly, be reliant on serendipitous search methods, and revolve around a broad or nebulous topic. In contrast, a systematic review involves explicit, systematic methods to search, identify, screen, appraise, analyze, and report on

a collection of research studies. The researcher begins with a focused question or topic, systematically searches and analyzes the relevant literature, and keeps detailed records throughout the process (Cooper, 2010; Gough et al., 2017).

Researchers who use systematic review methods are endeavoring to be transparent and rigorous in order to present updateable and useful results (Gough et al., 2017). The data in a review consist of primary studies, the studies identified during the search and screening steps of a review as being relevant to the pre-defined research question (Heyvaert, Hannes, & Onghena, 2017). Systematic reviews generally involve a similar sequence of steps: (1) define the question; (2) search the literature; (3) screen the results for relevancy and quality; (4) extract, analyze, and synthesize data; and (5) share findings (Cooper, 2010; Gough et al., 2017).

Historically, systematic reviews tended to focus on either quantitative or qualitative data and the type of data dictated appropriate analysis and synthesis methods. Reviewers of quantitative findings, often from randomized controlled trials, frequently used meta-analysis (Higgins & Green, 2011; Lau, Ioannidis, & Schmid, 1997). Reviewers of qualitative studies used different forms of meta-synthesis (Sandelowski, Docherty, & Emden, 1997), including interpretive synthesis (Jensen & Allen, 1996) and meta-ethnography (Noblit, Hare, & Hare, 1988). As systematic reviews have evolved to consider a mix of data types, the options for analysis techniques has grown tremendously (Dixon-Woods, Agarwal, Jones, Young, & Sutton, 2005; Whittemore et al., 2014).

Qualitative Approaches to Systematic Reviews

Qualitative synthesis differs from its quantitative counterpart of meta-analysis in its emphasis on pooling results to create something new (e.g., theory, concepts), rather than using statistics to aggregate findings or evaluate an intervention (Bearman & Dawson, 2013; Finlayson

& Dixon, 2008; Schreiber, Crooks, Stern, & Morse, 1997). While not as established as meta-analytic techniques (Whittemore et al., 2014), qualitative synthesis offers numerous methods including narrative summary, thematic analysis, realist review, meta-ethnography, interpretive synthesis, content analysis, meta-study, grounded theory, and vote-counting, many of which can be used to review qualitative, quantitative, and mixed methods studies (Bearman & Dawson, 2013; Dixon-Woods et al., 2005; Finlayson & Dixon, 2008; Heyvaert, Hannes, & Onghena, 2017; Whittemore et al., 2014).

While there are many options for incorporating qualitative synthesis into the analysis stage of a systematic review, there are few examples of researchers reporting on a qualitative approach throughout the entire systematic review process. Whittemore (2005) provided one example of applying a qualitative approach to the entire review process in her integrative review of integration in nursing. Whittemore reviewed a mix of qualitative and quantitative studies and used iterative concept analysis to develop a conceptual model of integration. Dixon-Woods et al. (2005) reported on new techniques they used to review and synthesize studies of varying research designs to create a theoretical conceptualization of healthcare access. Both Whittemore and Dixon-Woods et al. represent examples of researchers taking a qualitative approach throughout their systematic review of studies that are not of a single research design. In the next section, we describe another qualitative approach to systematic reviews—grounded theory—that can be applied throughout the systematic review process and is appropriate and well suited for reviewing a mix of qualitative, quantitative, and mixed methods studies.

Developing a Grounded Theory in a Systematic Review

Early use of grounded theory in systematic reviews (e.g., Eaves, 2001; Finfgeld, 1999; Kearney, 2001) was most dominant in the health fields and focused primarily on studies

examining qualitative evidence. Although Dixon-Woods et al. (2005) presented grounded theory as a method to review a combination of quantitative and qualitative studies, the one example provided (Kearney, 2001) involved only qualitative studies. In their handbook for conducting mixed methods research syntheses, Heyvaert et al. (2017) discussed grounded theory solely in the context of qualitative-only strands of segregated or contingent mixed methods research reviews.

