EDUCATOR ENVIRONMENTAL LITERACY: A MIXED-METHODS STUDY OF BEHAVIOR, IDENTITY, AND PRACTICES.

By

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ABSTRACT OF THE DISSERTATION

Educator environmental literacy: a mixed-methods study of behavior, identity, and practices.

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Environmental literacy has had an evolving definition over the last fifty years, most recently including knowledge, personal dispositions, skills, and behavior (Hollweg, et al., 2011). This work expands on that framing to situate EL in social-ecological systems. This contextual perspective sees EL as changing participation in these social-ecological systems, includes socially constructed practices instead of skills, and views those practices as key to both boundary-crossing between social-ecological systems and progression across a continuum of EL (Stables, 1998). The purpose of this dissertation is to explore educator environmental literacy using this perspective, specifically, designing an assessment of educator EL which includes practices, and explore more deeply respondents' answers to develop a robust view of New Jersey formal and nonformal educator EL.

This is accomplished using a mixed methods approach. First, the development, implementation, and analysis of the Teacher Environmental Literacy Assessment (TELA) is described. Interviews with a subset of formal and nonformal educators who completed

the assessment provide more context to their TELA responses, using thematic analysis. Finally, a modified version of the TELA is used to place educators at one of three levels of EL: functional, cultural, or critical, using criteria that expand on Stables (1998). Then further thematic analysis is used to develop a picture of the relationship between EL level and issue identification and views on student EL.

While there were several demographic effects on TELA scale scores, most interestingly, nonformal educators had higher scores on knowledge, behavior, and the practices of issue identification and strategy selection. In addition, there was s difference between the types of strategies selected by experts and educators – experts more frequently chose system-level behaviors, and educators chose personal-level behaviors. This difference between system-level and personal-level behaviors is also present in those strategies educators choosing to address environmental issues in TELA scenarios (system-level) and the types of behaviors they report actually engaging in (personal-level). This appears to be connected to a rejection among some educators of "political" or "activist" identities. Finally, educators at more advanced levels of EL provide more elaborate, technical explanations for why they chose issues in the TELA scenarios, and include social considerations more frequently in decisions of where to site an electronics waste plant. They also see their role in student EL as developing more parts of EL, moving from dispositions to knowledge, practices, and connection.

These findings support the use of a contextual perspective, and serve as platform to further the study of EL in a way that pays attention to participation and practices to help move educators along a continuum of EL development. Recommendations for further research and practice include the study of educator EL enactment in instructional

contexts and the development of deliberate communities that bring both pre-service and in-service teachers into contact with more experienced activists and educators.

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Carbon offsets for this project were purchased through NativeEnergy.

Dedication

This work is dedicated to my husband Eli and daughter Charly. Your unflagging support and encouragement, your love and humor, made this possible. Eli, you have been on this journey with me the whole way, from novice environmental educator to researcher. Charly, your arrival made me see the world differently, and want to change the world to make it a better place for you. Thank you both so much. I will always love you most.

To my late mother Charlotte, thanks for making sure the natural world was so integral to my childhood. It shaped more than you will ever know.

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Chapter 1. Introduction

In the late 1960's and early 1970's the U.S. and other global North countries saw an environmental revolution. Spurred by unprecedented environmental damage, and situated in a time of fighting for civil rights and against war, this period resulted in landmark legislation. This included the National Environmental Policy Act (NEPA) in 1970, a major rewrite of the Clean Air Act in 1970, the Endangered Species Act of 1973, and the 1974 Safe Drinking Water Act. Legislation such as this, though it had great benefit with regards to pollution, was not sufficient to spur high levels of environmental improvement. It was recognized that in order to create long lasting change, there must be education across people's lives that taught them how to act in an environmentally responsible way. Roth (1968) proposed "environmental literate" to mean those that acted positively to the environment, in contrast to the phrase "environmentally illiterate" used in the media. Concurrently, Stapp (1969) wrote for the first time about environmental education, which would produce "…a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work towards the solution." Following that was the first intergovernmental conference on environmental education in Tbilisi, Georgia (USSR) in 1977, which produced the Tbilisi Declaration (UNESCO, 1977).

Yet even with such forward thinking goals, and continued legislation, we continue to face major environmental issues fifty years later. Human impact on the planet is so great that scientists argue we are in a new geologic age, the Anthropocene (Crutzen, 2002; Crutzen & Stoermer, 2000; Steffen et al., 2007). At the same time as biophysical components of the earth system are impacted, we see the socially oppressed and

disenfranchised bearing a disproportionate impact of environmental degradation as well. We continue to grapple with such issues of environmental justice at many levels - from Cancer Alley in Louisiana (Blodgett, 2006), to the Dakota Access pipeline (Whyte, 2017) to the shipping of electronic waste to the global South where regulations do not protect the people living nearby (Iles, 2004).

Regardless of what is identified as an environmental issue, the human and biophysical aspects of the issue are entangled, unable to be truly teased apart. These social-ecological systems (Berkes, Colding, and Folke, 2003) share the traits of complexity, emergence, vulnerability, adaptability, transformability and potential resilience (Glaser, Krause, Ratter, & Welp, 2008). They can occur at multiple scales. Most relevant to this research are the complexity and emergent nature of the social-ecological systems. These systems can emerge as either the biophysical or social components change. For example, climate change causes sea levels to rise, putting NJ shore communities at greater risk for flooding and creating regulatory and policy challenges.

Given these continuing and emergent environmental issues, the pressure is greater than ever to create citizens that are environmentally literate in a way that fits into a highly mobile, information saturated world. There is a need for both youth and adults that are knowledgeable of biophysical and social systems, who understand the integration of social and environmental components of environmental issues, and that have attitudes and beliefs that benefit the environment and people, and that can identify issues and engage in investigation, evaluation and action on the best solutions in a given context. Without a citizenry that is so prepared, people in the U.S. and beyond will be unable to

engage with the environment in a sustainable way, threatening the stability of both human and ecological systems.

Environmental Literacy

Environmental literacy (EL), first described in 1968 (Roth) has changed conceptually over time, while still hewing to its roots. For many years, it was considered to be synonymous with the objectives of environmental education (EE), such as the Tbilisi goals (1977). Volk and colleagues (1984) describe EL in a critique of environmental education which they stated was "…failing in its endeavor to develop knowledgeable, concerned, competent, and participating citizens, i.e., environmentally literate human beings." (p. 12) Marcinkowski (1991) fleshed out the concept, including ideas of environmental issue scale, as well as the interface of natural and socials systems. Beginning in the early 1990's, as there was a call for environmental education standards and for professionalization of the field, frameworks for EL also began to emerge, with an eye towards its assessment. For example, Roth (1992) revisited his earlier work, and outlined four strands: knowledge, skills, affect, and behavior. He also outlined a continuum of EL, or three levels: nominal (developing awareness and rudimentary knowledge of the environment), functional (greater knowledge, including interactions between social and natural systems, as well as skills in communication and action), and operational (someone who routinely evaluates impacts of their actions and has ingrained interaction with the world at large). Later, Stables (1998) and Stables and Bishop (2001) take more critical readings of an EL continuum. Stables (1998) describes the levels as functional (knowledge of things in the environment and the ability to identify what is not immediately known), cultural (knowledge of the cultural and social roles of the natural

world and human impacts on them), and critical (the ability and willingness to engage with the deeper meaning of the environment and society, and use that to address issues, pushing back against hegemony). This research avenue has not been picked up, in favor of frameworks that lend themselves more easily to assessment. A more recent project, targeted for the assessment of EL, was published by the North American Association for Environmental Education (Hollweg et al., 2011). It synthesizes previous work and creates a framework composed of dispositions, knowledge, competencies, and environmentally responsible behavior practiced in multiple contexts.

The Contextual View of Environmental Literacy

The research in this dissertation takes a contextual view of EL. It is seen as both having multiple components, as in Hollweg et al. (2011), and existing on a continuum of how one engages with the environment and information about the environment. This approach aligns with Stables' (1998) continuum of functional, cultural, and critical EL. It departs from earlier frameworks, however, by perceiving environmental literacy as contextual and situated in social-ecological systems (Berkes et al., 2002). There is no absolute level of environmental literacy, no pass/fail mark, rather degrees of practice in engaging with social-ecological systems.

As with previous framings of EL, this contextual framing sees EL as multifaceted. There is, as with Hollweg et al. (2011), the inclusion of both biophysical and sociocultural knowledge, representing the entangled nature of social-ecological systems. Though there are common components of the biophysical and social knowledge, such as ecological processes (i.e. photosynthesis or carbon cycling) and systems fundamentals (i.e. feedback loops or emergence), much of it is dependent on the social-ecological

context an individual is in. Dispositions include environmental self-efficacy, one's perception of inclusion with nature (Schultz, 2002), and environmental identity (Kempton & Holland, 2003). Behavior is viewed as participation in multiple avenues of environmentally responsible behavior, using the categories of direct environmental, consumer, persuasive, political and legal action (Hungerford, & Tomera, 1977).

The contextual framing departs from previous models of EL through the inclusion of practices rather than skills. If we see EL as situated and on a continuum of engagement, then Lave and Wenger's work on situated learning (1991) and Wenger's on communities of practice (1999) is appropriate to apply. From this perspective, those individuals who are just becoming aware of the environment are entering into peripheral participation in the community of environmentally responsible citizens. It is as they increase both knowledge and develop practices common to the community (such as issue identification and analysis, generation and evaluation of solutions, and action, referred to in this proposal as the EL practices) that their participation becomes more central, and they progress along the continuum described by Stables (1998). These EL practices - identifying potential issues, finding relevant, high quality information about them, generating multiple potential solutions, evaluating them and choosing the best one for that context - are key to boundary crossing, or transfer, of environmental literacy between contexts, and are therefore potentially a productive path to producing environmentally literate citizens. A key question is how do we effectively assess these?

Educator Environmental Literacy

If EL is a necessary component of education for democratic equality, then it would seem desirable for all students to be exposed to high quality EE that improves their

EL. There has a been a great deal of research on middle and high school students' EL (for example, McBeth, Hungerford, Marcinkowski, Volk, & Meyers, 2011; Negev et al., 2008; Stevenson et al., 2013) and they have found that a common weakness in middle school students is in the area of issue identification, issue analysis, and action planning (Marcinkowski, Shin, Noh, Negev, Sagy, Garb, McBeth, Hungerford, Volk, Meyers, Erdogan, 2012), practices key to the contextual view of EL. This finding holds across studies of Israeli (Negev, et al., 2008), Korean (Shin, et al., 2005), Turkish (Erdogan & Ok, 2011), and North Carolina (Stevenson, et al., 2013) students. Stevenson and colleagues (2013) found that teacher experience has a complicated relationship to student EL, with performance on the cognitive skills component of the NELA (analogous to the practices in this framework) higher for students with teachers who have a Masters or in the field for 3-5 years, but the effect disappears for teachers in the field longer than five. This suggests that teachers may be a prime audience for development in EL. Nonformal educators – those working in settings outside of schools such as museums, science and nature centers, farms, etc. – also play an important role as providers of in the field experiences on field trips and outside of school hours.

Would it be desirable to hand an educator a math text when they have no knowledge in mathematics, or experience with mathematics practices? The same holds true for science, language arts, and most other content areas. Yet this is what happens with EE curricula regularly. I argue that educator environmental literacy can be seen as content knowledge. For those educators who work in content areas which address environmental issues, such as environmental science or geography, we should expect not only a knowledge of the ecological science, but also a knowledge of the social

components of issues, knowledge of and ability to engage with and address issues, and a generally positive disposition towards the environment – that is, a certain level of environmental literacy. EL is content rich - there is some knowledge necessary to meaningfully engage with social-ecological systems of environmental issues. This includes both ecological knowledge (systems, carbon cycling, and photosynthesis among others) and social knowledge (including the tragedy of the commons, capitalism's relationship with the environment, and civics). Yet it is not limited to content knowledge. It is through engagement with the EL practices that these types of content can be integrated into an understanding of the issue at hand, and participation can move towards critical EL.

There is a limited research body regarding teacher EL, and even less in the United States (Table 1.1). None of the literature explicitly addresses skills or practices, which are central to the contextual view. Amirshokoohi,(2010), studying pre-service teachers, included issue identification and analysis and action strategies, which align with practices in the contextual framework, and found them lacking. This leaves a gap in the research body - what is the state of teachers' EL practices?

Purpose and Research Questions

Given this dearth of knowledge, this dissertation seeks to use a mixed methods approach to develop an understanding of EL in both formal and nonformal educators, using the contextual perspective. It addresses three main research questions:

Table 1.1

Summary of findings in teacher EL research.

Study	Participants	Method	Findings
Hsu & Roth (1998)	Teachers in Taiwan	Quantitative Assessment	• Positive attitudes, high sensitivity, moderate self-efficacy • Felt confident in a limited range of actions • Environmental behavior was predicted by responsibility, perceived knowledge of strategies, and attitudes
Liu, et al. (2015)	Teachers in Taiwan	Quantitative Assessment	• High levels of environmental attitudes, moderate levels of environmental knowledge, and low levels of environmental behavior • Such levels of EL would make it difficult to reach national EE goals
Cheng & So (2015)	Primary teachers in Hong Kong	Mixed Assessment and interviews	• Individual background, motivation, and teaching are closely related • Individual commitment is most important factor in behavior
Swanepoel, Loubser, & Chacko (2002)	Teachers in South Africa	Quantitative Assessment	• Natural science teachers scored better overall • Teachers who received environmental professional development scored higher in awareness, attitude and willingness to act, but not knowledge
Cutter-Mackenzie & Smith (2001)	Primary teachers in Australia	Qualitative Interviews	• Teachers were either illiterate or nominally literate • Reported multiple barriers to implementing EE, such as cultural difficulties and curricular demands

1. How can we assess the EL of educators, in particular the practices aspect (issue identification and analysis, and the generation and evaluation of solutions) in an efficient, affordable way?
    a. What subscales should be included in an instrument that represent a contextual view of EL?
    b. Are there demographic factors that affect EL?
    c. Are there differences in the EL of formal and nonformal educators?
2. How do the components of EL interact?
    a. Is there a relationship between dispositions and behavior?
3. Can we construct a measure that will accurately determine what level of EL an educator has, on a continuum from functional to cultural?

This research will lay the groundwork for further research into educator environmental literacy and its effect on student literacy, provide a baseline for studies of the development of such literacy, as well as how knowledge interacts with behavior in the development of best environmental practices as citizens.

Overview of Dissertation

This dissertation addresses these research questions in the following way. In Chapter 2, I describe the development and use of the Teacher Environmental Literacy Assessment (TELA), an online assessment. Quantitative analysis that included ANOVA and Principal Components Analysis yielded demographic differences in scale scores, including the difference between nonformal and formal educators on key scales such as

Knowledge, Behavior, Environmental Identity, and Issue Identification. In addition, differences emerged in the patterns of strategy choice made by experts and educators, and the implications of that difference in the contextual perspective.

In Chapter 3, I report findings from an interview study with a subset of formal and nonformal educators that took the TELA. In this chapter, I report a portion of results from thematic analysis, focusing on the intersection of educator environmental self-efficacy, level of behavior (personal- or system-level), and identification as not political or activist, and propose avenues for moving individuals from a focus on personal-level behavior to an inclusion of more effective system-level behavior.

In Chapter 4, a mixed methods approach is used to locate educators on a continuum of increasing environmental literacy, from functional to critical. Key items from the TELA data and restructured scales better represent the critical level's understanding of social-ecological entanglement and move towards more effective behavior. Using this classification and interview data, I look at patterns in issue identification practices and their view of their role in student EL.

Chapter 5 closes out the dissertation by synthesizing the findings from previous chapters to create an enriched view of the contextual perspective, including recommendations for future work.

Chapter 2. The TELA: A New Tool for Assessing Educator Environmental Literacy

Abstract

This paper describes the measurement and outcomes of a novel teacher environmental literacy assessment. The Teacher Environmental Literacy Assessment (TELA) uses a contextual view of environmental literacy, and includes measures of Knowledge, Self-efficacy, Environmental Identity, Behavior, Issue Identification, and Strategy Selection. A sample of formal and nonformal educators and experts were selected to take and be interviewed about TELA responses. We found demographic differences, particularly between nonformal and formal educators. In addition, experts chose different types of strategies to address environmental issues than educators. The TELA can identify gaps in educator environmental literacy, which is vital content knowledge for educators.

Keywords: environmental education, environmental literacy, teachers, educators, assessment

Though environmental education has been formalized for 50 years (Stapp, 1969), we still struggle as a society with developing in our students a strong level of environmental literacy. Roth (1968) proposed "environmental literate" to mean those that acted positively towards the environment, in contrast to the phrase "environmentally illiterate" used in the media. More modern definitions, such as Hollweg, et al. (2011) provide a more nuanced approach, taking into account the environmental education goals that emerged from the 1977 UNESCO Intergovernmental Conference on Environmental Education, held in Tbilisi, Russia. The conference was convened to address the role of education in addressing environmental issues and create a plan of action. The Tbilisi Declaration (UNESCO, 1977) proposed:

- to foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;
- to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
- to create new patterns of behavior of individuals, groups, and society as a whole towards the environment.

Given continuing and emergent environmental issues, the pressure is greater than ever to create citizens that are environmentally literate in a way that fits into a highly mobile, information saturated world. There is a need for both youth and adults that are knowledgeable of biophysical and social systems, who understand the integration of social and environmental components of environmental issues, and who have attitudes that benefit the environment and people, and who can identify issues and engage in

investigation, evaluation and action on the best solutions in a given context; that is who are environmentally literate. Without a citizenry that is so prepared, people in the U.S. and beyond will be unable to engage with the environment in a sustainable way, threatening the stability of both human and ecological systems.

This paper will describe the development and use of a new instrument for the assessment of environmental literacy in educators, with an eye towards ensuring that educators are well prepared to work towards those goals.

Teacher Environmental Literacy

If environmental literacy (EL) is necessary to address existing and emergent issues, then it would seem desirable for all students to be exposed to high quality EE that improves their EL. Knowing the importance of teacher content knowledge (Shulman, 1986, Ball et al., 2008) − the content of a domain, including the structure of that knowledge, epistemological issues of what is expertise, and what holds as warrants - we must turn our attention to the EL of teachers. I argue that teacher environmental literacy can be seen as necessary content knowledge. For those educators who teach content that addresses environmental issues, such as environmental science or geography, we should expect not only a knowledge of ecological science, but also a knowledge of the social components of issues, knowledge of and ability to engage with and address issues, and a generally positive disposition towards the environment − that is, a certain level of environmental literacy.

Environmental literacy has been studied at multiple ages, including K-12 students (McBeth, et al., 2008; Ozsoy, Ertepinar, & Saglam, 2012; Saltan & Divarci, 2017; Stevenson, et al., 2013), university students (S. Hsu, 2004; Kaplowitz & Levine, 2005;

Lloyd-Strovas, Moseley, & Arsuffi, 2018), and adults (Coyle, 2005). Which elements are studied as environmental literacy varies, though the most common components are knowledge, dispositions, and behavior (see Genc & Akilli (2016) for a concise summary). Practices such as issue identification, planning action to address issues, and evaluating action choices are regularly left out of studies, with noticeable exceptions of the Middle School Environmental Literacy Survey (MSELS; Erdogan & Ok, 2011; McBeth, et al., 2008; Stevenson, et al., 2013) and a handful of others inspired by the MSELS (Negev, et al., 2008; Shin, et al., 2005).

There is a limited research body regarding teacher EL, and even less in the United States. This leaves a gap in the research body - what is the state of teachers EL practices? One challenge in comparing teachers across studies is that each study uses its own framework for EL, including or excluding different facets. While none of the literature explicitly addresses skills or practices, which are central to this study, there are some commonalities: knowledge, dispositions, and behavior.

There are multiple types of knowledge, however, in the limited teacher EL literature - background content knowledge (environmental science, biology, geology, etc.), knowledge of issues, knowledge of action strategies, and perceived knowledge of any of those. In an extensive study of secondary teachers in Taiwan, Hsu and Roth (1998) focused on teachers' perceived knowledge of content, issues, and strategies. They found that teachers had limited knowledge of strategies, but felt moderately confident in their knowledge of ecology, environmental science, and issues. Liu et al. (2015) also looked at national data for Taiwan teachers and found moderate levels of knowledge. Swanepoel, Loubser, and Chacko (2002), working with teachers in South Africa, found that teachers

who taught natural sciences scored better on their assessment as a whole, but environmental-themed professional development did not increase knowledge scores. In work with Australian primary teachers using Orr's (1992) definition of EL, Cutter-Mackenzie and Smith (2001) found that most of the teachers were environmentally illiterate or at a nominal level of EL - little knowledge, and not contextualized.

Hsu and Roth (1998) included several dispositions (environmental sensitivity, attitudes, responsibility, locus of control, and intention to act) in their work. Teachers had positive attitudes, high sensitivity, and moderate self-efficacy. Cheng and So (2015) studied the EL of primary school teachers in Hong Kong. The authors conclude that individual background, motivation, and teaching are closely connected, with individual commitment being the most important factor. In Swanepoel, et al. (2002), environmental professional development did seem to lead to higher awareness, attitude, and willingness to participate in actions.

Liu, et al. (2015) found low levels of environmental behavior in their participants. Hsu and Roth (1998) examined how different scales related to behavior score, and found the best predictors were environmental responsibility, perceived knowledge of strategies, attitudes, and place of residence with urban areas reporting more environmental action than rural areas.

Though limited, the research on teacher EL suggests a complex interplay of dispositions, knowledge, demographic factors, and behavior. The goal of the research described in this paper is to examine teacher EL in the U.S. using a novel instrument, the Teacher Environmental Literacy Assessment, which aligns with a contextual perspective on EL.

Environmental Literacy

Environmental literacy (EL), first described 50 years ago (Roth, 1969) has changed conceptually over time, while still hewing to its roots. For many years, it was considered to be synonymous with the objectives of environmental education (EE), such as the Tbilisi goals (UNESCO, 1977). Volk and colleagues (1984) describe EL in a critique of EE, which they stated was "…failing in its endeavor to develop knowledgeable, concerned, competent, and participating citizens, i.e., environmentally literate human beings." (p. 12) Marcinkowski (1991) fleshed out the concept, including ideas of environmental issue scale, as well as the interface of natural and socials systems. Beginning in the early 1990's, frameworks for EL turned an eye towards its assessment. For example, Roth (1992) revisited his earlier work, outlining four strands of EL: knowledge, skills, affect, and behavior. Later, Stables (1998) took more critical readings of EL, describing a continuum. Stables (1998) describes the levels as functional (knowledge of things in the environment and the ability to identify what is not known), cultural (knowledge of the cultural and social roles of the natural world and human impacts on them), and critical (the ability and willingness to engage with deeper meanings of the environment and society, and use that to address issues, pushing back against hegemony). Stables does note that these levels build on each other, and that "both cultural and critical literacy are impossible without functional literacy. Just as the ability to decode print is a prerequisite to the development of deeper levels of comprehension of the passage to be read, so is knowledge of the natural world a condition of the development of awareness of environmental issues and of the ability to take effective action." (p. 158) Stables' ideas, particularly that of critical environmental literacy, have

not been largely taken up in EE research, even as it has grown to include critical frameworks such as place-based education and indigenous voices. Emphasis has been placed on frameworks that are more easily assessed.

A more recent project, targeted for the assessment of EL, was published by the North American Association for Environmental Education (Hollweg et al., 2011). It synthesizes previous work and creates a framework composed of dispositions, knowledge, competencies, and environmentally responsible behavior practiced in multiple contexts. While the Hollweg et al.'s work does describe the importance of social-political and ecological knowledge, it does not include the notion of a gradation of literacy, nor the changing engagement with the environment with an advancing literacy. While Stables' work is theoretical and does not address how to get to this higher level of literacy, Hollweg et al. (2011) is explicitly practical, framing what can and should be assessed.

The Contextual View of Environmental Literacy

The proposed research takes a contextual view of EL. It is seen as multi-faceted and existing on a continuum of how one engages with the environment and information about the environment. It departs from earlier frameworks, however, by explicitly perceiving environmental literacy as contextual and situated in social-ecological systems (Berkes, et al., 2002), bringing to the forefront the social nature of literacy that Hollweg and colleagues include in the background. There is no absolute level of environmental literacy, rather degrees of practice in engaging with social-ecological systems.

As with previous framings of EL, the contextual view includes knowledge of biophysical and sociocultural systems, representing the entangled nature of social-

ecological systems. Though there are cross-contextual components of biophysical and social knowledge, such as ecological processes (i.e. photosynthesis, carbon cycling) and systems fundamentals (i.e. feedback loops, emergence), and possible avenues of action on issues, much of it is dependent on the social-ecological context an individual is in, opening EL up to multiple ways of knowing a system.

Dispositions include environmental self-efficacy, one's perception of inclusion with nature (Schultz, 2002), and environmental identity (Kempton & Holland, 2003). Behavior is viewed as participation in multiple avenues of responsible environmental behavior, using the categories of ecomanagement, consumer, persuasive, political and legal action (Hungerford, & Tomera, 1977).

The contextual framing departs through the perception of issue identification and action planning as practices rather than skills, emphasizing the social and embedded nature of both. Because EL is situated and on a continuum of engagement, we use the theory of situated learning (Lave & Wenger, 1991) and the work on communities of practice (Wenger, 1999) and legitimate peripheral participation (Lave & Wenger, 1991). From this perspective, individuals who are becoming aware of the environment and building a functional level of EL are entering into legitimate peripheral participation in the community of environmentally responsible citizens. While these newcomers are not yet experts, they are members of the community, and with experience and the attendant learning move towards expert status. Experts are those who have experience, who have robust practices and deep knowledge who have been shown to be effective in the solving or descriptions about solving critical environmental issues. As newcomers increase knowledge and develop practices common to the community (such as issue identification

and analysis, generation and evaluation of solutions, and action, referred to here as EL practices), their participation becomes more central, their identity shifts, and they progress along the continuum described by Stables (1998). In an EL context, experts have an understanding of social-ecological systems, and they are experienced at identifying issues and promising paths to address them. This legitimate peripheral participation framework aligns with Kempton and Holland's (2003) model of environmental identity. They describe three stages of social environmental identity, from becoming aware of issues (salience), to acting on issues and seeing oneself as an actor, and developing a knowledge base of how to effectively engage in environmental practices.

Research Question

This paper describes the use of the Teacher Environmental Literacy Assessment (TELA), which uses the contextual perspective to assess the environmental literacy of formal and nonformal educators. In particular, we look at demographic effects, educational background, and institutional setting, and how educators compare to experts. We expect that nonformal educators will have higher EL, as will those in the life and environmental sciences, and experts will approach environmental issues differently.

Methods

Instrument.

The TELA was developed using the contextual view of EL as a guiding framework. In alignment with the contextual framework of EL, seven scales were developed in addition to collecting demographic information:

- Knowledge – Twenty items (multiple-choice and open-response), including from the NEETF/Roper scale (Coyle, 2005), with additional questions embedded in the scenarios described below.
- Self-efficacy – A novel scale using a seven-point Likert-type scale addressing individual and collaborative efficacy on environmental issues.
- Connection to the environment - The graphical Inclusion of Nature in Self measure (Schultz, 2002) determines the extent to which respondents see nature and themselves overlapping, an essential component of the social-ecological systems used in this framework.
- Environmental identity – Novel five-point Likert-type scale based on three aspects of identity development from Kempton and Holland (2003).
- Behavior – Open-ended questions to solicit respondent behaviors, in five categories (Hungerford, & Tomera, 1977). Three categories are personal-level action: ecomanagement, persuasive, and consumer actions; two are at a systemic level: political and legal actions. Allowing for a variety of behaviors in multiple categories is fitting for issues in different contexts. It also addresses some issues with environmental behavior scales raised by Olson (1981) – with maximum scores in each category, a high score is not possible through low-impact personal sphere behaviors alone.
- Finally, three scenarios were constructed, similar to those used with the MSELS (McBeth, et al., 2008), to assess practices. Scenarios involving common environmental issues (changes in land use, the siting of an industrial waste facility, and logging/species conservation) yield two scores: Issue

Identification and Strategy Selection. Respondents' top two choices of issue and strategy (from the five used in the Behavior scale) are compared to those of experts from non-profits, academia, and state environmental agencies.

- Personal and teaching demographics (instructional setting, grade level, and subject taught), are collected at the end of the instrument.

The initial pilot of TELA was as a pre-post assessment for a professional development program. Additional piloting, including with small focus groups, occurred in fall of 2017. Initial analysis showed a high correlation between the environmental identity and self-efficacy scales. Those scales were modified and tested with another small group, which found that the scales were no longer highly correlated. In January 2018, the scenarios were sent to six experts from academia, state environmental agencies, and environmental non-profits in New Jersey, to determine what the expert responses are in a New Jersey context. These were used in scoring the TELA in the broader testing.

Sample.

Respondents to the online TELA survey came from two sources. Qualtrix recruited K-12 teachers from the U.S (n=100), with special effort towards a diverse sample. Additional respondents (n=160) were recruited through a combination of convenience and snowball sampling. Recruitment notices were sent via email, listserv, and social media to colleagues in formal and nonformal education settings, who then shared with their professional circles. A subsample of respondents (25 formal, 25 nonformal) also completed interviews to validate the instrument and explore responses more deeply.

Table 2.1

Gender, race, and ethnicity of TELA formal sample (%) and U.S. teaching population

	TELA	U.S. Public teaching (2015-16; IES-NCES)
Gender		
Female	76.8	64
Male	21.3	36
Other (incudes neither and prefer not to say)	1.5	–[a]
Race		
White	75.4	80
Black/African American	12.8	7
Asian-American/Pacific Islander	3.8	2
American Indian/Alaska Native	0	0[b]
Other/More than one	8.1	0[b]
Ethnicity		
Hispanic	12.3	9

[a] not calculated in study

[b] < l%, rounding to 0

The formal educator respondent sample was representative of the U.S. national teaching force (Table 2.1) in gender, race, and ethnicity, though it slightly over-represents racial and ethnic minority groups. The sample was representative in terms of higher education, with 54.3% having post-baccalaureate education, compared to the national figures of 55% for elementary teachers and 59% for secondary. For nonformal educators (Table 2), the sample slightly underrepresented minorities according to demographics by

Table 2.2

Race and ethnicity of the TELA nonformal sample (%) and U.S. EE population

	TELA	*U.S. EE teaching (Gupta, et al., 2015)*
Race		
White	86.7	53.8
Black/African American	4.4	19.5
Asian-American/Pacific Islander	4.4	1.0
American Indian/Alaska Native	0	3.1
Other/More than one	4.4	6.0
Ethnicity		
Hispanic	11.9	32.6[a]

[a] Percentage of environmental educators in EPA Region 2, which includes NJ. Information for overall sample was not included.

Gupta et al. (2018). No information is available for gender or educational attainment for nonformal environmental educators, but in the sample, 48.9% had a bachelors, and 18.4% had post-baccalaureate education. In the overall TELA sample, 13.8% reported they were financially struggling, 50.4% were stable, 33.8% were comfortable, and 1.9% were affluent.

Results

Instrument Scales

The descriptive statistics for the scales are presented in Table 3. Self-efficacy and Environmental Identity are both negatively skewed, which can be accounted for by

Table 2.3.

Descriptive statistics for TELA scales

	Score range	Min	Max	Mean	Std. Deviation	Cronbach's alpha
Knowledge	0-24	2	21	13.19	4.37	.778
Self-efficacy	4-28	4	28	23.50	4.02	.837
INS	1-7	1	7	4.78	1.39	N/A
Environmental Identity	8-40	16	40	35.16	5.38	.903
Behavior	0-15	0	13	4.87	3.16	N/A
Issue Identification	0-15	0	15	8.80	2.96	N/A
Strategy Selection	0-27	4	24	15.00	4.39	N/A

possible self- selecting error in the sample. In addition, cross-correlations were calculated for the seven scales (Table 4).

Knowledge.

Knowledge and Behavior scores were highly correlated (0.728; $p<0.01$). Knowledge is also highly correlated (0.562) with Issue Identification and moderately correlated with Strategy Selection (0.380), all $p<0.01$.

Environmental Identity.

Environmental Identity was moderately correlated ($p<0.01$) with Knowledge (0.475), and highly correlated with Self-Efficacy (0.534), INS (0.522), and Behavior (0.541).

Table 2.4.

Pearson's correlations for scales

	Knowledge	Self-Efficacy	INS	Environmental Identity	Behavior	Issue Identification	Strategy Selection
Knowledge	–						
Self-Efficacy	0.167**	–					
INS	0.323**	0.371**	–				
Environmental Identity	0.475**	0.534**	0.522**	–			
Behavior	0.728**	0.226**	0.365**	0.541**	–		
Issue Identification	0.562**	0.012	0.132*	0.259**	0.443**	–	
Strategy Selection	0.380**	0.100	0.101	0.166**	0.379**	0.283**	–

** Significant at the 0.01 level (2-tailed).
* Significant at the 0.05 level (2-tailed).

Demographic effects.

The TELA also included personal demographics (e.g. race/ethnicity, gender, perceived financial status, residence, level of education) and instructional demographics (e.g. setting, grade taught, and subject taught). An exploratory analysis of demographic effects on the TELA scales showed several interesting patterns around race/ethnicity, instructional setting, and level of education.

Gender.

The main effect found was that the category Other (responses of "Neither" and "Prefer not to say") scored significantly ($p<0.05$) lower than women or men on Self-efficacy, INS, Environmental Identity, and Issue Identification. In addition, women scored significantly lower than men on Issue Identification.

Race/Ethnicity.

Two patterns emerged in this analysis. First, Hispanics scored significantly ($p<0.05$) lower than non-Hispanics on scales of Knowledge and Behavior. Secondly, Whites scored significantly higher than those identifying as Black/African American and Other/More than one (American Indian / Alaska Native [n=1] was folded into this category for analysis purposes) on Knowledge and Behavior, higher than Black/African American on Issue Identification, and higher than Other on Self-efficacy and Environmental Identity.

Educational Attainment.

The highest level of education completed showed significant ($p<0.05$) effects on four scales: Knowledge, Behavior, Issue Identification, and Strategy Selection. In general, lower levels of attainment (high school, Associates, or some college) scored significantly lower across scales than post-baccalaureate levels of education. In addition Bachelors scored significantly lower than Some Grad School and Masters on Knowledge and lower than some grad school on Issue Identification.

Instructional Setting and Grade Taught

Respondents who worked in a nonformal setting scored higher ($p<0.05$) than those in public, private, or afterschool settings on Knowledge and Behavior and higher

than public or private on Environmental Identity and Issue Identification. For grades taught, the respondents teaching K-12 scored significantly higher than those teaching K-2, 3-5, 6-8, or 9-12 on Knowledge, Behavior, Environmental Identity, and Issue Identification. Multiple grades up to and including sixth also scored higher than K-2, 3-5, 6-8, and 9-12 on Knowledge. Grades K-8 scored higher than K-2, 3-5, 6-8, 9-12, and multiple grades up to and including sixth on INS.

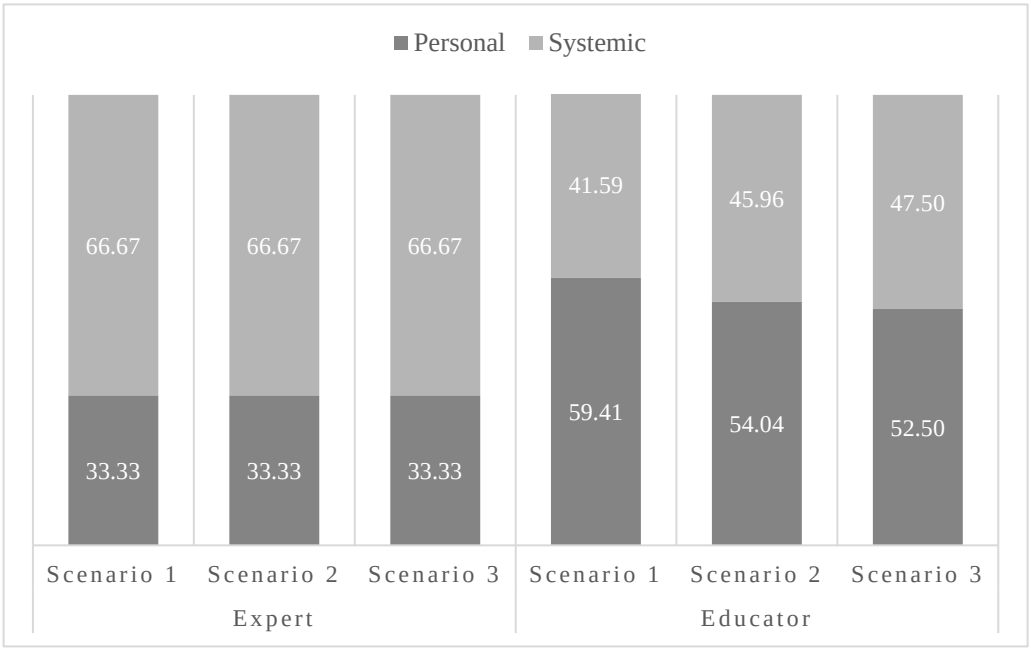
Issue Identification and Strategy Selection – Experts and Educators

Aligned with the contextual view of environmental literacy was the use of scenarios to assess the practices of issue identification and action strategy selection. While Issue Identification had significant differences in most demographics, Strategy Selection did not. However, when one compares the types of strategies chosen by the experts and educators, a pattern emerges. Experts chose systemic level variables 66.67% of the time, but educators only chose systemic level actions 45.02% of the time (Figure 2.1).

EL Profile of the TELA Sample

Scale scores were divided into Low, Moderate, and High ranges for comparability and compiled into a profile. The TELA sample profile using means is presented in Figure 2.2. Behavior falls in the Low range; Knowledge, INS, Issue Identification and Strategy Selection in the Moderate Range; and Self-efficacy and Environmental Identity in the High range.

Figure 2.1 Proportion of personal- and system-level actions ranked in the top two choices by experts and educators.



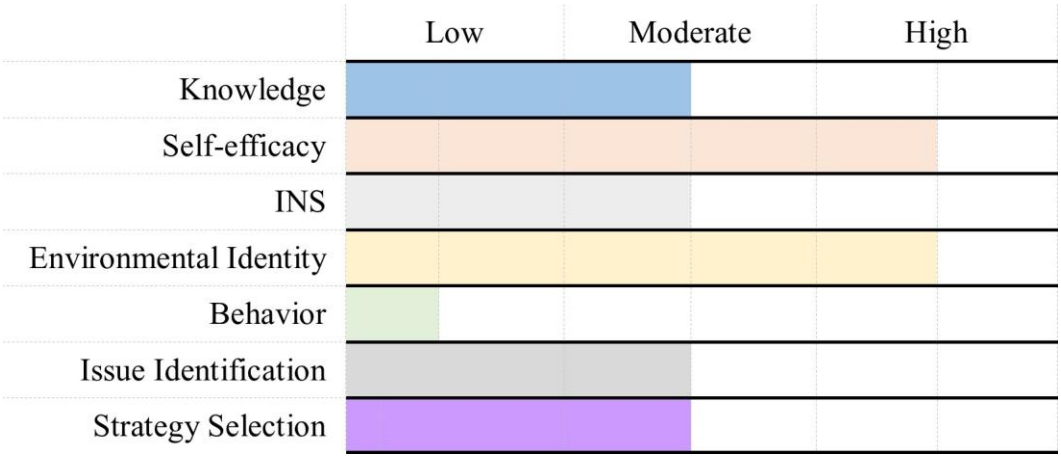


Figure 2.2. TELA sample environmental literacy profile.

Table 2.5.

Principal Component Analysis of TELA Scales

Component 1	Knowledge	0.832
	Issue Identification	0.781
	Behavior	0.755
	Strategy Selection	0.628
Component 2	Self-efficacy	0.811
	Environmental Identity	0.805
	INS	0.747

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization, rotation converged in 3 iterations.

Principal Component Analysis

A Principal Component Analysis was conducted on the TELA data after a Bartlett's Test of Sphericity indicated an adequate sample. The first two components explained 64.49% of the variance. Component 1 consisted of Knowledge, Behavior, Issue Identification and Strategy Selection, and Component 2 included the dispositions of Environmental Identity, Self-Efficacy, and INS (Table 2.5). This shows a relationship between the dispositional factors (component 2) as well as between practices, knowledge, and behavior.

Discussion

Scale correlations

A strong correlation between Knowledge and Behavior is in line with some research (Genc & Akilli, 2016; Murphy and Olson, 2008), but contradicts other work (e.g. Liu, et al., 2015; Fah and Siresena, 2014; Pe'er, et al., 2007). This higher correlation may be because of the wider scope of included behavior items, or because the Knowledge scale included both decontextualized multiple choice items and higher-level, contextualized items in which respondents answered within an environmental scenario, providing a more authentic assessment. In addition, Coyle (2005) and Murphy and Olson (2008) found that adults with high knowledge levels were more likely to engage in some behaviors: home energy saving, conserving water, donating to conservation groups, and avoiding toxic lawn chemicals.