The use of grounded theory in systematic reviews of quantitative, qualitative, and mixed methods studies mirrors an observed trend of grounded theory use in mixed methods research: few grounded theory studies are being used to produce a theory or theoretical framework (Creamer, 2018; Guetterman et al., 2017). Many reviews purporting to incorporate grounded theory have used grounded theory methods to develop themes, concepts, or categories, but failed to develop substantive theory (e.g., Brizay et al., 2015; Coffey, Tate, & Toland, 2013; Sawyer, 2017). Missing from current literature are any discussions addressing how to maintain methodological integrity when conducting a GT-SR.

Grounded theory provides more than just analysis tools, so in adopting a grounded theory approach, we recognized that the entire systematic review process would be influenced by grounded theory principles. Throughout our study, we incorporated key features of grounded theory, which we discuss in the next sections. Despite systematic reviews involving primarily quantitative sampling strategies and grounded theory privileging a qualitative, inductive approach, we maintained methodological integrity by respecting each tradition's core principles and at times maintaining separate strands (i.e., some steps involved strictly systematic review methods and other steps were solely grounded theory methods).

Core Principles of Grounded Theory

Since the publication of Glaser and Strauss' (1967/2006) foundational grounded theory text, methodologists have generally recognized multiple variants including classical grounded theory (Glaserian), realist grounded theory (Straussian), constructivist grounded theory (Charmazian), and situational analysis (Clarkeian), among others (Apramian, Cristancho, Watling, & Lingard, 2017; Kelle, 2019; Timonen, Foley, & Conlon, 2018). Rather than aligning with a particular variant and adhering solely to the associated paradigm, we embraced the idea of methodological dynamism in grounded theory (Ralph, Birks, & Chapman, 2015) and incorporated principles, tools, and beliefs from multiple variants. For example, we developed our theoretical model based on Corbin and Strauss's (2015) paradigm and conditional matrix but our coding aligned more closely with Charmaz's (2014) constructivist grounded theory coupled with theoretical coding as presented in Glaser and Strauss (1967/2006).

When deciding how to incorporate the existing research literature, we adopted a pragmatic attitude toward grounded theory and literature review (Charmaz, 2014; Thornberg, 2012). Despite the foundational authors' objections to introducing the literature prior to the development of categories (Glaser & Strauss, 1967/2006), as the study was the first author's doctoral dissertation, there were practical reasons to conduct a literature review. By reviewing existing research in environmental education prior to category development, we were able to confirm the lack of a model of environmental education for secondary students. Additionally, conducting a literature review served as a vehicle for identifying sensitizing concepts and confirming support for emergent categories (Charmaz, 2014).

Despite competing versions, grounded theory methodologists often acknowledge a shared set of commonalities among what Charmaz (2014) eloquently referred to as a constellation of

methods. Looking across criteria used by Creamer (2018) and Guetterman et al. (2017), we identified five core principles of grounded theory: (a) theory development; (b) theoretical sampling; (c) progression of abstraction in coding; (d) constant comparison; and (e) memoing. Other core principles certainly exist but we focused on the chosen five for their relevance and applicability to systematic reviews. In the following sections, we detail how each core principle was illustrated in our GT-SR of environmental education research.

Grounded Theory Principle 1: Theory Development

The required end product of a grounded theory study is a useful theory that has emerged from and is grounded in coded data (Bryant & Charmaz, 2007; Kelle, 2019). In this context, a theory is a constructed explanation of a phenomenon presented through identified categories and the relationships among these categories (Birks & Mills, 2015; Charmaz, 2014). A grounded theory can be presented in multiple forms, including as a model, diagram, framework, narrative, series of propositions, or conceptual schema (Bryant, 2017; Creswell & Poth, 2018). Emergent, explanatory grounded theories are most frequently low- to mid-range theories or substantive theories that are particular to a setting (Glaser, 2007; Kearney, 2007; Urquhart, 2019). A substantive theory is a low-level theory that focuses on a defined context, such as a specific group or setting, in contrast to formal or grand theories, which explain phenomena at much broader and general scales (Charmaz, 2014; Creswell & Poth, 2018; Glaser, 2007; Lempert, 2007). There is no claim of generalizability in a substantive theory. It is assumed to be tentative and to only apply in the specified setting with confirmation reserved for later studies.