Knowledge is also highly correlated with Issue Identification and moderately correlated with Strategy Selection. Knowledge of ecological systems and human impacts on them is necessary for being able to identify what in a scenario is likely to become an issue and what is a potentially productive strategy for addressing it. Some baseline level of knowledge is necessary for even a contextual environmental literacy, as Stables suggests that critical EL is not possible without a functional EL.

The high correlation between Behavior and Knowledge, and Behavior and Environmental Identity, along with its moderate correlation with INS support the Value-Belief-Norm theory of environmental behavior (Stern, 2000). This theory describes the importance of one's own sense of responsibility (evident in the Environmental Identity scale), and awareness of the potential impacts of an issue on something that has value

(evident in the Knowledge and Environmental Issue scales), combined with an ecological worldview (INS) and personal moral norms to the enactment of environmentally significant behavior. This view does not preclude outside influences, such as social-ecological system factors that may inhibit or support environmental behavior.

Environmental Identity was moderately correlated with Knowledge, and highly correlated with Self-Efficacy, INS, and Behavior. Kempton and Holland's framework of environmental identity (2003) is based on a developing awareness of environmental issues (Knowledge), taking action on issues (Behavior), and an increasing capacity for environmental action (Self-Efficacy), suggesting that this novel scale reflects that framework.

Demographic effects

The environmental field is an overwhelmingly White one (Taylor, 2018) and environmentalism is still often falsely perceived as a White endeavor (Greenberg, 2004; Pearson, Schuldt, Romero-Canyas, Ballew, & Larson-Konar, 2018), excluding Blacks and other minorities at many levels. In addition, Blacks and some Hispanics have been found to score lower on behavioral measures than Whites (Johnson, et. al, 2004) which may explain the difference between Knowledge, Behavior, and Issue Identification scores.

Respondents who worked in nonformal settings and those teaching grades K-12 (14 of 17 work in nonformal settings) scored higher than those in other settings on Knowledge, Behavior, Environmental Identity, and Issue Identification. Research demonstrates that college major has an effect on environmental knowledge, attitudes, and beliefs (Goldman, Yavetz, & Pe'er, 2014; Hodgkinson & Innes, 2001; Tikka, Kuitunen,

& Tynys, 2000). Nonformal educators are more likely to have an environmental degree, and 1) have greater exposure to environmental content in their schooling; and 2) be working in settings with an environmentally aware and/or active social cohort, leading to potential peer effects on identity. These could include modelling of environmental behaviors or a professional need to stay abreast of environmental issues. In interviews, participants spoke of both discussing and learning about issues from peers and co-workers and of learning about environmental issues because the topics were in their curriculum.

Lack of systemic actions

The difference in strategy selection between educators and experts on strategy reflects previous work on reasoning about environmental issues such as climate change. Hart (2011) demonstrated that framing that emphasizes system-level effects (which experts would be knowledgeable about) led to greater preference for policy change rather than individual behavior. Chua (2016) found that experts thought about climate change on a greater time scale than students, which would lend itself to higher level solutions. Thinking about issues at systemic levels, and at greater time scales, could lead to choosing what Stern (2000) called “environmentally significant behaviors” over those with limited impact. This difference can be explained through a legitimate peripheral participation framework - that as people participate more fully in the community of environmentally active citizens, developing deeper knowledge, they begin to choose strategies that will have more effect on larger scales.

The majority of educators did not choose systemic actions to address environmental issues. In interviews, both formal and nonformal educators said they

didn't feel it was their role to engage in political or legal action, or felt more comfortable taking personal action. Systemic action was usually limited to voting with environmental issues in mind. Some nonformal educators felt that persuading others to take issue was a natural extension of their job and life, while formal educators felt that it was in conflict with theirs. So the questions remains – how do we remove barriers to or increase comfort with systemic level actions?

Future Work

The TELA has helped us look at educator EL in a new light. With further study, it could be used with educators to assess their environmental literacy and identify areas for improvement, or used as a pre-post measure for professional development. To improve the quality of the TELA, Self-efficacy and Environmental Identity scales should be re-examined and tested with a more diverse sample to see if their skew is attributable to the instrument itself or self-selection effects.

With the TELA we have developed an instrument for assessing how environmentally literate educators are. Future research should begin to address how this environmental literacy is enacted in classroom practice. How do educators engage with environmental material in their instruction? What types of intervention improve different facets of EL from this view? How do we move teachers and their instruction to higher levels that integrate social aspects of environmental problems in meaningful, critical ways?

Chapter 3. The intersection of environmental self-efficacy, behavior, and identity in educators.

Abstract

Environmental educators in both formal and nonformal settings work to develop students' environmental literacy, with the goal of making citizens who care about the environment and are knowledgeable and prepared to engage in behaviors to address environmental issues. Yet little attention has been paid to educator environmental literacy. Here we report the findings from an interview study of formal and nonformal educators. Overall, educators favored personal-level behaviors. In addition, some educators reported poor self-efficacy in relation to environmental behavior, for three main reasons. The rejection of a political or activist identity is a recurring theme in both formal and nonformal educators.

Keywords: environmental literacy, teachers, educators, self-efficacy, identity

"A weak concept of environmental literacy… does not see fundamental issues as open to interpretation, as though the biophysical world is not dependent on our perception (and thus interpretation) of it." (Stables & Bishop, 2001, p. 94)

Preparing environmentally literate citizens who are willing and able to address continuing and emergent environmental issues is a key goal of environmental education (UNESCO-UNEP, 1977). Such preparation occurs in formal and nonformal contexts, where educators engage students of all ages in learning of all types. It is perhaps assumed that these professionals are not only knowledgeable, but also possessing the other facets of environmental literacy that they seek to develop in students. Yet the environmental literacy of these educators is rarely interrogated (Cheng & So, 2015; Cutter-Mackenzie & Smith, 2001; S.-J. Hsu & Roth, 1998; Liu, Yeh, Liang, Fang, & Tsai, 2015; Swanepoel, Loubser, & Chacko, 2002). The following paper is part of a larger mixed methods study on the environmental literacy (EL) of those educators (Authors, in review). Here we explore the intersection of their sense of self-efficacy, behavior, and identity.

Environmental Literacy

Environmental literacy is a complex construct comprised of four main components: knowledge, dispositions, skills in identifying and acting on environmental issues, and environmental behavior (Hollweg et al., 2011; Roth, 1969; Roth, 1992; Volk, Hungerford, & Tomera, 1984). Knowledge includes not only that of ecological systems, but also socio-political systems and environmental issues − where the two come into conflict. Dispositions is a broad category that includes many overlapping affective and psychological concepts that have been found to have effects on environmental behavior,

including but not limited to self-efficacy (e.g. Bandura, 1997; Hines et al., 1987; Marcinkowski, 2001; Schutte & Bhullar, 2017; Ünal, Steg, & Gorsira, 2018); connection to nature (e.g. Mayer & Frantz, 2004; Nisbet & Zelenski, 2013; Schultz, 2002); environmental identity (e.g. Clayton, 2003; Kempton & Holland, 2003; Stapleton, 2015), concern (e.g. Dunlap, 2008; Schultz, 2002a), and values (e.g. Ünal et al., 2018).

Behavior has been conceived in nearly as many ways, including environmentally significant behavior (Stern, 2000); personal and public sphere behaviors (Lu, Liu, Chen, Long, & Yue, 2017) and cultural and civic behaviors (Kempton & Holland, 2003). The work here uses the five category model (Sia, Hungerford, & Tomera, 1980) which includes five types of behavior: ecomanagement (direct action such as gardening, composting, recycling); persuasion (engaging with others to inform or convince them on an environmental issues); consumer (purchasing or not purchasing items due to the product's or company's environmental impact); political (using political processes at multiple levels to effect environmental change); and legal (using existing laws and regulations to effect environmental change).

Lastly, while there was a call for work with and research on issue identification skills early on in EL history (Hungerford & Volk, 1990; Peyton & Hungerford, 1980) they have not received as much attention as other components. Exceptions to that have been work using the Middle School Environmental Literacy Assessment and its adaptations (e.g. McBeth, Hungerford, Marcinkowski, Volk, & Meyers, 2008; Stevenson, Peterson, Bondell, Mertig, & Moore, 2013)

The Contextual Perspective on Environmental Literacy

The research discussed here uses a contextual perspective on environmental literacy. Like previous descriptions of EL, it includes multiple facets of an individual's literacy. Here those include knowledge of bio-physical and socio-political systems; key dispositions (environmental self-efficacy, connection with nature [Schultz, 2002] and environmental identity [Kempton and Holland, 2003]); practices; and behavior. This perspective has three key traits that set it apart from previous work on EL.

EL is situated in social-ecological systems.

Social ecological systems (SES) are composed of both ecological and social components which are inextricably entangled (Berkes, et al., 2002). They can occur at multiple temporal and spatial scales, and can be nested or hierarchical. The contextual perspective regards EL as situated within SES, rather than as an individual trait that is universal. These SES can be viewed as communities of practice (Lave and Wenger, 1991; Wenger, 1998). Such communities of practice include those individuals with greater expertise – greater knowledge and engagement with the system in ways that grapple with the social and ecological facets of issues; and less experienced individuals moving towards more central participation in environmental understanding and activity. Their participation changes their knowledge, and their knowledge changes their participation.

Each SES constrains and affords behaviors and dispositions by virtue of the presence or absence of social or ecological factors – one society may value collective effort over individual, another may prize the individual. One may already be a highly urban setting while one is feeling the first pangs of development. Therefore, expertise in one system does not transfer to another. While there is some knowledge that applies

across SES, such as understanding ecological processes (i.e. carbon cycling, succession) and social processes (i.e. methods of governance), there are differences in participation in each SES.

Practices facilitate boundary crossing.

In a situated view, a central aspect of participation is practice – the activity through which learning occurs. Practices can have an "improvisational, future-creating character" (Lave, 2009, p.231) that afford change. In an EL context, practices include activities that result in growing understanding of the SES – including but not limited to spending time in natural and built environments, working beside others on environmental action, or reading books or blogs recommended by environmentally knowledgeable friends or colleagues. Some EL practices, especially identifying issues, generating possible strategies to address them, and evaluating those possibilities, are practices that one can enact in multiple SES, with varying levels of expertise. Therefore, these can be seen as facilitating border crossing between systems (Akkerman & Bakker, 2011; Lave & Wenger, 1991; Star, 2010; Star & Griesemer, 1989; Wenger, 1998) – practices, people, or objects that exist in multiple communities, and bring components of one into another.

Practices facilitate movement through a continuum of literacy.

It is in this developing engagement with the SES, in the changing practice, that one's EL evolves. Here we look to Stables' (1998) work on a continuum of EL and see in it the changing practice of more central participation. Stables described three levels of EL – functional (knowledge of pieces of the natural environment); cultural (which begins to see the social and cultural meaning of the environment); and critical (which begins to wrangle on how the social and environmental systems are interwoven, and which enables

one to take action which creates change in the environment). The EL practices mentioned above help move one across this continuum by increasing the formal and practical knowledge of a SES and changing the nature of participation in that SES.

Dispositions in a contextual perspective.

The contextual perspective highlights three key dispositions that align with the traits of embeddedness and practices. Environmental identity and self-efficacy both connect to practices within social-ecological systems. Kempton and Holland's (2003) environmental identity examines the arc of identity that leads to sustained environmental practice. Self-efficacy refers to one's assessment of their competency – in this case their competency with individual and collective environmental behavior. Lastly, connection with nature represents one's perception of entanglement with the environment – being part of the environment or separate from it.

Kempton and Holland (2003) describe a "social environmental identity" that is defined by one's engagement with people around the environment more than one's direct relationship with the environment. It has a trajectory of three stages: *salience*, or becoming aware of environmental problems; *identification* as one who takes part in addressing environmental issues; and *increasing resources* for taking action on an issue. These resources include knowledge, but also connections with other actors and organizations in the community. Using this "social environmental identity" Stapleton (2015) illustrates the mutual influence of practice and identity in U.S. youths in an immersive climate program with a South Asian community, and how these identity and practice changes crossed boundaries between social-ecological systems.

Self-efficacy (Bandura, 1997), is one's evaluation of one's abilities to successfully complete or participate in a task. It has been found to have both direct (Schutte & Bhullar, 2017; Tabernero & Hernandez, 2011) and indirect (Huang, 2016) effects on environmental behavior. Hanss & Böhm (2010) theorized a sustainable development self-efficacy, and found four types: encouraging others to act sustainably; promoting environmental preservation through their own actions; promoting social fairness and economic welfare through one's consumption; and promoting social fairness and economic welfare through one's actions in general. The first type had the strongest effect on behavior. Other authors have explored the role of collective self-efficacy in addition to individual self-efficacy (Chen, 2015) and found it to be more influential on behavior.

A key driving force of the contextual perspective is that humans are entangled with ecological components of SES – they are part and parcel of the same system. To that end, to be truly environmentally literate, certainly at a critical level, one must recognize that entanglement. Research has found that connection with nature predicts environmental concern and behavior (e.g. Mayer & Frantz, 2004; Nisbet, Zelenski, & Murphy, 2009). The Inclusion of Nature in Self (Schultz, 2002a, 2002b; Schultz, Shriver, Tabanico, & Khazian, 2004) adapts previous social psychology scales to measure how connected or integrated individuals feel with nature, as part of measures of environmental concern. Here it is used to assess that integration in social-ecological systems.

The TELA

The Teacher Environmental Literacy Assessment (TELA, Authors, in review) uses this contextual perspective to investigate educator EL. It includes seven scales. The

knowledge scale includes both multiple choice and open response items using items from Coyle (2005) and items that are embedded in environmental scenarios. Three disposition scales include self-efficacy, Integration of Nature in Self (Schwartz, 2002), and environmental identity (Kempton & Holland, 2003). The behavior scale consisted of open responses to five categories of behavior: ecomanagement, consumer, persuasion, political and legal (Table 3.1; Hungerford & Peyton, 1980; Sia, et al., 1985). The first three categories can be considered personal-level behaviors – those that have an immediate effect on the individual or interpersonal level. The last two can be considered system-level behaviors – they move beyond the personal/interpersonal level and engage with large-scale, socio-political systems. System-level behaviors can be considered

Table 3.1.

Types of behavior included on the TELA.

Behavior category	Definition	
Ecomanagement	Direct action to benefit the environment (gardening, recycling, litter clean-up)	*Personal-level behaviors*
Consumer	Choosing to buy or not buy something based in the item's or companies environmental impact	
Persuasion	Discussing environmental issues in a personal or public setting. For educators, this includes discussing environmental issues not included in their curriculum.	
Political	Using political processes to effect environmental change (voting, writing legislators, participating in town councils).	*System-level behaviors*
Legal	Using existing laws and regulations (zoning, construction regulations, suing for environmental damages) to effect environmental change.	

to be more significant (Stern, 2000) than the personal-level because they affect the behavior of many individuals and systems.

Lastly, the TELA included three environmental scenarios (Figure 3.1) that represented three types of social-ecological systems. The first, about land development, is a local, familiar issue to residents of much of the state, and involves local and state government. The second, electronics waste disposal, is diffuse and has nested SES – the disposal could be local or global, and the device is used by users in many settings. The last scenario involves wildlife conservation, in a SES that is distant to most in this study, involving a type of animal with whom residents of NJ have a very contentious relationship. The scenarios yielded two scores for the TELA, addressing two EL practices – issue identification and strategy planning. For both scales, participant responses were compared to local NJ experts – environmental professionals from academia, non-profits, and state agencies. TELA responses served as the base for the interviews in the study presented here.

Methods

Recruitment.

Formal and nonformal educators were recruited for an interview study were recruited by a combination of convenience and snowball sampling. Educators were recruited to complete the TELA (Authors, in review) online in the second half of 2018, through social media, listservs, and word of mouth. At the end of the TELA, respondents could choose to leave their email if they were interested in completing a one-hour interview. They were contacted and invited to participate in an interview at their convenience. Those that completed the interview were compensated with a $50 gift card.

Scenario 1	Guy Hubbard is retiring from farming. His farm, totaling 150 acres, is now up for sale. A developer, Jensen Brothers Inc., is interested in purchasing the farm and has applied to the zoning board for a variance to create a multi-use community. This community would introduce both housing and shops to the property.
Scenario 2	Corporation X has developed a new electronic device, the Thingamajig, which has become very popular. With the increased production, they must decide where to place an additional waste disposal plant. One option is in a rural area that is previously undeveloped, but has a small white population. A second option is in an urban area with low property values and a primarily minority population. The final option is a site overseas in a developing country.
Scenario 3	The Harrison's deer, a small relative of the white-tailed deer that lives in mountainous areas, is being considered for the endangered species list. This would mean it can no longer be hunted, and its habitat may be preserved. International Logging wants to log a large area of land in the middle of the Harrison's deer's range. A group of local people want to preserve the land.

Figure 3.1 Environmental scenarios included in the TELA

Sample.

Fifty educators who worked with K-12 students (25 formal, 25 nonformal) completed the interview. Of those 50, seven were from states other than NJ (Arizona, Maine, New York, Pennsylvania, and Virginia). Due to technical and consent issues, 46 interviews were analyzed. Because of the first author's prior experience in the NJ environmental education community, she knew most of the nonformal educators professionally, and three of the formal educators.

Interview Structure and Analysis.

Semi-structured interviews were conducted either in person or over the phone. Interviews lasted from 40 to 90 minutes, with a typical length of 50 minutes. They were based on key questions from the TELA. These included items from the self-efficacy scale such as "I feel confident in my ability to create a change in the environment" and "I am confident in my ability to work with others to create a change to benefit the environment" and items from the environmental identity scale, including "I am aware of one or more environmental issues." Participants were given their response from the TELA, and asked to elaborate on it. If they felt their answers was in error, adjustments were noted. Their responses to the open-ended behavior questions for each category were relayed, and they were prompted to explain why they engaged in those behaviors, or if they could tell the interviewer more about why they did not engage in behaviors in categories they left blank. Because of the complexity of the environmental scenarios, participants were provided with their responses in a printed format for their reference. They were then asked if their rankings were still accurate or should be changed, then asked questions to explore their rationale in including those choices. Questions emerged during the interview process, as well such as "Given EL as we have defined it here, what is your role as an educator in developing student EL" and "What are the barriers to that?".

Using Dedoose, we conducted thematic analysis (Braun & Clarke, 2006) of transcripts, though some a priori codes were used as well. A priori codes were established based on TELA questions used (i.e. types of behavior, response strength to dispositional scale items, issue identification choices, strategies). After 40% of the transcripts were reviewed, themes were aggregated and condensed, and then applied to previous and later

transcripts. The code book was reviewed for construct validity by an expert in environmental literacy and an expert in qualitative environmental education research. Both found the constructs to be well founded, but code structure and hygiene changes (such as condensing redundant child codes from multiple parent codes) were recommended and implemented.

Results

Three major themes emerged from analysis: (1) Personal behavior only goes so far in addressing environmental issues. (2) There is a discontinuity between the levels of behavior educators report and what they plan. (3) Negative beliefs about politics and activists act as barriers to systemic behaviors.

Personal behavior only goes so far.

One of the first questions in the interviews asked them to explain their answer for the TELA self-efficacy item "I feel confident in my ability to create a change in the environment." Most educators replied positively to this statement, but slightly more than 20% replied neutrally or negatively. These were primarily formal educators who taught middle or high school. When asked to explain their rating, three themes emerged.

Their contribution was so small

The most common reason educators described their efficacy as limited was because of the sheer scope of environmental issues – their actions were small compare to the overall size of the related issues, and they were one of many. Henry, a public high school teacher, described it this way:

> I mean, I personally do a lot but it doesn't matter. Maybe it matters a little bit as, what do you call it, an example for students and for others. So, there's something to that I'm sure, but my recycling, my composting on its own has a little bit low

> impact in my view. We're not going to solve global warming if lots of people just turn their lights off.

Pria, a private middle school teacher:

> When you think about the number of people in New Jersey, you think about the number of people in general, I know I'm making a difference in my choices that impact how I have a little, little, little footprint on the world. But, I don't know that those choices I make, make an overall giant difference.

Amari, a public high school teacher, also describes his impact as very small:

> Like I don't drink plastic water. I think it's better that I don't, but I'm not confused. I know that it hardly amounts to a drop in the ocean compared to the amount of plastic bottles that are going to get consumed in the next five minutes.