Development of the Theoretical Model

In this GT-SR, we used grounded theory procedures to generate a substantive theory regarding how environmental education impacts pro-environmental behavior. We focused on

environmental education programs in the U.S. for secondary students and transferability of the theory beyond this specific context was not an intended goal. We presented our theory in the form of a visual model, entitled the Implementing Authentic Environmental Education Programs (IAEEP) model, with an accompanying narrative statement (see Bowers & Creamer, in progress, for the full model). Corbin and Strauss (2015) are the grounded theory methodologists who have focused the most attention on using a visual model to represent theory. They use the language of context, actions-interactions, consequences, core category, and conditions and discuss the use of two visual displays—a paradigm and the conditional/consequential matrix. Not all grounded theory researchers use these models and terms, but our specific context and phenomenon under study fit well with the features of these particular visual displays and associated language.

Summary of the Implementing Authentic Environmental Education Programs (IAEEP) Model

We constructed a theoretical model with components suggested by Corbin and Strauss (2105) that we modified to fit our context. Context is the unchanging, background conditions (individual and environmental) that impact program outcomes. In our model, the context is environmental education programs for secondary youth in the U.S. The environmental education process and its associated outcomes are also influenced by contextual conditions that exist prior to program implementation (e.g., facilitator style and characteristics; participant characteristics; program settings; and program duration) and intervening conditions that occur during or after the program (e.g., level of support from family and friends and amount of exposure to other environmental education). We identified strategies (which Corbin and Strauss refer to as actions-interactions) as the actions undertaken by educators that impact program outcomes. Example strategies from the model include demonstrating relevance, connecting with others, mitigating

complexity, creating a safe space, supporting self, and incorporating technology. The primary outcome (Corbin and Strauss use the term consequences rather than outcomes) of this process is an increase in the practice of pro-environmental behaviors. In our model, educators target this outcome by impacting an individual's level of environmental literacy. Effective environmental education programs for this audience do this through the core category of creating and implementing programs that are viewed as authentic by secondary-age youth.

Grounded Theory Principle 2: Theoretical Sampling

In theoretical sampling, a researcher chooses what data to collect, and when to do so, based on the emerging theory and associated development and densification of categories (Glaser & Strauss, 1967/2006; Holton, 2007). Theoretical sampling occurs after initial sampling and guides data collection once early iterative coding has identified preliminary categories (Bryant, 2017; Charmaz, 2014). In contrast to quantitative research that focuses on representativeness of the data sample and some forms of qualitative research that may seek out diverse samples to improve generalizability, grounded theory methodology uses theoretical sampling to ensure full representation of the phenomenon under study; the focus is on saturating theoretical categories rather than demographic categories (Hood, 2007; Morse & Clark, 2019). Instead of trying to achieve an arbitrary sample size or getting enough data from selected groups, theoretical sampling guides the researcher to collect additional data from sources that will facilitate category development by providing information about promising concepts and addressing questions that have arisen during coding (Corbin & Strauss, 2015). This theory-directed sampling (Birks & Mills, 2015) improves category development and leads to theory development by addressing gaps in the data, exploring unanticipated and puzzling findings, refining category properties, and, in some cases, seeking out negative cases (Charmaz, 2014; Creamer, 2018). Theoretical

sampling is an ongoing, cyclical process that ends when theoretical saturation is reached (Bryant, 2017). The researcher stops collecting new data when, based on the researcher's interpretation of the data, new categories have ceased to emerge and existing categories have been fleshed out and solidified (Charmaz, 2014; Dey, 2007).

Sampling procedures. The approach we used to sampling, like other core procedures, was adapted to reflect both the expectations for a systematic review and those of grounded theory, including theoretical sampling. We used a three-step approach that began with an initial round of sampling, then sought out additional articles to flesh out the properties of the core category of "authenticity".

Initial sampling of the literature. The initial sampling for our grounded theory systematic review involved a literature search using academic databases and standard systematic review protocol (Moher, Liberati, Tetzlaff, & Altman, 2009; Shamseer et al., 2015). Our initial sampling criteria (Charmaz, 2014) targeted empirical articles about environmental education programs in the U.S. for secondary students. Using search terms such as "environmental education", "middle school", and "high school", among others, we identified 1,146 possibly relevant studies (see Bowers & Creamer, in progress, for full details of the search and review process). Using additional criteria to review abstracts and, eventually, the full text of selected studies, we narrowed our sample to 27 studies. For a complete bibliography of all reviewed studies, see Bowers and Creamer (in progress).

We followed conventional grounded theory procedures to code the 27 articles and developed tentative categories from the emergent codes. From the open codes such as "being meaningful", "identifying as relevant", and "capturing attention," a core category, "authenticity," emerged from this process.

Second round sampling of the literature. Following the development of a preliminary set of categories, we used a two-step approach to theoretical sampling to flesh out the properties of the core category, "authenticity." Initially, we revisited our original sample of 27 studies, but this time we focused on studies that best addressed (i.e., were coded with the theoretical code of authenticity) the developing core category of authenticity. From this revisiting of a subsample of the original studies, we learned study authors were using strategies to promote environmental issues and science as authentic, meaningful, and relevant to students. A deeper reading of the selected articles allowed us to identify a number of codes related to the concept of authenticity and confirm the importance of strategies to promote authenticity.

Third round of sampling of the literature. As the study progressed, the first author began to wonder if she was forcing this idea of the importance of authenticity onto the data and if it was a concept that had salience in a wider body of literature. Before we could further develop theory, we needed additional studies to explore if authenticity was indeed an important construct in environmental education for secondary students. To address these questions and firm up the authenticity concept, we conducted a second systematic search of the literature. We maintained fidelity to the systematic search process by using exactly the same search terms, search parameters, and databases as we used in the initial search. Because several months had elapsed since we had conducted the initial search, this second search uncovered new studies that had either been published or added to the databases since the initial search. We also used ancestry searching (Conn et al., 2003) to identify additional studies; ancestry searching involved reviewing citations in the 27 included studies.

By repeating the initial search with an expanded date range and using ancestry searching, we identified an additional 12 relevant studies and were able to honor the idea of ongoing

sampling based on theoretical developments. We reviewed the 12 studies in our theoretical sample and used this data to further refine our coding categories and theoretical model, until we felt theoretical saturation had been achieved. Additionally, we coded each of the 12 new articles for level of support of the core category of authenticity. Three of the studies were coded as providing some support and the remaining nine studies were coded as providing a high level of support.

Grounded Theory Principle 3: Progression of Abstraction in Coding

Coding is the process where the researcher uses a form of shorthand (single words or phrases) to assign meaning to the data (Birks & Mills, 2015). Unlike many other types of qualitative coding, grounded theory coding involves moving beyond description of the data to conceptual abstraction (Holton, 2007). The purpose of coding in grounded theory is to progress through increasing levels of abstraction allowing codes, categories, and concepts to emerge from the data to generate theory (Belgrave & Seide, 2019; Bryant & Charmaz, 2007). To facilitate movement to higher levels of abstraction, grounded theorists identify various coding phases and concepts, including open coding, axial coding, coding families, coding paradigm, substantive coding, and theoretical coding (Corbin & Strauss, 2015; Holton 2007; Kelle, 2007, 2019). Additional complex coding techniques, such as evaluation coding, causation coding, and versus coding, have been identified as being potentially well-matched for grounded theory coding (Saldaña, 2016).

Charmaz (2014) sees at least two coding phases: initial and focused. In initial coding, the researcher asks questions of the data and remains open to all possible directions to allow the data to guide the theory. Charmaz advocates for the use of simple, direct codes and the use of gerunds to remain focused on action. During focused coding, initial codes that emerge as prominent and

pervasive are promoted to categories and the initial codes themselves may be coded. Finally, theoretical coding further elevates the level of abstraction by integrating codes and categories (Glaser & Strauss, 1967/2006; Holton, 2007). Theoretical coding connects existing literature with the identified codes and categories to create an integrative, robust theory (Creamer, 2018).

Coding phases. In our GT-SR, we followed Charmaz's coding process involving initial and focused coding, and added theoretical coding. We used NVivo, a qualitative analysis software program, to facilitate the management of large amounts of coded data and the organization of emerging and evolving codes and categories. Figure 10 provides an excerpt of the final coding dictionary to illustrate the connections we made among data, codes, and categories. This part of the coding dictionary focused on analyzing strategies that environmental educators were using in the education programs with middle school and high school students.