Henry, Amari, and Pria shared a sense of inability to make an impact on large issues with small actions, even while they know they believe they are doing the right things. If we look at their behavior scores, Henry had a moderate score, Pria a high score, and Amari a low score, so this phenomenon wasn't restricted to one range of reported behaviors.

Other, harmful behaviors outweighed positive behaviors

Some educators expressed the belief that although they engaged in behaviors that were beneficial to the environment, they also engaged in behaviors that were detrimental, minimizing their overall impact. Ava, a public high school teacher who scored low on behavior and moderate on issue identification, described her limits as "I like my central air and my car." Sophia, a public middle school teacher said:

> Like I think I can make changes on the margins, so like there are small things that I do. Like I compost... and I gave up straws, and those kinds of things, but I also commute to work 25 miles, and I still fly, which you could do everything all day long and if you're still gonna fly, that sort of negates it.

Elizabeth, a public elementary teacher, describes having constraints that result in choosing environmental behaviors with a negative impact:

> Then, I also find as a new mom, it's tough to be really aware of, "Okay, I don't have the time to make my own baby food all the time," so I am buying Gerber in the little plastic containers and it's horrible and those kinds of things. I feel like there's a convenience of things and then, there's what you can do and I try to do everything that I possibly can within my limits right now.

This reflected trends across the interviews. When educators described where they fell short or engaged in "bad" behavior, it was most frequently driving or owning a car, followed by purchasing decisions, energy use, and flying.

More systemic change is needed

The last theme that emerged here was that, as Henry referenced above, environmental issues exceed the scope of individual action and require systemic, large scale efforts. Linda, the only nonformal educator to express this limited efficacy, said:

> Because I think I can do my part in help to shape changes in the environment but I believe so much, this is a larger scale that needs to be more legislative and more governmental run at a much higher level than what I have control over.

Ethan, a public high school teacher, believed that the power for change lay in an organized effort:

> I think just in order for something to really take place, even nationwide … there needs to be some policies in place so that it's not just isolated people… I think at the rate the environment's going downhill, that something needs to happen, and it's not going to be just one person, sporadically here and there. It needs to be more of an organized, I guess, call to action for it to really save what's happening to our environment.

Jeff, a private high school teacher, saw economic policies as a key part to systemic action:

> I don't think that individuals on their own, when they're not within a strategy and group movement… I don't think that the change is really going to occur… there needs to be things like carbon tax, and things like that. I think people need to feel it in their pocketbook, or else there's going to be a tragedy of the commons, where people kind of feel like other people are cheating, so why should they have to bear the cost.

Unlike Linda and Jeff, who reported protesting, voting, and communicating with legislators, all system-level behaviors, Ethan did not report any political or legal behavior. Overall, a significant portion of educators, almost entirely formal middle and high school teachers, felt that they had limited efficacy in creating change to benefit the environment, for three main reasons: their actions are small, they engage in other harmful behaviors, and real change requires more systemic, organized efforts.

A discontinuity between systemic and personal level actions.

The interviews included discussions of behavior in two parts – participants' reported behavior, and the behavior they would choose to address issues in the environmental scenarios. In the scenarios, participants were given the five categories of behavior from the behavior scale, and asked to rank them in order from the one they would most likely use to least likely. System-level behaviors appeared more frequently in the most likely rankings (Table 3.2) while personal-level behaviors were most often ranked as least likely (Table 3.3).

Participant reasons for placing persuasion in the most likely strategies involved talking to a wide variety of audiences, including neighbors, community members, town meetings, or arranging talks between communities and corporations. This places persuasion as straddling the two types of behavior – the personal (friends and neighbors) and the systemic (working with town zoning process, or talking to corporations). When

Table 3.2

Behaviors Participants Ranked as Most Likely to Use to Address Issues Identified in TELA Scenarios (Code Counts).

Most likely to engage (rank 1-3)	SCEN 1	SCEN 2	SCEN 3
Ecomanagement*	23	18	10
Consumer*	14	24	3
*Persuasion**	*40*	*33*	*22*
*Political***	*32*	*35*	*21*
*Legal***	*31*	*27*	*23*

* Personal-level behaviors ** Systemic level behaviors

Table 3.3

Behaviors Participants Ranked as Least Likely to Use to Address Issues Identified in TELA Scenarios (Code Counts).

Least likely to engage (rank 4-5)	SCEN 1	SCEN 2	SCEN 3
*Ecomanagement**	*24*	*26*	*10*
*Consumer**	*31*	*22*	*18*
Persuasion*	9	14	4
Political**	14	7	3
Legal**	14	16	1

* Personal-level behaviors ** Systemic level behaviors

asked why they placed political and legal high in their rankings, reasons included the urgency of the situation (logging scenario), the need for a bigger entity to deal with a large corporation (land development and electronics waste scenarios) or they identified specific laws or processes, such as the community zoning (land development), Endangered Species Act (logging), or the Clean Water Act (land development and electronics waste scenarios). Others believed these strategies were simply more effective.

When asked why they ranked consumer and ecomanagement behaviors as less likely, responses included that there was no clear role for consumer action (land development scenario) or that it was hard to know where the product came from (wildlife conservation scenario), ecomanagement and consumer action could only occur too late in the process after damage had occurred (land development scenario), or that the strategies just weren't that effective (land management, electronics waste, and wildlife conservation scenarios).

Educators clearly preferred systemic level action when identifying strategies to address environmental issues. Yet a different picture emerged when analyzing the types of behaviors participants reported engaging in (Table 3.4). Here, ecomanagement and consumer behaviors clearly were the most frequent behaviors, with legal behavior a distant last.

Barriers to systemic level action.

On the behavior portion of the TELA, the political and legal options were often left blank. The interviews included questions on why they had chosen behaviors, and why they hadn't engaged in a given category of behavior. One theme, across categories, was

Table 3.4.

Frequency of Behaviors Reported by Educators in Interviews (Code Counts).

Type of behavior	Code count	
Ecomanagement	93	*Personal level behaviors*
Consumer	92	
Persuasion	71	
Political	58	*System level behaviors*
Legal	16	

lack of money and time. Looking at political and legal action specifically, three other themes emerged.

Doubt in the political system

One portion of educators that explained low levels of political behavior expressed mistrust in politicians or the political system. Some connected this doubt or lack of confidence to the current administration, but for others it was more generalized. As Audrey, a public elementary teacher said, "I like the idea of writing to my legislator, but I don't know if they read them." When asked why she didn't engage in any political or legal behaviors, Erin, a public middle school teacher, expressed it thus:

> I don't think I knew I could, so that's interesting… You know, I mean for myself, I just avoid it, but I don't know… Like, is it actually going to make a difference or am I just wasting my time? So, if I'm the only one doing it, I don't necessarily ... that sounds bad when I say it out loud. But, I think that's really what it comes down to, like I think I'd be wasting my time.

Inexperience and lack of confidence

As Erin suggested above, not all educators knew that they had political or legal options to address environmental issues or felt they had limited abilities. Katie, a nonformal educators who teaches grades K-12, said "I'm not good with the political and the legal thing so I couldn't imagine me being able to remedy by doing that." Audrey, a public elementary science teacher, expressed doubt in being able to change an issue in her school building as "I was saying this problem at my school [facilities putting recycling in the trash]. I could whistle blow on my school, I suppose. I don't really know how that would work, or if it would work**.**" Nora, a public middle school teacher, believed that the lack of knowledge of political and legal remedies was widespread:

> I know we have an EPA, a DEP, but I think the public in general are pretty much unaware of the laws… I don't think that our government goes out of their way to engage the public in general about what's happening. So if you're not already a member of an environmental group and you're not getting those little blasts of things and being asked to write to law makers because a bill is coming up, how would you know? And so I think people just don't know and I don't think our government goes out of their way to tell us either.

Identity

"I'm not real like a police type… I mean if it's in a public area that's one thing, but if it's private land, I kind of mind my own business, I guess." (Abby, public middle school teacher) The final theme that emerged to explain lack of political or legal action reflects educators' identity as not political or activist. This emerged in discussions of their own behaviors as well as the strategies they ranked for the environmental scenarios. Penelope, a public early childhood teacher who also worked in a nonformal context during the summer and on weekends, describes herself:

> Yeah, but I'm not political. I'm not that type that says, hey, do you believe in conservation? Do you think you could come out with me and hold some signs against Trump's environmental issues? I don't even do that myself. If [environmental organizations] send letters, this, that, if it's really easy, I'll do it. But if it's not, shame on me.

Even as he acknowledged the value of political and legal action, Eliot, a nonformal educator who works with elementary students, didn't identify as the person to engage in them. "It's tough for me, because I really believe in the political sphere, and when it comes to such heated issues... there's a time and a place for that… I'm not that person."

Claire, a nonformal educators who works with grades K-12, not only rejected the political/activist label, but juxtaposed it with that of educator:

> Basically I think it's where your mindset is. And I think I'm more of an educator and not so much of an activist. And I'm very grateful for the activists who are out there who take on that role. And that's a different personality and I'm not usually that personality. I'll sign the petitions, I'll talk to people when I have the chance in person, but I'm not out on the picket line or the confrontational or whatever. So, yeah… We'll talk about this and I'll explain to you in such a compelling way, right.

This is a theme that also came up when discussing examples of their persuasion behavior, where educators described persuasion as being an extension of their work or their teaching, while also noting that one of the barriers to such action is not wanting to force their beliefs on others or be "preachy".

Both formal and nonformal educators discuss the complexity of having opinions on environmental issues and educating others about those issues, or the "two hat problem" described by Hug (1977). Dan, a nonformal educator who works with K-12 students:

> I don’t, again, it’s not what I do in the environment. And partially it’s kind of built into my justification for being able to say what I say and talk to who I talk to ‘cause I am not… I’m not the street protester, spray painting things, and then teaching kids. They can’t ever draw that line on me.

Caleb, a private high school language teacher, who talked about walking the fine line of letting students know his own positions on environmental issues they discussed, said he feels comfortable with the stance he has taken because “I always come at it from a moral perspective rather than a political perspective. So even [though] there's some environmental issues that people try to make political, and it's not, it's a moral issue”

There exists, also, a tension with employers. Those educators employed by public entities (i.e. schools, parks, government agencies) often have limits on what they can say and often a ban on what is perceived as advocacy. Frank, a nonformal educators who teaches elementary students and works for a county park, described it this way:

> Being a county representative, I am not allowed to take a political stance. Only the free holders for the county can take a political stance. So anything on a national political scheme of the environment and the Keystone pipeline or the pipeline coming through Hunterdon County… I cannot take a stand on it. I have to technically try to present both sides and let the public take a mindset. Now I'm not going to deny in all my lecture programs and all I will go like this and say, "Me personally," and I'll give a personal opinion.

In summary, three main themes about self-efficacy and behavior emerged. A portion of educators, primarily middle and high school formal educators, expressed doubt in their ability to create real change through their behavior because they were “one drop in the ocean” (Amari), because they engaged in other negative behaviors, or because more systemic behavior was needed for real change to occur. When looking at their reported behaviors and the behaviors they would use to address potential issues in environmental scenarios, there was a lack of coherence between the two. Personal-level

types of behavior were reported more frequently, but in the scenarios, persuasion and system-level behaviors were more likely to be a highly-ranked behavior, with personal-level behaviors less favored.

Discussion

There appears to be little research on environmental educators' rejection of an activist/political identity. In fact, there are multiple definitions of "activist" from "active involvement in environmental organizations and demonstrations" (Stern, 2000) to the "organized participation in environmental issues… expressed in specific activities reflecting a commitment to environment channeled in formal settings and realized through institutional structures" (Marquart-Pyatt, 2012). Schmitt, Mackay, Droogendyk, & Payne (2019) state that activism "must involve behavior that leads to systemic change social change (increased regulation of industry, economic incentives, cultural shifts away from materialism, restriction of political power of fossil fuel industry)." In a study of pre-service teachers (Campigotto and Barrett, 2017), students described an activist as someone who went beyond caring for the environment and engaged in large scale behavior.

Merriam Webster (2019) defines an activist as "one who advocates or practices activism: a person who uses or supports strong actions (such as public protests) in support of or opposition to one side of a controversial issue." It is this controversial nature that some educators seem to be shying away from. When Caleb referred to the political nature of environmental issues, he called up the divide, often along political party lines, on how to manage the environment and natural resources. He reframes it as moral, moving away from the controversial connotation of political. Both Claire and Dan allude to this

controversial nature, and confrontational nature of an activist with their references to picket lines and demonstrations. These images echo those expressed by the pre-service teachers in Campignotto and Barrett (2017), some of whom specifically avoided behaviors because of the perception of activists as extreme. It is this negative duality that led to Hug's (1977) two hat problem, yet claiming an activist identity is correlated with system-level environmental behavior (Kempton & Holland, 2003).

In addition to rejecting the activist identity, there was a rejection of the political in interviews. This appears to extend to political action. Political action was less frequently reported than any category other than legal. Other than identity reasons, distrust of and doubt in political systems and inexperience restricted some educators' behavior. There were some educators (n=24) that talked about engaging in political action, principally voting, signing petitions, and communicating with their legislators. A small number (n=5) reported protesting for science and environmental issues, such as the March for Science. This is a sample of people that are already more inclined towards the environment, who feel knowledgeable about a wide variety of issues, report feeling personally connected to the environment, and see humans and the environment as interconnected, yet nearly half are not engaging in systemic-level behaviors, behaviors that are necessary for large scale environmental change.

So the question becomes, if we want more educators who are experienced and competent in these systemic-level behavior so that they can help foster their students' competence, how do we move them from the personal-level behaviors such as ecomanagement, consumer, and persuasion to the more impactful system-level behaviors that they say would be more effective in environmental scenarios? What supports can be

put in place to help them change their practice and identity to accommodate these more significant behaviors?

Looking at the personal-level behaviors that educators already engage in with regularity, how can those be expanded to include the new practices of political and legal behaviors? All categories overlap to some extent. Riding a bike is perceived by some educators as a behavior with direct environmental benefit, placing it in the ecomanagement category, and as a choice to not purchase fossil fuels for a car, placing it in the consumer category for others. Persuasion straddles the divide of personal and systemic behaviors by including consumer actions – writing to corporations, sharing boycotts with others – and political – communicating with politicians, speaking at town meetings. Research is needed to examine how to leverage existing persuasion behavior to move educators to more system-level behaviors in a way that aligns with their identities.

Lastly, more research is needed on this phenomenon of educators rejecting political and activist identities when that conflicts with other components of their identities. As environmental educators, how do they reconcile those two parts – the environment and education? Formal educators are likely members of teachers unions, which are politically active – how is political environmental behavior different?

Conclusion

A significant portion of environmental educators from formal and nonformal settings have low self-efficacy towards environmental change and they identify three main reasons for that: they are one small part of the problem, they engage in negative behaviors that counteract the positive, and there needs to be more organized, systemic action to create real change. Educators preferred systemic-level action when asked to

rank strategies they would use to address environmental issues, yet report engaging in personal-level behaviors more frequently. Looking at barriers to system-level behaviors, they described negative opinions of politics/the political, a lack of experience or ability in that type of behavior, and a rejection of the activist/political identities. Further study should examine ways to build system-level behavior in environmental educators, through already existing behaviors or pedagogically, using practice-focused methods such problem-based learning (Barrows, 1986; Hmelo-Silver, 2004) to expand educators' repertoire of behavior and practice.

Chapter 4. Developing Critical Thinkers and Creating New Solutions: The Effects of Educators' Level of Environmental Literacy on Their View of Student Environmental Literacy and Issue Identification Practices.

Abstract

Research on environmental literacy in students and adults has often used ratings of high and low to indicate the extent of one's environmental literacy. Such ratings miss the nuances that a continuum could provide. This research expands on Stables' environmental literacy continuum, using a contextual perspective on environmental literacy. This expanded framework is then applied to formal and nonformal educators, and patterns are described. Interviews with the educators were analyzed to discern differences at three levels in issue identification and views of their role in student environmental literacy. In general, educators with a cultural or critical literacy provided more complex explanations of issue identification and viewed their role in student environmental literacy as developing multiple facets, including practices.

Keywords: environmental literacy, educators, situated learning, practices, identity

We are in a time of environmental crisis, from global issues like climate change (IPCC, 2013) and loss of biodiversity (IPBES, 2019) as well as myriad issues at smaller scales. While some claim that environmental education must be reformed (Saylan & Blumstein, 2007), the field continues to work towards developing citizens who are environmentally aware, concerned, and knowledgeable, and prepared an willing to take action to address current issues and prevent future ones., in line with the Tbilisi goals (UNESCO, 1977). This combination of traits compose the construct of environmental literacy (EL). While research has been done with students of all ages (e.g. Hsu, 2004; Kaplowitz & Levine, 2005; McBeth, Hungerford, Marcinkowski, Volk, & Meyers, 2008; Ozsoy, Ertepinar, & Saglam, 2012; Stevenson, Peterson, Bondell, Mertig, & Moore, 2013) and adults (Coyle, 2005), not much has been conducted with the educators responsible for helping develop others' EL. Yet we argue that such educator EL is necessary to develop environmentally literate citizens of the future. The research presented here examines formal and nonformal educator EL, placing it on a continuum from function to critical (Stables, 1998) and looking for its effects on teachers issue identification practices and their views of student EL.

Educator Environmental Literacy

There is a small body of research on educator environmental literacy, chiefly of formal educators and outside of the U.S. (Amirshokoohi, 2010; Cheng & So, 2015; Cutter-Mackenzie & Smith, 2001; Dada, Eames, & Calder, 2017; Ernst, 2007; S.-J. Hsu & Roth, 1998; Liu et al., 2015; Swanepoel et al., 2002). Cheng and So (2015) studied the EL of primary school teachers in Hong Kong and concluded that individual background, motivation, and teaching are closely connected, with individual commitment being the

most important factor. In a national assessment of teachers in Taiwan, Liu et al. (2015) found high levels of environmental attitudes, moderate levels of environmental knowledge, and low levels of environmental behavior. Cutter-Mackenzie & Smith (2001) found that the teachers they interviewed were either environmentally illiterate or had a nominal level of environmental literacy. No studies have looked at formal and nonformal educators together, though they both have a role in developing student EL.

When we look at literature connecting teachers to students' EL, Stevenson and colleagues (2013) found that teacher experience has a complicated relationship to student EL, with performance on the cognitive skills component of the Middle School Environmental Literacy Assessment (analogous to the practices in this framework) higher for students with teachers who have a Masters or in the field for 3-5 years, but the effect disappears for teachers in the field longer than five. Ernst (2007) looked at the relationship between, among other things, teachers' EL and their use of environment-based education. She found that the decision to use environment-based education methods was strongly influenced by EL knowledge and skills, environmental sensitivity, positive environmental attitudes, and receptiveness to environment-based education methods. This suggests some aspects of environmental literacy were influential in the type of instruction used.

The contextual view of environmental literacy

The contextual perspective on EL (Authors, in review; Authors, in review) is one that is situated in social-ecological systems (Berkes, et al., 2002), with multiple affordances and constraints on knowledge, dispositions, and behavior. It is important to note that individuals are part of multiple social-ecological systems of different temporal,

spatial, and social dimensions at any time. Given its situated nature, the contextual perspective emphasizes the importance of boundary crossing (Lave & Wenger, 1991) – using knowledge and engaging in practices in multiple systems. Indeed, experts, from a situated perspective, "…face the challenge of negotiating and combining ingredients from different contexts to achieve hybrid solutions." (Tuomi-Grohn, Engestrom, & Young, 2003, p. 3). This can be done in several ways. Wenger (1998) identifies individuals who serve as brokers, introducing practices into one COP from another. Wenger (1998) also describes boundary encounters, or events that provide connections between COP. Boundary objects are objects that inhabit multiple, intersecting social worlds (Akkerman & Bakker, 2011; Star, 2010; Star & Griesemer, 1989). Using a boundary crossing explanation of knowledge and practices in multiple contexts, it is apparent why educators should themselves be environmentally literate and capable of connecting their EL practices with their environmental practice. They can serve as brokers and choose objects and encounters that will develop their students' own EL to be used in multiple contexts.

Legitimate peripheral participation describes the entry into a community of practice, a stage of membership that brings individuals into a community, as they learn about who is part of the community, its practices, and what constitutes full participation and expertise (Lave & Wenger, 1991; Wenger, 1998). While not as knowledgeable (in as expansive sense) as experts, peripheral participants are still members of the community who are developing their own knowledge through participation and use of practices.