Initial Codes	Categories	Theoretical Codes
Assigning group roles Building community Developing partnerships Interacting with peers Interacting with experts Sharing results Teaching others Using technology to connect Working in groups	Connecting with others	Authenticity Differentiation from conventional classroom instruction
Alleviating anxiety Being open to all viewpoints Creating empowerment Cultivating feelings of safety	Creating a safe space	
Connecting to research-based best practices Eliciting prior knowledge Encouraging logical progression Focusing on specific topic/theme Increasing knowledge and skills Using models and simulations Using systems thinking	Mitigating complexity	
Offering adventure activities Building empowerment Tapping into creativity Increasing knowledge and skills Engagement and enjoyment Reflecting Providing vocational/college prep	Supporting self	

Figure 10. Excerpt from coding dictionary focused on strategies used by environmental educators.

Initial and focused coding. During initial coding, we used descriptive and In Vivo codes to organize the data into meaningful chunks (Saldaña, 2016). As the chunks we were coding represented descriptions of what educators were doing in the classroom, we followed Charmaz's suggestion of using gerunds as codes. For example, when study authors described programs involving group activities, we coded this text as "Working in groups". As coding progressed into focused coding, we added new codes but simultaneously began to see how these initial codes were grouping together into categories. Looking across a set of codes that included "Interacting with peers", "Working in groups", and "Sharing results", we noted how these particular codes were all about having students connect with other people, such as their peers and community partners. We created a categorical/focused code called "Connecting with others" to demonstrate the shared structure among this one set of initial codes.

***Theoretical coding*.** As we became more familiar with the data and continued coding new data, the theoretical codes began to emerge that linked the categories. Eventually, reflection on the data and codes suggested two dominant theoretical codes: *Authenticity* and *Differentiation from conventional classroom instruction*. During this process of theoretical coding, we explored the existing literature to have a more nuanced understanding of the idea of authenticity and how secondary educators are using new teaching strategies to move beyond conventional classroom learning. As part of the theoretical coding, we developed the theoretical model, which involved creating a dynamic visual display that captured the relationships and structure among the emerging categories, theoretical codes, and context. As suggested by Charmaz (2014) and Creamer (2018), this model was informed by theoretical coding which united the data with existing, relevant literature.

Grounded Theory Principle 4: Constant Comparison

To achieve the increasing level of abstraction in coding that we describe above, grounded theory researchers use the analytic process of constant comparison. The constant comparative method begins as soon as the first piece of data is collected and continues throughout data collection and analysis until an integrated theory is achieved (Birks & Mills, 2015; Bryant, 2017). Constant comparison involves looking for similarities and differences in the data by asking questions of the data and coding and making continual comparisons including comparing data to data, codes to data, codes to codes, categories to codes, and categories to categories (Charmaz, 2014; Corbin & Strauss, 2015). By identifying similarities among data and codes, data and codes can be grouped together to eventually form cohesive, logical, and abstracted categories (Corbin & Strauss, 2015; Dey, 2007). Constant comparison also welcomes the discovery of differences among data and codes, with deviant cases contributing to the recognition that a developing theory may need to include additional components (Bryant, 2017; Covan, 2007). In addition to comparing data and codes, grounded theory researchers who embrace consulting existing research and literature can also use the constant comparative methods to compare their developing findings and theory with existing theory and thought (Thornberg & Dunne, 2019). Constant comparisons revealing similarities and differences among data, codes, and existing literature help further the development and refinement of categories and their properties, with the ultimate goal of theory elaboration and integration (Dey, 2007; Hood, 2007).

Theoretical saturation. Given the dynamic and iterative nature of the constant comparison method, novice researchers may struggle with knowing when to stop constantly comparing data and codes. Grounded theory researchers use theoretical saturation as a

benchmark to determine the stopping point for data gathering and analysis. Theoretical saturation occurs when the emergent categories are determined to be well developed (Corbin & Strauss, 2015), achieving what Nelson (2017) termed *conceptual depth* and indicating that no new categorical dimensions or properties are emerging (Holton, 2007). Glaser and Strauss (1967/2006, p. 61) described saturation in terms of fleshing out the characteristics of categories, rather than a theoretical model: "Saturation means that no additional data are being found whereby the sociologist can develop properties of the category."

Process of analysis in the GT-SR. In our GT-SR, we used constant comparative methods starting with the launch of initial coding and movement into focused and, eventually, theoretical coding. This type of analysis is facilitated in a systematic review as the primary data source is comprised of published studies, which, unlike people or events, can provide new examples that are always available for analysis. We used NVivo features, like text search and matrix coding, to assist in the constant comparison of data and codes. Our analysis did not involve a simple one-time read and coding of each study, rather the lead author read and reread parts of each study many, many times, becoming immersed in the data to ensure our theoretical model became fully developed and integrated.

As our theoretical model developed, we also compared our findings with existing research. Specifically, we explored literature about the emerging core category of authenticity to discover if the idea of authenticity had been previously linked to program effectiveness in environmental education research and in secondary school education research more broadly. While the constant comparison method can make grounded theory coding and analysis time consuming, it is required for a thorough understanding of the data and relationships among data, codes, and categories that will lead to theory (Timonen et al., 2018).

Grounded Theory Principle 5: Memoing

In a grounded theory study, memos are contemporaneous, informally written records of the researcher's analytic thoughts and reflections (Birks & Mills, 2015; Bryant, 2017). Memo writing begins as soon as soon as the process of data collections begins and continues throughout analysis providing an interactive space where the researcher engages with the data (Charmaz, 2014; Lempert, 2007). Memos are not simple descriptions or summaries of the data; instead, memos are researcher-created conceptualizations of the data that move analysis toward theoretical integration by increasing abstraction, illuminating patterns, and identifying gaps (Lempert, 2007). Additionally, memos can help researchers address reflexivity and their own positionality, find their voice, think creatively, and connect data to existing literature (Lempert, 2007; McGhee, Marland, & Atkinson, 2007; Thornberg & Dunne, 2019). Memos serve as written documentation of how the researcher started with raw data and moved into theory development, which can facilitate communication among research team members and help in the presentation of findings (Charmaz, 2014; Corbin & Strauss, 2015).

Memos do not have to be written in a certain way, at certain times, or be a certain length (Corbin & Strauss, 2015). For novice researchers, however, grounded theory experts offer several tips and tools to support memoing. Procedural advice includes dating and titling memos, which can help if a researcher decides to eventually sort and code the memos (Birks & Mills, 2015). Charmaz (2014) recommends pre-writing strategies such as clustering and freewriting to jump start the memoing process. Memos can be created as part of a research journal (Charmaz, 2014; Corbin & Strauss, 2015) and researchers can use qualitative analysis software to help create, organize, and utilize memos (Friese, 2019).

Creating memos in the GT-SR. We employed a range of memos throughout our review process that varied in length, format, and content. In memos created early in analysis, we adhered to Strauss and Corbin's (2015, p. 117) advice urging researchers to "just brainstorm and let loose with their thoughts, " and we strove for deeper levels of analysis as the study progressed to support the development of codes and categories, as suggested by Charmaz (2014). Figure 11 presents an excerpt from a memo written early in the study as the first author reflected on the emergence of a possible intervening condition. We share the memo examples with the caveat that, as Charmaz suggested, memos are written for personal use not public viewing.

10/9/18

Exposure to EE

Do we ask one reading program to permanently lead to reading success, no, it's a curriculum across all grades. So EE should be seen as a lifelong endeavor. So in a model of EE, an intervening condition could be additional exposure to EE. This would involve seeing EE as maintenance. First exposure to EE creates an env identity or env behavior, follow up programs maintain this.

Figure 11. Early memo on an emerging intervening condition.

As the study progressed, analysis was more focused on the development of the core category and this is evident in later memos. Figure 12 provides an excerpt from a memo where the first author reflected on the possibility of authenticity emerging as the core category.

3/18/19

Memo Title: Promoting category?

The authenticity category is feeling more important. Several study authors allude to the idea, even using the term "authentic". I ran a text search to view all instances authors used a variation of the term (see Word Tree in Query Results) and it shows up in 15 articles and many post coding memos.

When the students in these EE studies talk about their experiences, they often seem to indicate they appreciate the relevance of the work they did, but it goes beyond relevance (which is important). They talk about their teachers and like it when the teacher seems to care about the issue (have enthusiasm) but also want teachers to be open-minded. They don't like it when they feel a teacher is too overly pro-environmental and not open to hearing other sides. Somehow that plays into authenticity as they don't feel like that is authentic. I think that's because the teachers that may be too green are the same ones who stress being open to other viewpoints but then their actions don't match up with this.