The EL practices also reflect the changing nature of engagement with the environment, moving from the legitimate peripheral participation of a novice to the

deeper participation of an expert. This parallels Stables' (1998) continuum of EL, which describes changing engagement with the environment. Stables describes his continuum chiefly in terms of types of knowledge and the potential for action, but here we expand that to include types of behavior and the view of the social entangled with the ecological, represented here by the Integration of Nature in Self (Schultz, 2002c).

A continuum of environmental literacy

Stables' (1998) continuum of environmental literacy has three levels. At the *functional* level, one has knowledge, sometimes deep and complex, of the biophysical components of a place and how they interact. There is an ability to conjecture on identification based on contextual clues. Within the context of New Jersey, where this study takes place, this would be understanding why there are pines in south NJ, oaks and hickories in the central to northern parts of the state, and hemlocks in the northern parts. The level of behavior is low, chiefly consisting of direct action which benefits natural elements, and the view of issues may be guided by cause and effect, with little attention paid to the interactions of complex systems.

The *cultural* level involves an increased level of knowledge, including a growing understanding of the role biophysical components play in culture/society, and the way humans affect the landscape. Continuing with the New Jersey example, this would include a more expansive kind of knowledge – not just an understanding how the Pine Barrens affected the type of human activity in them and how the human activity shaped the Pine Barrens, but also the mythos of the Pine Barrens. Behavior includes that which benefits landscapes and ecosystems, and building relationships between people and place, and remains chiefly at the personal level. The view of issues at this level begins to

include social dimensions, but may not emphasize the full integration of social and ecological aspects of problems in a complex way.

The *critical* level is needed for effective action. It involves developing an understanding of human effects on environmental degradation and issues, paths to remedy them, and engagement in that action. At this stage, individuals start to question the status quo and look for alternate paths. We add here that critical level individuals are grappling with the social impacts of environmental issues and the concept of social-ecological systems. In a New Jersey context, understanding and acting on the interaction of global climate change and species change in pine barren ecosystems. Behavior change addresses environmental issues through multiple avenues, with an eye to the social impacts of various remedies, and includes engaging in systemic-level behaviors that support larger scale of change. Issues may be viewed as complex social-ecological problems with secondary and tertiary impacts typical of complex systems.

It is through interaction and engagement with the natural environment and the social environment that brings this movement along the continuum. Connection and experiences with the ecosystems near you, as well as interaction with more experienced and knowledgeable people in an around those ecosystems and related issues – the social-ecological systems – help develop, in tandem, the knowledge and practices that characterize more advanced levels of EL.

The Teacher Environmental Literacy Assessment

It is this contextual perspective, including the value of practices and viewing EL on a continuum of changing engagement, facilitated by practice and participation, that guided the development of the Teacher Environmental Literacy Assessment (TELA). The

Table 4.1

Components of the Teacher Environmental Literacy Assessment.

Scale	Description
Knowledge	• Multiple choice items from Coyle (2005) that include ecological and issue topics. • Climate items from studies with Rutgers students. • Open response and multiple choice items embedded in environmental scenarios which address socio-political topics such as which level of government handles an issue and systems thinking topics such as predicting what would happen to a habitat if a key species is removed.
Self-efficacy	• Novel scale measuring respondents' self-efficacy towards making environmental change.
Integration of Nature in Self	• Single-item graphical representation of how integrated one is with nature (Schultz, 2002b.)
Environmental Identity	• Novel scale using Kempton & Holland (2003) "social environmental identity" trajectory.
Behavior	• Open response items soliciting behaviors engaged in in the last two years in five categories: ecomanagement, persuasion, consumer, political, and legal.
Environmental scenarios	• Three environmental scenarios (land development, electronics waste disposal, and species conservation) requiring respondents to identify an issue and rank potential strategies (from above behavior categories) to address those issues. Responses scored by comparing to expert responses. Yields two scores: Issue Identification and Strategy Selection.

TELA is an online assessment composed of multiple scales (see Table 4.1).

Barriers to environmental education

Regardless of their level of engagement, knowledge, and participation, educators can encounter barriers within the contexts that they teach. These barriers can be within the educational system, the classroom, or themselves. Borg, Gericke, Höglund, & Bergman (2012) examined the reasons teachers in Sweden, where sustainable development is a required topic, reported. They found that teachers lacked inspiring examples, expertise on sustainable development, time to implement changes, administrative support. They also felt it was not relevant to their subject. Teachers' educational practices, including pedagogy, were often discipline-based, and inclusion was greater when those practices overlapped with the tenets of sustainable development, such as including multiple perspectives and avenues. Other researchers (Corney, 2006; Cutter-Mackenzie & Smith, 2001; Hanna, 1992; Summers, Corney, & Childs, 2003) identified similar themes of lack of knowledge, administrative support, and time. Ernst (2007), studying teachers in the U.S., also reported the emphasis on state standards and testing as a barrier to use environment-based education in their classrooms.

Research Questions

Given this framework for an EL continuum, we have three major research questions.

1. Can we utilize TELA date to locate educators on a continuum from functional to critical EL?
2. What do educators at different places on the continuum believe about their role in student EL and EL barriers?
3. Are there differences in the practice of issue identification in educators at different places on the continuum?

Methods

Participants.

Participants were formal and nonformal educators who work with students in grades K-12. Of the 46 educators that participated, 19 worked in nonformal settings, 23 in public schools, and 4 in private schools, Six of the total were from states other than New Jersey (Maine, New York, Pennsylvania, and Virginia). After taking the TELA online, they self-selected into an interview study. They were reimbursed with a $50 gift card for a one-hour interview.

Data sources.

To address the first research question, measures of key dimensions in alignment with the above continuum of EL were pulled from the Teacher Environmental Literacy Assessment (TELA; Authors, in review). This online assessment included measures of knowledge, self-efficacy, INS, environmental identity, and behavior. In addition, to assess practices, participants identified issues and strategies for addressing those issues in three environmental scenarios. For this study, the knowledge scale was restructured to create five new scales: conceptual knowledge (ecology and environmental concepts such as renewable resources, and the persistence of CO_2 in the atmosphere), issue knowledge (e.g. relevant U.S. issues such as air pollution, nuclear waste disposal), socio-political knowledge (e.g. the appropriate governmental level to address issues, the federal agency that handles environmental issues), systems thinking (e.g. predicting what happened in a habitat disrupted by logging, what would happen to the ecosystem if a key species is removed), and environmental justice (the definition of environmental justice). These represent the different types of knowledge represented at each stage of the continuum.

Systems thinking and environmental justice were given their own scores because of their importance to critical EL. The behavior scale of the TELA, which had been scored by giving one point for each behavior in each of the five categories (up to 3 points per category), for a max of 15 points, was rescored. In the new scoring method, one point was given for personal-level behavior categories (ecomanagement, consumer, persuasion) participants engaged in, and two points for each system-level category, for a total possible score of 7 points. System-level categories were weighted more heavily in accordance with the types of behaviors experts chose (Authors, in review) and their greater impact (Stern, 2000). Lastly, the Integration of Nature in Self scale (INS; Schultz, 2002) was included to assess their conception of integration of social and ecological components in a social-ecological system. The proposed levels of each measure at each level of EL is represented in Table 4.2. First, using these criteria, participants were placed

Table 4.2.

The Levels of Each Variable at Points of the EL Continuum.

	Functional	Cultural	Critical
Conceptual Knowledge	Low to moderate	Low to high	Moderate to high
Issue Knowledge	Low to moderate	Moderate to high	High
Socio-political Knowledge	Low	Low	Moderate to high
Behavior	Low to moderate (no system-level, more ecomanagement)	Moderate (includes some consumer and persuasion)	High (includes system-level behaviors)
Environmental Justice	Low	Low to moderate	Moderate to high
Systems Thinking	Low	Moderate to high	Moderate to high
INS	Low	Moderate	High

in one of the three levels of the continuum based on their scores on the seven scales. Then a principal components analysis using SPSS statistical software was performed, and individuals plotted against the components for visual inspection.

To address questions two and three, data was taken from hour-long interviews that covered the content of the participants' TELA responses and emergent topics. For this study in particular, we used responses regarding why they chose the issues they identified in the environmental scenarios, and from responses to questions on how they saw their role in student EL and the barriers they see to that. Thematic analysis (Braun & Clarke, 2006) was conducted using Dedoose software on interview transcripts, and themes addressing issue identification and educators' role in and barriers to student EL were highlighted.

Results

Placing educators on a continuum of environmental literacy.

Using the criteria in Table 4.1, educators were identified as having functional, cultural, or critical EL. Functional level educators comprised 17.4% of the sample, cultural level 43.5%, and critical level 39.1%. There were educators who lay on the boundary between two categories – decisions on which level to place them in were made chiefly on the presence of system-level behavior. Looking at instructional setting, 61.1% of those at a critical level were nonformal educators. At the functional level, only 12.5% were nonformal educators. Demographic factors for the sample and each level are presented in Table 4.3.

Descriptive statistics for the seven scales described above are presented in Table

Table 4.3

Demographic Characteristics of Interview Sample and by Level of EL.

	Non-white*	Hispanic	Female	Education > Bach	Residence		
					Rural	Sub	Urban
Sample	15.2	6.5	73.9	63.0	13.0	41.3	45.7
Functional	37.5	11.1	88.9	50.0	12.5	75.0	12.5
Cultural	15.0	0.0	75.0	60.0	15.0	45.0	40.0
Critical	5.6	12.5	72.2	72.2	11.1	22.2	66.7

* Includes Black/African American and Other/more than one

Table 4.4.

Descriptive Statistics for Scales.

	Range	Min	Max	Mean	Std. Dev
Conceptual Knowledge	0-7	3	6	4.76	.848
Issue Knowledge	0-7	3	7	5.80	1.067
Socio-political Knowledge	0-2	1	2	1.22	.417
Behavior	0-7	1	7	3.91	1.363
Environmental Justice	0-3	0	3	1.24	.923
Systems Thinking	0-5	1	5	3.41	1.066
Integration of Nature in Self	1-7	2	7	5.02	1.105

Table 4.5.

Cross-correlations of Scales.

	Conceptual Knowledge	Issue Knowledge	Socio-political Knowledge	Behavior	Environmental Justice	Systems Thinking	Integration of Nature in Self
Conceptual Knowledge	–						
Issue Knowledge	.536**	–					
Socio-political Knowledge	.213	.248	–				
Behavior	.289	.248	.190	–	.		
Environmental Justice	.444**	.432**	.151	.176	–		
Systems Thinking	.357*	.268	.093	.331*	.349*	–	
Integration of Nature in Self	.148	.267*	.086	.046	.213	.294*	–

** Significant at the 0.01 level (2-tailed). * Significant at the 0.05 level (2-tailed).

4.4. INS was skewed towards higher scores, which reflects the pattern in the larger sample (Authors, in review). No participants scored at the bottom of the conceptual and issues knowledge scales.

Cross correlations are provided in Table 4.5. There were moderate correlations between multiple scales, with the strongest between conceptual knowledge and issue knowledge. Environmental justice, one of the qualifiers for critical EL, was moderately

correlated with conceptual and issue knowledge as well as systems thinking, another marker for critical EL.

The component matrix and scree plot from the principal components analysis are shown in Table 4.6 and Figure 4.1, respectively. The first component accounted for 37.5% of the variance, and included conceptual knowledge, issue knowledge, systems thinking, and environmental justice. These last two are key to critical EL. The second component included socio-political knowledge, behavior, and INS. Together the two components accounted for 52.1% of the variance.

Using the component scores from the PCA, individuals were plotted against the two components. Individuals were then marked with a symbol indicating their level of environmental literacy (Figure 4.2). There is a clear continuum, with transition zones, present.

Table 4.6.

Component Matrix for Scales.

Component 1	Conceptual Knowledge	.757
	Issue Knowledge	.748
	Systems Thinking	.642
	Environmental Justice	.691
Component 2	Socio-political Knowledge	.551
	Behavior	.431
	Integration of Nature in Self	-.659

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

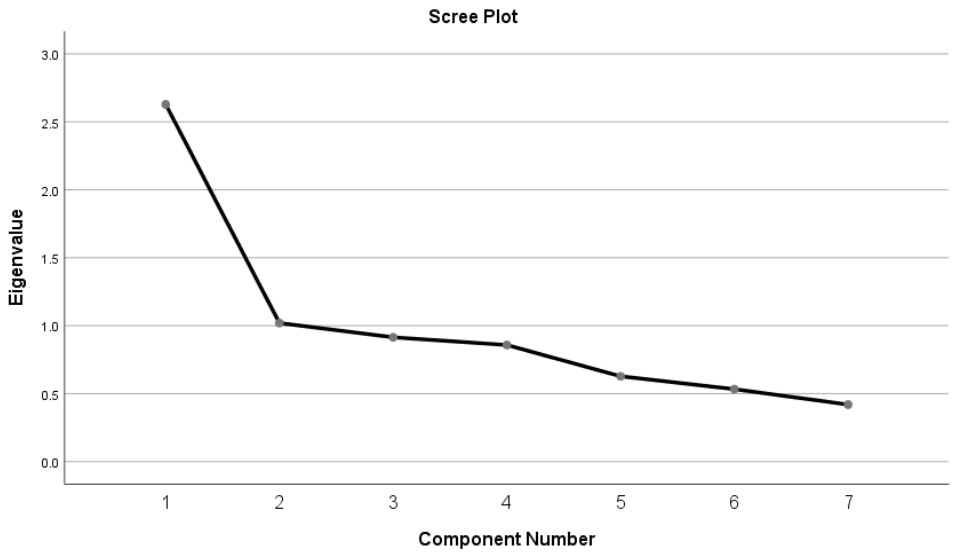


Figure 4.1. Scree plot for components.

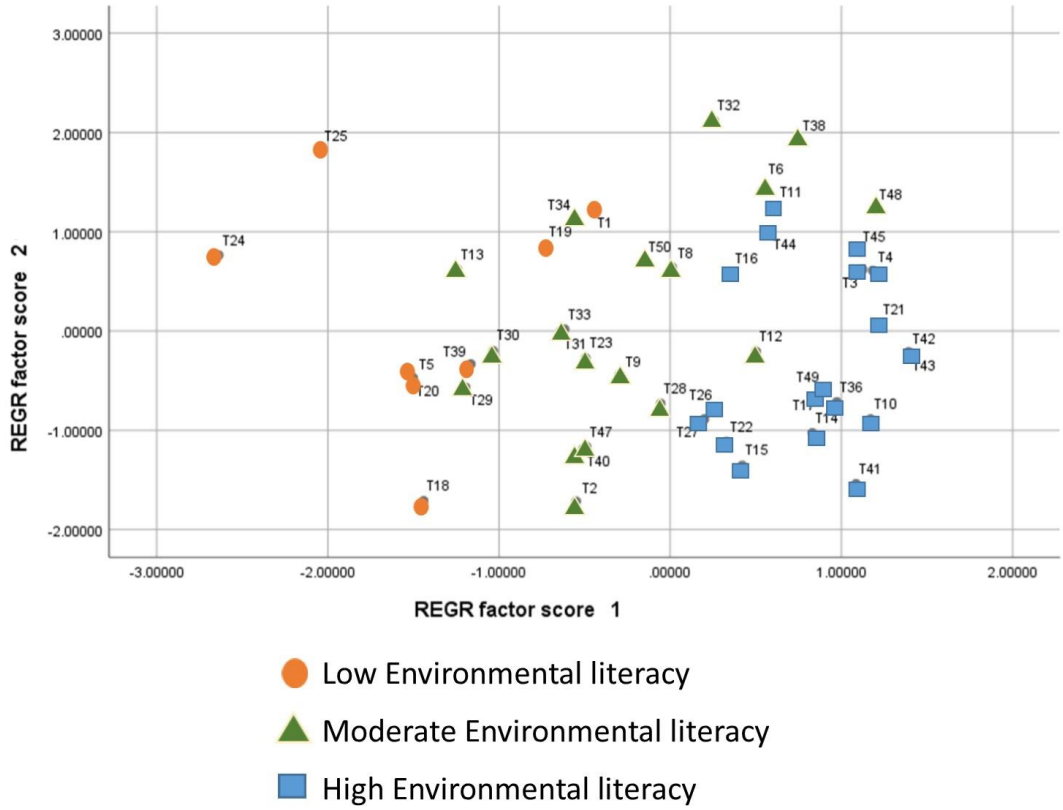


Figure 4.2. Distribution of individuals across the two components, marked by level of environmental literacy.

Their role in student environmental literacy.

A question that emerged from interviews was "If we think of EL as we've discussed it today, how do you see your role in developing student environmental literacy?" Responses were coded into the four facets of EL – knowledge, dispositions, practices, and behavior. A fifth facet emerged during analysis – connection. This included connection to nature and connecting their lives to the environment. Few educators saw developing student behavior as a role, and many said it wasn't their role to preach or tell them what to do. Dispositions (primarily awareness, but also empathy, love, and identity) were the most frequently described roles, followed by knowledge, practices, and connection.

Dispositions

There were some noticeable differences between educators at different levels of EL. In general, those at a functional level gave answers with much less elaboration, and were focused more on awareness and knowledge. Ethan, a public high school educator, functional EL, responded:

> Just making them aware. I mean, I'm not ... I guess, I don't have to be an environmental class to kind of just point out ... point out things like the recycling and the ... if they're at a lab station, make sure the water's off if they're not using it, just things that, like, everything's ... everyday things that they actually could do in their daily lives, or their daily routines.

Caleb, a cultural level private high school educator, talked about awareness of issues:

> Well, I try to tie it into the French curriculum, which isn't always easy. But when we have these decisions coming from France, the French speaking about what they're doing to protect the environment. And then I'll usually bring in an article in French, for them to translate, and we'll talk about it. Just to make them aware of what's going on, not to try and change their opinion.

While Sophia, a critical level public middle school educator, framed awareness of the environment like this:

> So just to raise awareness through everyday practices is so easy to do. And it could be the weather, or it could be here in the park, like I started the year with a jar of ticks, and just asking them, how many of you got bit by a tick this year? How many of you noticed there's more ticks? You know, that kind of thing. When do you notice, like we planted bulbs. We did a bulb project, and like when do they come up, and do you see that there's a difference of when plants are budding? There's just so many things that they just pay attention, are right there, and then they just all have different interests. Some are more interested in animals, or their travel, or just like the weather because they're outside exercising.

Educators identified dispositions beyond awareness. Contrast how Elizabeth, an elementary educator with a functional EL, describes love of nature:

> Since I work with children that are so young, I feel like my role is just to teach them to love the environment, to love the earth, to love the animals, to love plants, to learn about these things and to know that they're all essential and necessary for the survival of people for our planet to continue to thrive... If kids find the value in our planet and find the value in our environment, then hopefully they can make a difference and they can continue to move us, push us in the direction that matters.

with how Nisha, a nonformal educator that works with elementary students and has a cultural EL, frames empathy:

> And I think for environmental ed, empathy is really important because what I think humans [do] is saying, "That's an animal, I'm a person." But when you start to see, "I am a being and that is a being," you can start to empathize. I think my role is developing those character traits that make them feel more of a community. I mean community with salamanders, community with spiders, community with trees. Not necessarily community with humans, because I think that's easy.

Nisha expresses more of a sense of interconnectedness that characterizes later levels of EL – rather than emphasizing loving something because it is important for human

survival, instead she frames the human and the ecological as equals, and part of the same system.

Connection

The threads of connection that are woven into the disposition responses above extended through the responses of many cultural and critical level educators, but was limited in functional level educators. Connection for these educators is multifaceted, from the other community members Nisha talks about, and the love and care for nature and animals Elizabeth seeks, to connecting the environmental science topics to students' lives as Sophia does. Bella, a nonformal educator working with elementary students in a major urban center, with a cultural EL, works to bridge the two:

> … You can't remove yourself from nature. It is everywhere, even in the biggest, busiest, bustling city where all you see is pavement. It's still there. So I try really hard to have them see that, and that they are connected to nature. Because I think before you have that ... how can they care? How could they ever take any other steps? How could they ever care about any environmental issues, vote the way that I would hope they would vote, anything. Participate in a cleanup, get a job in a field that helps the environment. Like none of that happens if they feel like nature's over there for other people and not something that's for them. … And also realizing that there are problems and kind of connecting those actual problems that are in their community that they can see and want to do something about. I think yeah, you can't really do anything. You can't just be like, you know what's really a problem? Plastics in the ocean. And they're like, okay, but I didn't have dinner last night, and I haven't had new shoes in four years. Like that's not a relevant issue. Connecting to relevant local issues, and before that, really just noticing, realizing that nature is in their community.