Barnett et al. reference the idea of authenticity a lot: "Unfortunately, few students work with tools regularly used by scientists or pursue authentic inquiries using current scientific data" and "Participatory learning environments…should be designed to engage learners in authentic science" and "learners should be working in participatory science and should be given the opportunity to participate in a professional community and not simply hearing about the work of other authentic science communities." Skinner et al. writes "Most important, gardening introduces activities that are authentic and meaningful, potentially instilling pride and ownership". Lots and lots of similar texts coded as relevant, meaningful, real world, and authentic.

It's definitely on my mind today as I was interviewing someone for another project and one of them used the term to talk about how important it is to be honest with middle school students--that they just know when something is not authentic. It reminded me of a conversation with my son where he talked about how you just know when adults are being real or when they are putting up a front to seem cool or look like they care when they don't. Even my younger kids can tell when I am not really paying attention to something they are saying and instead have my mind elsewhere. Kids are good at spotting fakeness.

I wonder if authenticity shows up as important in counselling middle and high schoolers. Teachers must know this about students at this age. I know there is lots of research on making math and science more obviously connected to student's everyday lives--the idea of relevance. EE is a real issue with real consequences that affects everyone--everyone breathes air, everyone drinks water. Kids need to be able to see this and good strategies accomplish this--they reveal that EE is authentic.

Figure 12. Later memo reflecting on importance of authenticity.

Discussion

As one of the more structured approaches in qualitative research, grounded theory is a natural fit for systematic reviews. Charmaz (2017, pp. 1-2) has defined grounded theory as "a systematic approach to qualitative inquiry for the purpose of theory construction." Charmaz's use of the descriptor "systematic" underscores this natural fit—both grounded theory and systematic reviews, through prescribed methods and steps, value systematicity. In our GT-SR, the more structured and codified grounded theory core principles of coding, constant comparison, and memoing easily dovetailed with the methods of a systematic review. Theoretical development and theoretical sampling required more thought and effort to incorporate into the GT-SR, so we focus on these two core principles in our discussion. We also address potential criticisms of using grounded theory with a systematic review.

Implications for Developing Theory in a GT-SR

By having development of a substantive grounded theory as the goal of our grounded theory systematic review, we intended to create a useful, practical conceptual framework that environmental education practitioners and researchers can use to more effectively design, implement, and evaluate programs for a specific context (secondary students in the U.S.). As previously noted, numerous existing sources provided lists of environmental education strategies, but a lack of an overarching theme rendered these lists cumbersome and complex. Knowing that theory development was our end goal forced coding and analysis to be more thoughtful and interpretive (Charmaz, 2014) to guarantee that we did not simply generate more lists of strategies and outcomes; nor is our model a list of themes. Iterative coding and higher levels of abstraction, aided by the development and re-development of a visual theoretical model, helped us to see the complex connections and integration among strategies and contexts that led to the desired

program outcome of pro-environmental behavior. As a substantive theory, our model applies to a specific context but may also contribute to the development of more formal theories about environmental education (Lempert, 2007).

Implications for Using Theoretical Sampling in a GT-SR

Theoretical sampling, which requires flexibility (Corbin & Strauss, 2015), may appear to be incompatible with systematic reviews as systematic reviews achieve their desired transparency and repeatability by adherence to a predefined, linear search process (Gough et al., 2017). However, Charmaz (2014) has emphasized the specificity and systematicness of the method and our systematic review was able to capitalize on this. In a systematic review, there is frequently one search conducted at the beginning of the review process that identifies the final set of studies to be reviewed. In our review, the main search for data did occur at the start of the study, but we remained open to the possibility of conducting searches to identify additional studies as the review progressed and questions emerged. In contrast to quantitative studies, there was not a target sample number we aimed for, rather we identified enough studies to achieve theoretical saturation. Our identified population was secondary-age youth in the U.S. and the setting was environmental education programs—beyond that, we did not specify any desired characteristics or distribution of studies. For example, we did not include a certain amount of studies with high school students versus middle students, or formal environmental education versus informal environmental education. By not being bound to a certain number of studies in our final sample, we were able to allow analytical leads to guide data collection decisions, both within the original sample and in an effort to identify additional studies.

While funding agencies, institutional review boards, professors, and advisors may require a defined sample size prior to conducting a study, the flexibility and contribution to theory

development of theoretical sampling can be used to argue for its use. If all else fails, researchers can follow Stern's (2007) recommendation of simply making up a number to act as a placeholder in research proposals and other planning stages of a research project.

Theoretical sampling also offers possibilities to focus on particular types of studies or studies with specified audiences. While participant characteristics emerged as an important context in the IAEEP model, we noted a lack of consistent descriptive data about individual study samples. In the spirit of theoretical sampling, future research could continue to explore this topic with a focus on marginalized student populations by seeking out studies that explicitly describe program participants as being members of marginalized groups in U.S. communities.

Addressing Criticisms of Using Grounded Theory in a Systematic Review

Despite the seemingly good fit between grounded theory and systematic reviews, Dixon-Woods et al. (2005) noted several possible complications when using grounded theory in reviews. Dixon-Woods and colleagues suggested that grounded theory lacked enough transparency to satisfy the expectations of systematic reviews. In this article, we hope to have met this challenge by sharing our experiences with a GT-SR to clearly and explicitly show how grounded theory tools and principles can be used to conduct a rigorous and transparent review. Additionally, the core principle of theoretical sampling addresses Dixon-Woods et al.'s concern that grounded theory methodology offers no guidance on deciding which studies to include in a review. Grounded theory principles suggest identifying and including studies that contribute to the development of categories and an integrated theory. Finally, Dixon-Woods et al. (p. 48) suggested that the "methodological anarchy" in grounded theory hinders its use as a review approach. Instead, we embrace the methodological dynamism of grounded theory (Ralph, Birks, & Chapman, 2015) and believe that combining strengths of different grounded theory variants

while aligning to a shared set of core principles creates a review method that is adaptable and useful. We show alignment between our review and these core grounded theory principles to provide evidence that this barrier of methodological anarchy can be overcome by acknowledging and privileging this common core.

Conclusion

As published, peer-reviewed research continues to grow, research reviews will become increasingly important tools to help researchers remain up-to-date and guide future research. The field of knowledge synthesis offers countless options of how to conduct reviews and methodologists from a variety of research traditions offer guidance to advance the field. The common suggestion to use meta-analysis in systematic reviews (Cooper, 2010) suggests a quantitative focus in reviews, but qualitative research offers rigorous review methods of its own, such as thematic analysis, realist synthesis, and meta-synthesis (Bearman & Dawson, 2013; Kastner et al., 2012). Grounded theory, one of the stalwarts of qualitative research, has been promoted as a review approach (e.g., Dixon-Woods et al., 2005; Wolfswinkel et al., 2013) but there are few examples in the published literature of systematic reviews that faithfully incorporate the full range of grounded theory principles throughout the review process. By demonstrating alignment between our study and core grounded theory principles, we have attempted to show how grounded theory can be successfully and effectively used in a systematic review to develop a theoretical model grounded in the data.

From our experience of conducting a GT-SR, we identified four general recommendations for researchers wanting to undertake their own GT-SR:

1) Be familiar with basic principles and defining characteristics of both grounded theory and systematic reviews.

2) Be flexible as the review progresses and be willing to revise methods as needed.
3) Both grounded theory and systematic review methods emphasize the importance of documenting what is done during a study. Create and maintain an ongoing system to record what is done as part of each step of the review.
4) Prioritize theory development and reflect on this goal throughout the review by developing a model, framework, or similar organizational tool. Systematic reviews can easily evolve into a descriptive summary of other studies, so having the primary, explicit goal of theory development can help a GT-SR stay on track to meet the goal of a grounded theory study.

In closing, we offer an overarching recommendation for researchers interested in combining grounded theory methodology with systematic review methods: be conscious and intentional about the use of grounded theory. As many studies illustrate, it is easy to assign the label of grounded theory to a study, but far harder to demonstrate true methodological integrity (Charmaz, 2017; Creamer, 2018; Guetterman et al., 2017; Timonen et al., 2018; Urquhart & Fernandez, 2013). Just as grounded theory researchers constantly and consistently compare data, codes, and categories, we continually compared our research practices to the ideals of grounded theory. We revised plans as needed, focused on the documentation of our work, and incorporated techniques to support grounded theory core principles. The hard work, extensive time, and deep (sometimes painful) thought required by a grounded theory study (Strauss & Corbin, 2015) coupled with the attention to detail and rigor of systematic reviews (Gough et al., 2017) can be demanding, but generating a theoretical model that has its roots in the thoughtful work of dedicated researchers (represented by the reviewed primary studies) is a worthy reward.

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