Henry, a critical level public high school educator, goes further to connect environmental issues with students' current and future lives:

> Well, I think my main role is in getting them to care and to see why environmental issues are important to their lives. We'll talk about energy and I'll say, "Well, you're all going to own a home someday. Are you going to want to spend $200 a month on electricity or $8 a month? You could do that if you

> switched out from incandescence to LEDs." That gets into the discussion of short-term and long-term costs and benefits. How much does this LED cost versus this?

These both demonstrate an understanding of the social aspect of environmental issues beyond the ecological knowledge aspect of the functional level. The critical level goes further by connecting social and economic impacts, at multiple time scales.

Practices

The last theme for educators' view of their role in student EL is that of developing practices. Practices here are the socially constructed ways of participating that develop knowledge and are mutually influenced by knowledge (Lave & Wenger, 1998; Wenger 1999). Practices are key to the contextual perspective, as they help one progress across levels in the continuum. Educators with a functional level of EL did not mention practices in their responses. Audrey, a public elementary teacher with a cultural EL, talks about the importance of perspective taking:

> So I feel like it's really important to show the kids both sides of an environmental issue and let them kind of come to their own conclusions about. And really think about things from multiple different perspectives. Which is like the whole Flint, Michigan issue. I had the kids, okay if you were a doctor, what's the problem here? How are you gonna solve that problem? All right, what if you're a teacher? What's the problem? If you're a nurse, if you're a soccer player, if you're ... you know, so like I feel like it's really important to make sure that you give the kids the tools to be able to critically think rather than just tell them what to think.

While Rose, a nonformal educator who works with students K-12 with a cultural EL, emphasizes the intersection of knowledge, investigative practices, and communication practices:

> Whether it's why does this work? How does this work? What happens when X and Y meet? So that they learn how to think critically on their own and how to formulate questions that, in such a way that they're going to be respectful and they're going to be able to ask them of anyone… So basically, we want to create

> kids that have a sound understanding of basic scientific concepts and have an understanding of how to go online and find good answers to environmental questions they have. Because nobody can know everything about all the environmental topics there are.

Ruby, a nonformal educator who works with elementary students in a major urban center, and has a critical EL, sees the importance of systems, a marker of critical EL, and the goal of using these practices in multiple settings:

> Also then to hopefully build some of the skills to think, if we can think critically about systems and about food webs, and things that we observe in this part of our ecosystem when hopefully then when they're considering the impacts of other contemporary issues they're able to translate some of that analysis, some of that ability to critically think about these things to bigger issues, to different issues.

Multiple educators referred to critical thinking, such as Lilly, a nonformal educator working with grades K-12, who has a critical EL. She sees this as a trait everyone should have and be able to use when they are presented with new issues.

> I think my role is to help them to become critical thinkers. To help them to be consumers of information that they don't believe everything they read, that they could go back and look where it came from and is this real or not. I think teaching them to look at things critically and to evaluate where it comes from and is it real or not and to have at least, I mean not everyone is going to become a scientist and that's okay because we need artists and everyone else in the world too. They need to have at least a basic understanding so they can critically read it or something like that and say, "Well, okay at least I trust Pinelands Preservation, that these people are going to do the right thing."

In the contextual perspective (and most views of EL), knowledge and dispositions is necessary, but not sufficient to foster necessary behavior. Practices, and participation with more expert individuals, is what supports students engaging in those practice and behaviors themselves. This means that those educators at the functional level are not fully supporting their students EL.

Barriers to EL.

Educators identified several types of barriers to developing student EL (See Table 4.6), which reflect findings from previous research (Borg, et al., 2012; Corney, 2006; Hanna, 1992) but expand on. There were no differences in barriers identified by educators of different levels of EL, however nonformal educators identified a type of barrier, Access, which formal educators did not.

Issue Identification.

Participants were prompted to elaborate on their choices for most relevant issues for the three scenarios on the TELA (Figure 3.1). Focus here will be on Scenario 1 (land development scenario) and Scenario 2 (electronics waste scenario). Several patterns emerged, some of which applied to all scenarios, and some of which applied to certain scenarios.

All scenarios

Educators at the cultural and critical levels provided more elaborate and technical responses. Compare the responses of Harper (public elementary, functional EL), Rose (nonformal, K-12, cultural EL), and Dan (nonformal K-12, critical EL), who all identified runoff and habitat loss as the most relevant issues in the land development scenario:

Harper:

> Because soil will absorb some water and drag and finally it's like, will prevent everything washing away. It'll stop erosion. And if there's no trees or anything, the animals that eat depend on the trees and the grass won't need to eat, so that means they're either gonna die or be forced into an area that has grass, but have to contend with more animals. And so they're still gonna decrease their population.

Table 4.6.

Types of Barriers to Student Environmental Literacy Identified by Educators.

Type of barrier	Examples
Structural Societal level factors	• Poverty • Children's overscheduled lives • Social tendencies to live in bubbles, be technology dependent, or lack system thinking.
Schooling Structural factors specifically related to the educational system	• Lack of administrative support • Curriculum that doesn't focus on the environment • Focus on high-stakes testing
Instructional Factors related to individual teachers and instruction	• Time they have with students • Lack of access to high quality data and information • They don't teach science • Teachers have to really want to do it
Attitudes Prevalent attitudes	• Biophobia • Apathy towards the environment
Access * Lack of access to students or lack of student access to nature	• Loss of middle school and high school students for both field trips and out of school programming • Transportation
Student Factors related to students	• Student developmental level • Generational differences • Students can't think quantitatively
Parents Factors related to parents	• Parent attitudes or behavior are not supportive • Lack of parental supervision/guidance • Too many parent restrictions

* This type of barrier was found only in nonformal educators.

Rose:

> So, water runoff in the area is about a permeable surface issue. Permeable versus impermeable surface issue, and then reduce habitat for local plant and animal species. Just, if there are, if a development is going in and it's becoming paved and there's monoculture losses and so forth, there won't be a species diversity of vegetation to support the native populations. And it's going to kick lots of animals out of their home.

Dan:

> I mean, I'd have to see the development plans, but yeah, I mean, you very much could be messing with ... well, you're definitely going to mess a little bit with infiltration from all the roads, you're definitely going to mess with that. And then almost all farms have little barriers where things hide out, and they're going to level that and make it into grass. Probably.

Harper describes soil as "having drag" that will prevent erosion, while Rose introduces the concept of permeable and impermeable surfaces, evidence of human effects on the landscape that comes with a cultural level of EL. Her attention to vegetative diversity and native (vs alien or invasive) species also indicates a more sophisticated understanding of ecosystem functioning. Dan goes a further step, and requests development plans, suggesting that such damage is not inevitable, but can be mitigated by human choices and behavior.

This increasing complexity as we moved along the continuum was echoed in the electronics waste scenario and the logging/endangered species scenario, as well. In the electronics waste scenario, this was most visible with regard to the issue of "The waste disposal plant will disproportionately affect disadvantaged communities." Here, the increasing complexity was evident in the prevalence of the issue at each level and the manner in which that disproportionate impact occurred. Again, contrast the explanations

for choosing “the waste disposal plant could introduce toxins into a community” and “the waste disposal plant will harm groundwater and drinking water source.” at each level:

Elizabeth, public elementary, functional level of EL:

> It's definitely going to affect the environment around it and I know we have issues here with our [City] drinking water. We're getting notifications every couple months about lead and other things in our drinking water. "Don't drink this. Don't do that. It's harmful for babies and pregnant people and your family." That's scary because with those treatment plants and everything as it is, if they're struggling with what they have, having extra waste management plants and things like that are going to put more pressure on those plants and without safe drinking water and water to bathe in and those kinds of things, that really affects the surrounding areas and the environment.

Laura, public high school, cultural level of EL:

> The toxins was ranked first because inevitably with electronic production there going to be man-made or man combines compounds which are not present in the environment and the environment cannot handle naturally, so that would be the toxins introduced. And then those would then harm ground water and drinking water resources inevitability. Because, especially if this corporation is in a country and state where waste management is not highly regulated, there's probably not going to be the best liners if any liners are present to form a barrier between the waste the ground water sources. Especially if they're factoring in value of property and possibly even a developing country because it might just be a dump and that would be horrible, yeah.

Seth, public middle school, critical EL, drawing a parallel between the waste disposal issue and fracking:

> Again, from personal experience from seeing other places where there's hydro fracking clearly shows a danger of what can happen to ground water. Things like the Love Canal, things where it's cancer clusters and stuff like that. All those things, and even going back to Rachel Carson and Silent Spring, that should be mandatory reading. The other thing is that hydro fracking makes sense, it's not a bad idea, but the problem is it's like a risk reward thing. It's like, could you screw up the ground water? Yes. What happens if you screw up the ground water? Eh, not worth it. That's kind of it. When I hear something like that, 'cause everyone's always like, "Oh, put this liner and that liner down and impermeable clay will build and it'll be wonderful," I'm like, "What if you're wrong?" And if you can't give me a real answer…

Here, Harper identifies the issue from personal experience with tainted water in her community. Laura provides more elaboration, discussing the types of toxins that would likely be present and the technology that would be used, and begins to reference social dimensions. Seth places the issue in both historical (Rachel Carson, Love Canal) and contemporary (fracking) context, and discusses the risk-reward analysis of environmental issues, placing him firmly in the critical level of EL.

As the level of EL progressed, so too did the agreement with issues identified by experts. In the land development scenario, experts most often identified runoff as a relevant issue, followed by loss of a carbon sink and then a change in the local culture and an economic benefit to the community tied for third. Functional level educators identified chiefly runoff and habitat loss as the main effects. The loss of a carbon sink and change in the local culture (and the secondary and tertiary issues that would result from that) began to appear by the cultural level, and by the critical level, choices were even more aligned and expanded upon, with little representation for habitat loss. In the electronics waste scenario, experts placed introducing toxins as a relevant issue most frequently, followed by a disproportionate impact on disadvantaged communities, then harming groundwater and drinking water. A similar alignment occurred, with more frequent and elaborate discussion of disproportionate impact in the higher levels.

Differences unique to scenarios

Land development – a familiar issue

The three scenarios were chosen for their social-ecological character. The land development scenario reflects a real and ongoing issue in New Jersey, so the issue is familiar and immediately relevant. Most of the educators interviewed referenced

experience with the issue. Lucy, a public middle school teacher with critical EL, when identifying runoff and loss of habitat, quipped “I was kind of responding from the standpoint of, "Wait. I lived through this. It was [about] water and plants". This local, immediate time and space nature of the issue meant that there was an overall higher level of base knowledge. For example, Frank, a nonformal educator working with elementary students, at a functional level, gave a detailed explanation of why runoff was key to his county:

> Everything here, Somerset, Middlesex, Union, we have to make sure that the reservoirs are discharging enough water through the south branch of the Raritan because they pull off of the Raritan for their water sources. Again, being historically also an agrarian county, runoff and non point source pollution is just always something big that we hit with kids at home and all, and also because it's something that they can have an impact on. We can control our non source point sources a bit better. When you bring in the developers and all, one of the big things now with all the new developments is there are all these management associations with these new developments, and they're bringing in the landscapers who just throw down the fertilizer, because they're doing all the mowing, versus sort of the old style where you bought your house and you had to take care of your lawn. So you’ve got to be wary of what's going down on the lawn. Probably still in this county, 70% of the population still draws on wells.

This level of explanation was not present in other scenarios, and shows that context and social-ecological system are important – while he landed on the low end of the continuum, he shows an understanding of this issue, an issue that was almost universally recognized as something happening in their communities. That awareness of the issue of development ran through most of the responses, with both awareness of the issue in general and personal stories of both runoff and habitat impacts to their homes and neighborhoods.

Electronics waste – global and diffuse

Electronics waste, and many other wastes, is an issue that most people contribute to but rarely see the end result. Almost all the educators who interviewed with me had a cell phone with them, but very few had first-hand experience with waste disposal sites near their homes or workplaces, because it is often sent elsewhere, including overseas. This issue was chosen for this diffuse, remote nature of the issue, and because it provided an opening for a discussion of environmental justice, one of the indicators used in determining the level of EL. One of the possible issues was "The waste disposal plant will disproportionately affect disadvantaged communities." To further explore this issue, participants were asked where they would put the waste disposal site: a rural area that is previously undeveloped, but has a small white population; an urban area with low property values and a primarily minority population; or a site overseas in a developing country.

Several patterns emerged. At the functional level, responses were most frequently that they can't decide or an urban site. At the cultural level, a rural site was most frequently chosen, because it would impact fewer people and would be better regulated and managed, followed by "I can't decide." We start to see at this level an advocacy for examining the lifecycle of the product and making changes in the production or disposal – to either change how it is made to produce less waste or not make it at all. This movement away from the status quo and into new possibilities is a hallmark of the later stages of the later stages of the continuum. It becomes even more prevalent in the critical educators, as it became the most popular choice. Amari, a public high school teacher with a cultural level of EL, provides an explanation:

> So where do I put it? I don't know what to say. I certainly would not accept the options presented to me, like none of those for me are options that are satisfactory. The fact that the waste has to go somewhere makes me want to ask questions, "Well, why are you producing this much waste in the first place? Are there other ways that this product can be made?" Which, I'm just certain that there are. And if there aren't, figure it out. Show me a plan. Like if I'm the decision maker, it's like how do we avert this from ever happening again sir? And then we can start talking, but I need a full plan.

Two overarching patterns can be seen as educators at different EL levels discuss their reasoning behind issue identification. First, there is greater elaboration and greater complexity in responses from educators at more advanced levels. There is also greater integration of social and ecological issue components. When we look at differences between issues, the traits of the environmental scenario had an effect. The scenario which was local and familiar to educators, land development, had examples of deeper knowledge at lower levels than did the diffuse global scenario on electronics waste. However, this less immediate scenario also seemed to provide an opening for the critical trait of looking for new solutions that challenge the status quo, in this case refusing the three site options and looking at the product lifecycle to reduce waste production.

Discussion

The quantitative analysis of the modified TELA items did demonstrate that educators could be placed on a continuum of environmental literacy at three levels: functional, cultural, and critical. Looking at the PCA scatter plot (Figure 2), it is clear that this method is imperfect – there are zones in which educators at different levels intermingle. Perhaps this is also due to the nature of a continuum – a gradient rather than steps. These transition zones are also evident in the interview data. While the excerpts presented in this paper are typical for each level, there were also atypical responses that

seemed higher or lower than the level designated for that individual. This was most common between the cultural and critical levels, happening a handful of times – a response would be higher or lower than expected on that facet of EL, but other facets would be in line with expectations. There were often sharp differences between those at a functional level and those in the later levels.

This might be remedied by some adjustments to this shorter version of the TELA. In particular, due to the available material, there were only two items on the socio-political knowledge scale. Additional items on this scale may help provide more nuance, especially since socio-political knowledge is a key trait of a critical level of EL. Because of the situated nature of EL, these socio-political items should be developed in the social-ecological system that the assessment is used in, just as expert responses to scenarios should be from within the social-ecological system as well.

When asked about their role in student EL, it became clear that critical and cultural educators had thought about their role more than functional level educators – their responses were longer and more nuanced. In addition, they included practices such as perspective taking, issue investigation, information evaluation, and critical thinking that they hoped their students would be able to use in multiple contexts – boundary crossing in a situated view (Lave & Wenger, 1991). Critical educators still included dispositions as did the functional educators, but also included other facets of student EL, such as knowledge and practices. In addition there was an emergent theme of connection – connection to nature, connection of content to student lives, including issues in their own communities. This represents the growing understanding of the integration of social and ecological components of social ecological systems that comes with advancing EL.

Surprisingly, the only difference in the view of barriers was between nonformal and formal educators. Perhaps this is because of educators working in one of two systems: schooling and nonformal settings. Each has their own set of constraints and affordances. Nonformal educators work in a non-compulsory setting, so they worry more about access, both people's access to nature, especially those educators in urban settings, and their own access to students. In our experience with nonformal environmental education providers, supported by the educators in this study, school bookings at many nonformal settings drop precipitously at the middle school transition because of more complex schedules, transportation woes, and curriculum alignment issues. At the same time, tweens and teens move away from out-of-school programming at these sites because of increasing demands on their own schedule as well as developmental and social changes (Olsson & Gericke, 2016).

The content and increasing complexity of responses from functional to critical levels in both the issue identification and student EL responses are a good example of Kempton and Holland's (2003) "social environmental identity" framework used in the contextual perspective. In that framework, people progress from salience, becoming aware of environmental issue(s); to viewing themselves as people who are active on environmental issues; and finally to having increasing resources, both knowledge and social, for sustained engagement with environmental issues. The ends of this spectrum can be seen in the educators here. Ethan works with special education students in a public high school, and had just taken a class on environmental science the summer before our interview, and had become aware of both environmental science content and issues. He is at a functional level, but has plans for more advanced behaviors and is eager to learn

more – the salience stage. At the other end is Seth, who is a second career middle schoolteacher who previously worked in outdoor recreation. He had robust behavior, deep knowledge, and was reading environmental books. He has a critical level of EL, which becomes apparent in his responses – they are nuanced, and connect multiple issues, both historic and current, local and global. His environmental identity is clearly at the increasing resources stage.

Interestingly, of the seven formal educators who identified themselves as second-career teachers during interviews, four were at a critical level and three were at the upper end of the cultural level. These educators came from science research, the nonformal environmental education world, outdoor recreation, and government service. This suggests that they bring resources with them, as part of their identity that may influence their EL and their teaching practice. Perhaps looking for a different way of living to address environmental issues that is present at higher levels of EL extends to looking for new ways to approach teaching that facilitates an emphasis on connection and practices.

Further research

One of the short-comings of research with self-selecting participants is that there may be nonresponse bias (Armstrong & Overton, 1977), represented here by the low number of educators with functional level of EL. This research should be extended to a more robust sample which included educators who are not actively engaged in teaching environmental topics, and those who are that are in non-science classrooms, since science teachers are over-represented in this sample. To further understand educator EL, there should be classroom-based research with educators of different levels of EL to see how their EL is enacted in their educational practice.

At the same time, seeing the overlap between environmental identity and literacy, what experiences can we provide for pre-service teachers to help them develop their EL before entering practice? If we view EL as content knowledge for teaching, then at the very least science and social studies teachers should be developing their EL. Looking at the correlation of the conceptual knowledge, issue knowledge, and environmental justice, it is clear that these knowledges are needed as a foundation for more complex ideas, as Stables (1998) suggests, but context within social-ecological systems is also needed. One such avenue for teacher preparation is to provide out of classroom experiences in the community that will develop their knowledge of environmental issues as both social and ecological in nature and as happening to real people. There are several ways to reach this goal: environmental problem-based learning (Hmelo-Silver, 2004), action research (Carr & Kemmis, 2003) or citizen science (Crall, et al., 2013). All can provide experience with the interdisciplinarity of environmental issues, and making room for them in a disciplinary curriculum, which is a problem reported by educators in this study and others (Borg, et al., 2012; Campigotto & Barrett, 2017; Corney, 2006; Hanna, 1992), as well as prepare future educators to use them with their own students. Pedagogies such as these that emphasize participation and engagement may also support systems thinking, which was correlated with conceptual knowledge, behavior, and environmental justice.

Chapter 5. Discussion

This dissertation has investigated educator environmental literacy (EL) from three perspectives: assessing multiple facets quantitatively, examining the relationship between self-efficacy, behavior and identity, and finally implementing a continuum model and looking at the relationship between level of EL, the practice of issue identification, and beliefs about student environmental literacy. These three threads weave together to give a more detailed picture of the contextual perspective and lay the ground work for further study of educator EL.

The contextual perspective of EL has four main facets: knowledge, dispositions, practices, and behavior and it is situated in social-ecological systems that afford and constrain those components. In addition the contextual perspective of EL emphasizes practices for both boundary crossing and EL development, and it views EL on a continuum of developing engagement that expands on Stables (1998).

In Chapter 2, I shared the development and use of the Teacher Environmental Literacy Assessment (TELA). In an attempt to measure practices of issue identification and action planning, the TELA included three environmental scenarios (Figure 3.1). The sample was roughly representative of the educator population in the U.S., slightly over-representing minorities in formal educators and slightly under-representing them in nonformal educators. There appeared to be some concerns with the novel self-efficacy and environmental identity scales, which may be an artifact of the scale or the sample, but needs to be examined more closely. There was strong correlation between knowledge and behavior, which is not typical for previous research, but not an anomaly (Genc & Akilli, 2016; Murphy and Olson, 2008). There were also moderate correlations between

knowledge and environmental identity and issue identification. With the above caution about the self-efficacy, it was also moderately correlated with behavior, knowledge, self-efficacy, Integration of Nature with Self, and knowledge. There were some demographic effects, but perhaps the most interesting one was the difference between nonformal and formal educators. Nonformal educators scored higher than formal educators on knowledge, behavior, issue identification, and strategy selection. Finally, there was a difference in the type of behaviors that experts who completed the scenarios and educators (Figure 2.1). Experts more frequently chose system-level behaviors such as political and legal action, while educators more frequently chose personal level behaviors such as ecomanagement, consumer, and persuasive actions.

This difference between system-level and personal-level behaviors was revisited in Chapter 3, where I described findings from an interview study of a subset of formal and nonformal educators who had taken the TELA. Three main intersecting themes emerged. (1) A group of educators reported low environmental self-efficacy, with three main reasons: their individual contribution was too small in the overall picture, they also engaged in negative environmental behavior than counteracted their positive behavior, and more systemic, organized behavior was needed for real change. (2) While educators ranked system-level behaviors highly for actions they would take to remedy issues that arose from the environmental scenarios, they reported engaging in these types of behavior infrequently. (3) There appeared to be four main reasons why educators did not engage in these system-level behaviors: time, doubt in the political system, inexperience with these types of behavior and lack of confidence in one's ability to do so, and a sense of identity that rejected political and activist components.

Chapter 4 combines TELA and interview data to examine the relationship between EL level, issue identification, and how educators perceived their role in student EL. I further elaborated on the traits associated with Stables' (1998) continuum, and expanding it to include multiple types of knowledge, behavior, and issue identification practice, then created criteria for each level. Using data extracted from the full TELA, I assigned educators to a functional, cultural, or critical level of EL. This was then confirmed using a principal components analysis and cluster analysis. The adapted TELA appeared to discriminate between levels, with some overlap, as expected from a continuum. Using this level assignment, I analyzed responses to interview prompts about the reasons they identified issues in the land development and electronics waste scenarios and where they would place the waste disposal site in the electronics waste scenario. In general, educators with more advanced EL provided reasons that were more elaborate, more technical, and that more fully integrated social components of issues. Responses to interview questions on their roles in student EL showed that while educators at all levels saw developing positive dispositions, it was only at higher levels that knowledge and practices gained prominence. A theme of connection – between students and the environment, between environmental knowledge and issues and student lives – emerged in analysis, and was also more prevalent in later levels of EL. Finally, there were no differences in the view of barriers to student EL between educators at different levels, but issues of access – to the environment, but also to students – was present only with nonformal educators.

Implications

The contextual perspective is a novel framework for EL that pulls together situated learning theory (Lave and Wenger, 1991; Wenger, 1999), previous framings of EL and implicit values of those frameworks, such as the importance of context. By putting context at the forefront of EL, it recognizes the importance of the intersection of social and ecological forces. Its emphasis on practices and participation driving the advancement of one's EL and assisting in the movement between social-ecological systems aligns it with work on social environmental identity (Kempton & Holland, 2003; Stapleton, 2015) which emphasizes the importance of participation and identification to sustained environmental action, which is the ultimate measure of EL.

The findings from this dissertation reveal interesting findings for the contextual perspective. First, the principal components analysis indicated that the first component was composed of behavior, knowledge, and the practices of issue identification and strategy selection. This provides further support that participation, represented by changing knowledge, behavior, and practices, are key to environmental literacy, providing more explanation of variance in scores than dispositions. This relationship between knowledge, EL level, and issue identification is echoed by interview participants in Chapter 4. As the level of EL increased, explanations for issue identification became more technical and elaborate.

In the shortened version of the TELA, there is no longer a correlation between behavior and any other scale other than systems thinking. This is possibly because of the change in behavior scoring, with system-level behaviors weighted more than personal-level behaviors. These more significant behaviors were relatively uncommon in the

subsample, for the reasons described above. In addition, there was a moderate correlation between systems thinking and INS, supporting the importance of social-ecological systems in the conceptual perspective.

An understanding of the social aspects of environmental issues, such as environmental (in)justice is key to the critical level of EL. The environmental justice from the knowledge scale on the full TELA was pulled out as its own scale for the shortened TELA, and correlated moderately with conceptual knowledge, issue knowledge, and systems thinking. That said, only 2 of the 46 interview participants scored a maximum score of 3 on the scale, though many of those scoring 2's could provide examples when given the definition of environmental justice, and it was reflected in their siting decisions in Chapter 4. This is an area that needs to be addressed in further refinement of the scale and in work with educators.

Future research

One of the necessary next steps is to use the TELA with a broader audience of educators and one with less likelihood of a nonresponse bias (Armstrong & Overton, 1977). This study should better represents educators without an interest in environmental education, and that better represent non-science subjects. In the full sample, 71% of respondents taught at least some science. This clearly is not disciplinarily representative of the formal teaching population, though it may more closely represent the nonformal educator population, which often teaches multiple disciplines. This broader testing may also make clear whether the issues with the self-efficacy and environmental identity scales are because of the constructed scale or sampling bias.

While some of the findings are tied directly to being an educator, such as the views of student EL, other findings, such as demographic effects on the TELA and the effect of EL level on issue identification rationale, may be applicable beyond educators. The TELA and the modified short version from Chapter 4 can be used with any adult audience. Indeed, it may be informative to compare educators in multiple settings with non-educator adults on overall environmental literacy and to look for similar effects found in Chapter 3 – the feelings that individual actions can't make an impact, and the negative identification towards the labels "political" and "activist".

Future study with educators should expand to address how educator EL is enacted in instruction. With a combination of instructor observation and curriculum (at both district and classroom levels) analysis, such a study could build on the findings which describe differences in educators' views of student EL at different points of the continuum. This would be particularly interesting with regard to "controversial" topics, both local and global, building on the growing body of quantitative work on climate change education (e.g. Anderson, 2012; Lombardi & Sinatra, 2013; Wise, 2010). Also of interest is how an educator's identity as political or not may impact instruction, particularly in social-ecological systems that are conservative versus those that re generally progressive.

Implications for Practice

How do we implement the findings from this dissertation to work with in-service and pre-service educators? First, based on the initial TELA findings, educators overall had moderate levels of knowledge, INS, and issue identification and a low level of behavior, with nonformal educators scoring significantly higher on the measures of

knowledge, behavior, environmental identity and issue identification. One potential path to increasing formal educator EL is to include more environmental education in teacher preparation courses. Previous research (Amirshokoohi, 2010; Pe'er, Goldman, & Yavetz, 2007) has found low levels of EL in pre-service teachers. Others have found it is dependent on major (Goldman, Ayalon, Baum & Haham, 2015), though Goldman, Yavetz, and Pe'er (2014) found that environment-affiliated majors in a teacher education program only attributed gains in knowledge to their course of study and actually became more anthropocentric in their values over the course of study. In the contextual perspective, participation and practices go hand in hand with changing knowledge, together moving one across the continuum of increasing EL. Similarly, Kempton and Holland (2003) describe a movement beyond salience of environmental issues that takes place with increasing participation in the environmental community. Yet Campigotto and Barrett (2017), in their study of student teachers who were actively involved in environmental activism and volunteer experiences in a province that required environmental integration in the curriculum report that students felt there was no place in the pre-service curriculum for that activist role in a curriculum that leans heavily on disciplinary curriculum guidelines, and neglects students experiences outside of the classroom.

So how to include these types of experiences in teacher preparation programs is the next question. Dada, Eames, and Calder (2017) found that a survey course for pre-service teachers in New Zealand which covered environmental and sustainability topics and environmental education topics resulted in little overall change in knowledge, but increased confidence in teaching environmental topics. They suggest deeper dives into

topics, and include action strategies, which could transfer to behavior. Such deeper dives could take two potential forms. First, partnerships with environmentally active undergrad and graduate students from environmental fields and environmentally literate in-service teachers have the potential to change participation, develop boundary-crossing practices, and increase EL. Second, environmental problem-based learning (Barrows, 1986; Hmelo-Silver, 2004) holds promise for helping teachers and students grapple with complex environmental issues and develop EL practices that will assist in boundary-crossing. Both are promising avenues for research/practice programs. While there is a still a great deal to be learned about educator EL, the research described in this dissertation provides a strong foundation to build upon as we continue to research the topic, and potential paths for practice in teacher preparation and professional development.

References

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research*, *81*(2), 132–169.

Amirshokoohi, A. (2010). Elementary Pre-service Teachers ' Environmental Literacy and Views Toward Science , Technology , and Society (STS) Issues. *Science Educator*, *19*(1), 56–63.

Anderson, A. (2012). Climate change education for mitigation and adaptation. *Journal of Education for Sustainable Development*, *6*(2), 191-206.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, *14*(3), 396–402. https://doi.org/10.1177/002224377701400320

Ball, D. L., Thames, M. H., Phelps, G., Loewenberg Ball, D., Thames, M. H., & Phelps, G. (2008). Content Knowledge for Teaching: What Makes It Special? *Journal of Teacher Education*, *59*(5), 389–407. http://doi.org/10.1177/0022487108324554

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freedman & Company.

Barrows, H. S. (1986). A taxonomy of problem-based learning methods. *Medical Education*, *20*(6), 481-486.

Berkes, F., Folke, C., & Colding, J. (Eds.). (2000). *Linking social and ecological systems: management practices and social mechanisms for building resilience*. Cambridge University Press.

Blodgett, A. D. (2006). An analysis of pollution and community advocacy in "Cancer Alley": Setting an example for the environmental justice movement in St James Parish, Louisiana. *Local Environment*, *11*(6), 647–661. http://doi.org/10.1080/13549830600853700

Borg, C., Gericke, N., Höglund, H. O., & Bergman, E. (2012). The barriers encountered by teachers implementing education for sustainable development: Discipline bound differences and teaching traditions. *Research in Science and Technological Education*, *30*(2), 185–207. https://doi.org/10.1080/02635143.2012.699891

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101.

Campigotto, R. and Barrett, S. E. (2017) Creating space for teacher activism in environmental education: Pre-service teachers' experiences. *Canadian Journal of Environmental Education, 22*, 42-57.

Carr, W., & Kemmis, S. (2003). *Becoming critical: education knowledge and action research*. Routledge.

Chen, M. (2015). Self-efficacy or collective efficacy within the cognitive theory of stress model: Which more effectively explains people's self-reported proenvironmental behavior? *Journal of Environmental Psychology*, *42*, 66–75. https://doi.org/10.1016/j.jenvp.2015.02.002

Cheng, I. N. Y., & So, W. W. M. (2015). Teachers' environmental literacy and teaching - stories of three Hong Kong primary school teachers. *International Research in Geographical and Environmental Education*, *24*(1), 58–79. https://doi.org/10.1080/10382046.2014.967111

Chua, F. (2016). *How do experts and novices think about climate change? Thinking routines as learning and assessment tools*. Harvard Univeristy. Retrieved from

https://dash.harvard.edu/handle/1/27112690
Clayton, S. (2003). Environmental identity: A conceptual and an operational definition. In Clayton, S. and Opotow, S. (Eds) *Identity and the natural environment: The psychological significance of nature.* (45-65). Cambridge: MIT Press.
Corney, G. (2006). Education for sustainable development : An empirical study of the tensions and challenges faced by geography student teachers. *International Research in Geographical and Environmental Education*, *15*(3), 224–241. https://doi.org/10.2167/irgee194.0
Coyle, K. (2005). *Environmental Literacy in America*. Washington, D.C.
Crall, A. W., Jordan, R., Holfelder, K., Newman, G. J., Graham, J., & Waller, D. M. (2013). The impacts of an invasive species citizen science training program on participant attitudes, behavior, and science literacy. *Public understanding of Science*, *22*(6), 745-764.
Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Los Angeles: Sage.
Crutzen, P. J. (2002). Geology of mankind. *Nature*, *415*, 2002.
Crutzen, P. J., & Stoermer, E. F. (2000). The "Anthropocene." *Global Change Newsletter*, *41*, 17–18.
Cutter-Mackenzie, A., & Smith, R. (2001). Gauging primary school teachers' environmental literacy. *Australian Association for Research Education International Education Research Conference*, *2*(2), 45–60. Retrieved from http://epubs.scu.edu.au/educ_pubs/555
Dada, D. O., Eames, C., & Calder, N. (2017). Impact of environmental education on beginning preservice teachers' environmental literacy. *Australian Journal of Environmental Education*, *33*(3), 201–222. https://doi.org/10.1017/aee.2017.27
Dunlap, R. E. (2008). The New Environmental Paradigm scale: From marginality to worldwide use. *The Journal of Environmental Education*, *40*(1), 3–19.
Erdogan, M., & Ok, A. (2011). An assessment of Turkish young pupils' environmental literacy: A nationwide survey. *International Journal of Science Education*, *33*(17), 2375–2406. http://doi.org/10.1080/09500693.2010.550653
Ernst, J. (2007). Factors associated with k-12 teachers' use of environment-based education. *Journal of Environmental Education*, *38*(3), 15–31. https://doi.org/10.3200/JOEE.38.3.15-32
Genc, M., & Akilli, M. (2016). Modeling the relationships between subdimensions of environmental literacy. *Applied Environmental Education and Communication*, *15*(1), 58–74. https://doi.org/10.1080/1533015X.2016.1141724
Glaser, M., Krause, G., Ratter, B., & Welp, M. (2008). Human/nature interaction in the Anthropocene: Potential of social-ecological systems analysis. *Gaia*, *17*(1), 77–80.
Goldman, D., Ayalon, O., Baum, D., & Haham, S. (2015). Major matters : Relationship between academic major and university students' environmental literacy and citizenship as reflected in their voting decisions and environmental activism. *International Journal of Environmental & Science Education*, *10*(5), 671–693. https://doi.org/10.12973/ijese.2015.260a
Goldman, D., Yavetz, B., & Pe'er, S. (2014). Student teachers' attainment of environmental literacy in relation to their disciplinary major during undergraduate studies. *International Journal of Environmental & Science Education*, *9*(4), 369–

383. https://doi.org/10.12973/ijese.2014.222a
Greenberg, M. R. (2004). Concern about environmental pollution: How much difference do race and ethnicity make? A New Jersey case study. *Environmental health perspectives*, *113*(4), 369-374.
Gupta, R., Fraser, J., Shane-Simpson, C., Danoff-Burg, S., & Ardalan, N. (2018). Estimating scale, diversity, and professional training of environmental educators in the U.S. *Environmental Education Research*, *4622*, 1–17. https://doi.org/10.1080/13504622.2018.1435778
Hanna, G. (1992). Overcoming barriers to implementing outdoor and environmental edcuation. In *Proceedings of the AEE 20th International Conference.* (pp. 77–84).
Hanss, D., & Böhm, G. (2010). Can I make a difference ? The role of general and domain-specific self-efficacy in sustainable consumption decisions. *Umweltpsychologie*, *14*(2), 46–74.
Hart, P. S. (2011). One or many? The influence of episodic and thematic climate change frames on policy preferences and individual behavior change. *Science Communication*, *33*(1), 28–51. https://doi.org/10.1177/1075547010366400
Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *The Journal of environmental education*, *18*(2), 1-8.
Hmelo-Silver, C. E. (2004). Problem-based learning: what and how do students learn ? *Educational Psychology Review*, *16*(3), 235–266.
Hodgkinson, S. P., & Innes, J. M. (2001). The Attitudinal Influence of career orientation in 1st-year university students: Environmental attitudes as a function of degree choice. *The Journal of Environmental Education*, *32*(3), 37–40. https://doi.org/10.1080/00958960109599144
Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). *Developing a framework for assessing environmental literacy*. Washington, DC.
Hsu, S.-J., & Roth, R. E. (1998). An assessment of environmental literacy and analysis of predictors of reponsible environmental behaviour held be secondary teachers in the Hualien area of Taiwan. *Environmental Education Research*, *4*(3), 229–259.
Hsu, S. (2004). Thee ffects of an environmental education program on responsible environmental behavior and associated environmental literacy variables in Taiwanese college students. *The Journal of Environmental Education*, *35*(2), 37–49.
Huang, H. (2016). Media use, environmental beliefs, self-efficacy , and pro-environmental behavior. *Journal of Business Research*, *69*(6), 2206–2212. https://doi.org/10.1016/j.jbusres.2015.12.031
Hug, J. (1977). Two hats. In J. Aldrich (Ed.), *The Report of the North American Regional Seminar on Environmental Education. A confrontation with the issues: Environmetnal education for the real world* (p. 75). Columbus: Ohio State University.
Hungerford, H. and Peyton, R.B. (1980). A paradigm for citizen responsibility: Environmental action. *Current Issues VI*, *400*(166), 0-0.
Hungerford, H. R., & Tomera, A. N. (1977). *Science in the Elementary School: A Worktext*. Stipes.
Hungerford, H., & Volk, T. (1990). Changing Learner Behavior through Environmental

Education. *Journal of Environmental Education*, *21*(3), 8–21.
Iles, A. (2004). Mapping environmental justice in technology flows: Computer waste impacts in Asia. *Global Environmental Politics*, *4*(4), 76–107. http://doi.org/10.1162/glep.2004.4.4.76
IPBES. (2019). Global Assessment Summary for Policymakers. Paris: IPBES. Accessed on May 10 at https://www.ipbes.net/news/ipbes-global-assessment-summary-policymakers-pdf
IPCC. (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley, (Eds.). Cambridge: Cambridge University Press. doi:10.1017/CBO9781107415324.
Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14–26. http://doi.org/10.3102/0013189X033007014
Kaplowitz, M. D., & Levine, R. (2005). How environmental knowledge measures up at a Big Ten university. *Environmental Education Research*, *11*(2), 143–160. https://doi.org/10.1080/1350462042000338324
Kempton, W., & Holland, D. C. (2003). Identity and sustained environmental practice. In Susan D. Clayton, Susan Opotow (Eds.) *Identity and the natural environment: The psychological significance of nature*, 317-341. Cambridge: MIT Press.
Lave, J. (1991). Situating Learning in Communities of Practice. *Perspectives on Socially Shared Cognition*, *2*, 63–82. https://doi.org/10.1037/10096-003
Lave, J. (2009). The practice of learning. In K. Illeris (Ed.) *Contemporary theories of learning: Learning theorists… in their own words.* New York: Routledge. 200-208.
Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation* . Cambridge: Cambridge University Press.
Liu, S. Y., Yeh, S. C., Liang, S. W., Fang, W. T., & Tsai, H. M. (2015). A national investigation of teachers environmental literacy as a reference for promoting environmental education in Taiwan. *Journal of Environmental Education*, *46*(2), 114–132. https://doi.org/10.1080/00958964.2014.999742
Lloyd-strovas, J., Moseley, C., & Arsuffi, T. (2018). Environmental literacy of undergraduate college students: Development of the environmental literacy instrument (ELI). *School Science and Mathematics*, *118*, 84–92. https://doi.org/10.1111/ssm.12266
Lombardi, D., & Sinatra, G. M. (2013). Emotions about teaching about human-induced climate change. *International Journal of Science Education*, *35*(1), 167-191.
Lu, H., Liu, X., Chen, H., Long, R., & Yue, T. (2017). Who contributed to "corporation green" in China ? A view of public- and private-sphere pro-environmental behavior among employees. *Resources, Conservation and Recycling*, *120*, 166–175. https://doi.org/10.1016/j.resconrec.2016.12.008
Marcinkowski, T. (1991). The relationship between environmental literacy and responsible environmental behavior in environmental education. *Methods and techniques for evaluating environmental education.* Paris: UNESCO.
Marquart-Pyatt, S. T. (2012). Explaining environmental activism across countries across countries. *Society & Natural Resources*, *25*(7), 683–699.

https://doi.org/10.1080/08941920.2011.625073
Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, *24*(4), 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001
McBeth, W., Hungerford, H. R., Marcinkowski, T., Volk, T. L., & Meyers, R. (2008). National Environmental Literacy Assessment Project: Year 1, National Baseline Study of Middle Grades Students Final Research Report. Retrieved from http://www.epa.gov/education/docs/MASTERNELA_Year1Report_081208_.pdf%5Cnhttp://www.oesd.noaa.gov/outreach/reports/Final_NELA_minus_MSELS_8-12-08.pdf
Merriam-Webster. (2019). Dictionary by Merriam-Webster: America's most-trusted online dictionary. Accessed May 4, 2019. https://www.merriam-webster.com/dictionary/activism
Murphy, T. P., & Olson, A. M. (2008). *The Third Minnesota Report Card on Environmental Literacy: A survey of adult environmental knowledge , attitudes and behavior*. St. Paul, MN.
Negev, M., Sagy, G., Garb, Y., Salzberg, A., & Tal, A. (2008). Evaluating the environmental literacy of Israeli elementary and high school students. *The Journal of Environmental Education*, *39*(2), 3–20. https://doi.org/10.3200/JOEE.39.2.3-20
Nisbet, E. K., & Zelenski, J. M. (2013). The NR-6: A new brief measure of nature relatedness. *Frontiers in Psychology*, *4*, 1–11. https://doi.org/10.3389/fpsyg.2013.00813
Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The Nature Relatedness Scale: Linking individuals' connection with nature to environmental concern and behavior. *Environment and Behavior*, *41*(5), 715–740.
NSIDC (2018). Springtime for the Arctic. Retrieved from http://nsidc.org/arcticseaicenews/2018/06/springtime-for-the-arctic/
Olson, M. E. (1981). Consumers' attitudes toward energy conservation. *Journal of Social Issues*, *37*, 108-131.
Olsson, D., & Gericke, N. (2016). The adolescent dip in students' sustainability consciousness - Implications for education for sustainable development. *Journal of Environmental Education*, *47*(1), 35–51. https://doi.org/10.1080/00958964.2015.1075464
Ozsoy, S., Ertepinar, H., & Saglam, N. (2012). Can eco-schools improve elementary school students' environmental literacy levels ? *Asia-Pacific Forum on Science Learning and Teaching*, *13*(2), 1–26.
Pe'er, S., Goldman, D., & Yavetz, B. (2007). Environmental literacy in teacher training: Attitudes, knowledge, and environmental behavior of beginning students. *The Journal of Environmental Education*, *39*(1), 45-59.
Peyton, R. B., & Hungerford, H. R. (1980). An assessment of teachers' abilities to identify, teach, and implement environmental action skills. In A. B. Sacks, L. L. Burrus-Bammel, C. B. Davis, & L. A. Iozzi (Eds.), *Current issues VI: The yearbook of environmental education and environmental studies.* (pp. 155–172). Washington, D.C.: ERIC.
Rochman, C. M., Tahir, A., Williams, S. L., Baxa, D. V., Lam, R., Miller, J. T., … Teh, S. J. (2015). Anthropogenic debris in seafood: Plastic debris and fibers from textiles

in fish and bivalves sold for human consumption. *Scientific Reports*, *5*, 1–10. http://doi.org/10.1038/srep14340

Roth, C. E. (1992). *Environmental literacy: Its roots, evolution and directions in the 1990s*. Columbus, OH.

Saltan, F., & Divarci, O. F. (2017). Using blogs to improve elementary school students' environmental literacy in science class. *European Journal of Educational Research*, *6*(3), 347–355. https://doi.org/10.12973/eu-jer.6.3.347

Saylan, C., & Blumstein, D. (2011). *The failure of environmental education (and how we can fix it)*. Berkeley: University of California Press.

Schmitt, M. T., Mackay, C. M. L., Droogendyk, L. M., & Payne, D. (2019). What predicts environmental activism ? The roles of identification with nature and politicized environmental identity. *Journal of Environmental Psychology*, *61*(March 2018), 20–29. https://doi.org/10.1016/j.jenvp.2018.11.003

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4–14.

Schultz, P. W. (2002a). Environmental attitudes and behaviors across cultures. https://doi.org/10.9707/2307-0919.1070

Schultz, P. W. (2002b). Inclusion with nature: The psychology of human-nature relations. In S. W. P. Schmuck P. (Ed.), *Psychology of Sustainable Developmentvelopment.* (pp. 61–78). Boston: Kluwer Academic.

Schultz, P. W. (2002c). Inclusion with nature: The psychology of human-nature relations. In W. P. S. Peter Schmuck (Ed.), *Psychology of Sustainable Development* (pp. 61–78). Boston, MA: Springer.

Schultz, P. W., Shriver, C., Tabanico, J. J., & Khazian, A. M. (2004). Implicit connections with nature. *Journal of Environmental Psychology*, *24*(1), 31–42. https://doi.org/10.1016/S0272-4944(03)00022-7

Schutte, N. S., & Bhullar, N. (2017). Approaching environmental sustainability : Perceptions of self-efficacy and changeability. *The Journal of Psychology*, *151*(3), 321–333. https://doi.org/10.1080/00223980.2017.1289144

Shin, D., Chu, H., Lee, E., Ko, H., Lee, M., Kang, K., Min, B., & Park, J. (2005). An assessment of Korean students' environmental literacy. *Journal of the Korean Earth Science Society*, *26*(4), 358-364.

Sia, A., Hungerford, H. R., & Tomera, A. N. (1980). Selected predictors of environmental behavior: An analysis. *Journal of Environmental Education*, *17*(2), 31–40.

Stables, A. (1998). Environmental Literacy: functional, cultural, critical. The case of the SCAA guidelines. *Environmental Education Research*, *4*(2), 155–164. https://doi.org/10.1080/1350462980040203

Stables, A., & Bishop, K. (2001). Weak and strong conceptions of environmental literacy: Implications for environmental education. *Environmental Education Research*, *7*(1), 89–97.

Stapleton, S. R. (2015). Environmental identity development through social interactions, action, and recognition. *Journal of Environmental Education*, *46*(2), 94–113. https://doi.org/10.1080/00958964.2014.1000813

Stapp, W. B. The concept of environmental education. *Environmental Education*, *1*(1), 30-31.

Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, & Human Values*, *35*(5), 601–617. https://doi.org/10.1177/0162243910377624

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, "translations" and boundary objects : Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology. *Social Studies of Science*, *19*(3), 387–420.

Steffen, W., Crutzen, P. J., & Mcneill, J. (2007). The Anthropocene : Are humans now overwhelming the great forces of nature. *AMBIO A Journal of the Human Environment*, *36*(8), 614–621. http://doi.org/10.1579/0044-7447(2007)36

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, *56*(3), 407–424. https://doi.org/10.1111/0022-4537.00175

Stevenson, K. T., Peterson, M. N., Bondell, H. D., Mertig, A. G., & Moore, S. E. (2013). Environmental, Institutional, and Demographic Predictors of Environmental Literacy among Middle School Children. *PLoS ONE*, *8*(3). https://doi.org/10.1371/journal.pone.0059519

Summers, M., Corney, G., & Childs, A. (2003). Teaching sustainable development in primary schools: An empirical study of issues for teachers. *Environmental Education Research*, *9*(3), 327–346. https://doi.org/10.1080/13504620303458

Swanepoel, C. H., Loubser, C. P., & Chacko, C. P. C. (2002). Measuring the environmental literacy of teachers. *South African Journal of Education*, *22*(4), 282–285.

Tabernero, C., & Hernandez, B. (2011). Self-efficacy and intrinsic motivation guiding environmental behavior. *Environment and Behavior*, *43*(5), 658–675. https://doi.org/10.1177/0013916510379759

Taylor, D. (2018). *Diversity in Environmental Organizations: Reporting and Transparency* (Vol. 1). Ann Arbor, MI.

Tikka, P. M., Kuitunen, M. T., & Tynys, S. M. (2000). Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. *The Journal of Environmental Education*, *31*(3), 12-19.

Tuomi-Grohn, T., Engestrom, Y., & Young, M. (2003). From transfer to boundary-crossing between school and work as a tool for developing vocational education. In T. Tuomi-Grohn and Y. Engestrom (Eds.) *Between school and work: New perspectives on transfer and boundary-crossing.* Amsterdam: Pergamon.

Ünal, A. B., Steg, L., & Gorsira, M. (2018). Values versus environmental knowledge as triggers of a process of activation of personal norms for eco-driving. *Environment and Behavior*, *50*(10), 1092–1118. https://doi.org/10.1177/0013916517728991

UNESCO. (1977) The Tbilisi Declaration. In *Intergovernmental Conference on Environmental Education* (pp. 14-26).

Volk, T. L., Hungerford, H. R., & Tomera, A. N. (1984). A national survey of curriculum needs as perceived by professional environmental educators. *The Journal of Environmental Education*, *16*(1), 10-19.

Wenger, E. (1999). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Whyte, K. P. (2017). Tthe Dakota Access Pipeline, environmental injustice, and U.S. colonialism. *Red Ink*, *19*(1), 154–169. http://doi.org/10.1002/9781118241455.fmatter

Wieczorek, A. M., Morrison, L., Croot, P. L., Allcock, A. L., MacLoughlin, E., Savard, O., … Doyle, T. K. (2018). Frequency of microplastics in mesopelagic fishes from the Northwest Atlantic. *Frontiers in Marine Science, 5*, 1–9. http://doi.org/10.3389/fmars.2018.00039

Wise, S. B. (2010). Climate change in the classroom: Patterns, motivations, and barriers to instruction among Colorado science teachers. *Journal of Geoscience Education, 58*(5), 297-309.

Acknowledgment of previous publication

The papers included in chapters 2-4 have been submitted for publication in the following form:

Chapter 2 The TELA: A new tool for assessing educator environmental literacy.
Hunter, R. and Jordan, R.
Submitted to *The Journal of Environmental Education*

Chapter 3 Educator environmental literacy: the intersection of self-efficacy, behavior, and identity.
Hunter, R. and Jordan, R.
Submitted to *Environmental Education Research*

Chapter 4 Developing critical thinkers and creating new solutions: The effects of educators' level of environmental literacy on their view of student environmental literacy and issue identification practices.
Hunter, R. and Jordan, R.
Submitted to *Environmental Education Research*

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Appendix A. Teacher Environmental Literacy Assessment (TELA)

Note for administering the TELA:

The TELA is designed using a contextual perspective, which views environmental literacy as embedded within social-ecological systems. This is especially pertinent in the Scenarios portion of the TELA. The issue identification and strategy selection questions in the Scenarios portion are designed to be scored against the responses of environmental experts from the local social-ecological system. In the research presented here, those were environmental professionals from academia, state agencies, and environmental non-profits in the state of New Jersey.

Scoring issue identification

Calculate the frequency of response for each issue choice in the expert sample and determine the top three responses. Assign the most frequent response a value of 3, the second-most frequent response a value of 2, and the third most frequent response a value of 1.

Use those values to score TELA respondents' choices. See the scoring example for Scenario 2 Issue Identification below:

Scenario 2 Expert responses and scoring value

Choice	***Points***
Intro toxins	3
Disproportionate	2
Harm groundwater	1

For example, the response in Scenario 2:

The placement of the waste disposal plant could damage wildlife habitat. 0 points

The waste disposal plant could introduce toxins into a community. 3 points

Would equal **3 points.**

The response

The waste disposal plant could introduce toxins into a community. 3 points

The waste disposal plant will harm groundwater and drinking water sources.

1 point

Would equal **4 points**

Strategy selection

Strategy selection responses are useful in illuminating patterns within the TELA sample, and for pre-post changes in individuals.

Of most importance in these selections are the top three responses. Calculate the frequency of expert responses at each rank – the top three responses at rank order 1, the top three responses at rank order 2, and the top three responses at rank 3. Then score responses for the TELA sample at each of the top three ranks. So if a respondent choices were the same as the expert responses at ranks 1, 2, and 3, they would have a score of nine (3 points for rank 1, 3 points for rank 2, and 3 points for rank 3). If a respondent chose the second most likely first rank response (2 points), the first most likely second choice (3 points), and a choice that was not highly ranked by experts, they would have a

score of 5. If there was no agreement at all, the score would be 0. See the scoring for a Scenario 2 response below:

Scoring a strategy choice response

TELA respondent choices							*Choice Scores*			
Strat Eco	Strat Pers	Strat Cons	Strat Pol	Strat Legal	Strat Other	Other -Text	*Rank 1*	*Rank 2*	*Rank 3*	***S2 Strat Score***
2	3	1	4	5	6		*0*	*0*	*2*	**2**

Rank 1 = Consumer
Rank 2 = Eco-management
Rank 3 = Persuasion

Scenario 2 Expert ranking and points

Rank 1	**points**
persuasion	3
legal	2

Rank 2	**Points**
Political	3
Legal	2

Rank 3	**Points**
Consumer	3
persuasion	2
ecomanagement	2
legal	2

TELA items

There are many different kinds of animals and plants, and they live in many different types of environments. What is the word used to describe this idea?

- ○ Multiplicity
- ○ Biodiversity
- ○ Socio-economics
- ○ Evolution
- ○ Don't know

Carbon monoxide is a major contributor to air pollution in the U.S. Which of the following is the biggest source of carbon monoxide?

- ○ Factories and businesses
- ○ People breathing
- ○ Motor vehicles
- ○ Trees
- ○ Don't know

How is most of the electricity in the U.S. generated? Is it….

- ○ By burning oil, coal, and wood
- ○ With nuclear power
- ○ Through solar energy
- ○ At hydro-electric plants
- ○ Don't know

What is the most common cause of pollution of streams, rivers, and oceans? Is it…

- ○ Dumping of garbage by cities
- ○ Surface water running off yards, streets, paved lots, and farm fields
- ○ Trash washed into the ocean from beaches
- ○ Waste dumped by factories
- ○ Don't know

Which of the following is a renewable resource?

- ○ Oil
- ○ Iron ore
- ○ Trees
- ○ Coal
- ○ Don't know

Ozone forms a protective layer in the earth's upper atmosphere. What does ozone protect us from? Is it…

- ○ Acid rain
- ○ Global warming
- ○ sudden changes in temperature
- ○ Harmful, cancer-causing sunlight
- ○ Don't know

Where does most of the garbage in the U.S. end up?

- ○ Oceans
- ○ Incinerators
- ○ Recycling centers
- ○ Landfills
- ○ Don't know

What is the name of the primary federal agency that works to protect the environment? Is it the…

- ○ Environmental Protection Agency (the EPA)
- ○ Department of Health, Environment, and Safety (the DHES)
- ○ National Environmental Agency (the NEA)
- ○ Federal Pollution Control Agency (the FPCA)
- ○ Don’t know

Which of the following household wastes is considered hazardous waste? Is it…

- ○ Plastic packaging
- ○ Glass
- ○ Batteries
- ○ Spoiled food
- ○ Don't know

What is the most common reason that an animal species becomes extinct? Is it because...

- ○ Pesticides are killing them
- ○ Their habitats are being destroyed by humans
- ○ There is too much hunting
- ○ There are climate changes that affect them
- ○ Don't know

Melting of Arctic snow and ice will likely result in rising sea levels.

- ○ True
- ○ False

Scientists have not determined the best solution for disposing of nuclear waste. In the U.S., what do we do with it now? Do we...

- ○ Use it as nuclear fuel
- ○ Sell it to other countries
- ○ Dump it in landfills
- ○ Store and monitor the waste
- ○ Don't know

What is the primary benefit of wetlands? Do they

- ○ Promote flooding
- ○ Help clean the water before it enters lakes, streams, rivers, or oceans
- ○ Help keep the number of undesirable plants and animals low
- ○ Provide good sites for landfills
- ○ Don't know

How long does it take for C02 in the atmosphere to disperse?

- ○ 20 years
- ○ 50 years
- ○ 75 years
- ○ 100 years

Dispositions

Self-efficacy

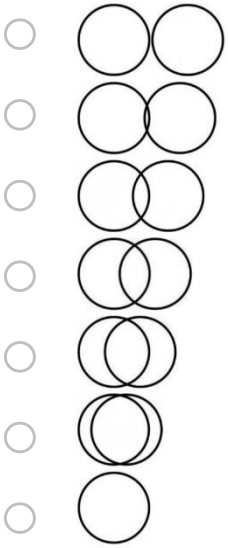
Where would you place yourself on each of the following statements about making a change for the better in the environment? Select the choice that best describes how you feel about the statement.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I feel confident in my ability to create a change in the environment.	○	○	○	○	○	○	○
I can choose behaviors that help the environment.	○	○	○	○	○	○	○
I usually make good choices on environmental issues.	○	○	○	○	○	○	○
I am confident in my ability to work with others to create a change to benefit the environment.	○	○	○	○	○	○	○

Page Break

Integration of Nature in Self

Below, please choose the picture which best describes your relationship with the natural environment, with one circle representing you and the other representing the natural environment. Please answer spontaneously with what comes to your mind first.



Page Break

Environmental Identity

Select the choice which best describes how closely the statement describes you.

	Not at all	Slightly	Not sure	Somewhat	Very much
I feel like I have a strong connection to the environment.	○	○	○	○	○
I am aware of one or more environmental issues.	○	○	○	○	○
I often think about one or more environmental issues.	○	○	○	○	○
I see myself as someone who cares for the environment in one or more ways.	○	○	○	○	○
I believe that I am responsible for taking care of the environment.	○	○	○	○	○
I believe that others are responsible for caring for the environment	○	○	○	○	○
I believe that nature and people are interconnected.	○	○	○	○	○
I have made changes in my life to remedy one or more environmental issues. (8)	○	○	○	○	○

Page Break

Behavior

We can engage with environmental issues in many different ways, depending on the issue and the circumstances around it. Below are some types of ways to address issues.

Eco-management refers to directly working with the environment to improve it – i.e. planting trees, picking up litter, recycling. Have you engaged in eco-management in the last two years?

- ○ Yes
- ○ No

Skip To: Q37 If We can engage with environmental issues in many different ways, depending on the issue and the ci... = No

Page Break

Can you please share some examples?

_____

Persuasion refers to discussing an environmental issue in private or public conversations to inform or convince others of your position on an issue. For educators, this would include discussing environmental issues in the classroom that are *not included in your school curriculum.* Have you engaged in persuasion in the last two years?

- ○ Yes
- ○ No

Skip To: Q41 If Persuasion refers to discussing an environmental issue in private or public conversations to info... = No

Page Break

Can you please share some examples?

_____

_____

Page Break

Consumer action refers to making an impact on an environmental issue through purchasing or not purchasing products. Have you engaged in consumer action in the last two years?

- ○ Yes
- ○ No

Skip To: Q45 If Consumer action refers to making an impact on an environmental issue through purchasing or not pu... = No

Page Break

Can you please share some examples?

_____

_____

Page Break

Political action refers to working within the processes of local, state or federal government to change the outcome of an environmental issue. Have you engaged in political action in the last two years?

- ○ Yes
- ○ No

Skip To: Q49 If Political action refers to working within the processes of local, state or federal government to... = No

Page Break

Can you please share some examples?

_____

_____

Legal action refers to using the enforcement of existing local state, or federal laws to remedy an environmental issue. Have you engaged in legal action in the last two years?

- ○ Yes
- ○ No

Skip To: Q53 If Legal action refers to using the enforcement of existing local state, or federal laws to remedy a... = No

Page Break

Can you please share some examples?

_____

Page Break

Have you engaged in a method of addressing an environmental issue that does not fit into any of the above categories? If so, please explain here.

_____

Page Break

Scenarios (practices)

The following section consists of three scenarios and related questions. Read each scenario and answer the questions to the best of your abilities.

Page Break

Scenario 1
Guy Hubbard is retiring from farming. His farm, totaling 150 acres, is now up for sale. A developer, Jensen Brothers Inc., is interested in purchasing the farm and has applied to the zoning board for a variance to create a multi-use community. This community would introduce both housing and shops to the property.

What are the two most relevant environmental issues generated by this scenario? Pick two.

- [ ] The development will change the water runoff in the area
- [ ] The development will remove a carbon sink and accelerate global warming
- [ ] The development will reduce habitat for local plant and animal species
- [ ] The development will introduce an economic benefit to the area
- [ ] The development will introduce toxins or pollutants into the environment
- [ ] There is a change in the local culture because of the proposed development.
- [ ] There are no environmental issues because of the proposed development.
- [ ] Other (8) _____

Page Break

Which of these strategies would you most likely use to remedy the issue(s) identified above? Drag and drop the options in the list to put them in rank order from 1 (most likely) to 6 (least likely).

_____ Eco-management (directly working with the environment to improve it – i.e. planting trees or picking up litter)

_____ Persuasion (discussing the issue in private or public conversations to convince others of your position on the issue)
_____ Consumer (making an impact on the issue through purchasing or not purchasing products)
_____ Political (working within the local, state or federal government to change the outcome of an issue)
_____ Legal (using the enforcement of existing local state, or federal laws to remedy an environmental issue.)
_____ Other (open response)

Page Break

Which factors would you take into account in deciding what action to take? Drag and drop the options in the list to put them in rank order from 1 (most important) to 4 (least important).
_____ Economic
_____ Social/cultural
_____ Environmental
_____ Other

Page Break

A friend has identified effluent as an important issue with the proposed new land use. At what level is this best handled?

- ○ Personal
- ○ Municipal
- ○ State
- ○ Federal
- ○ I do not know what effluent is

Page Break

Scenario 2

Corporation X has developed a new electronic device, the Thingamajig, which has become very popular. With the increased production, they must decide where to place an additional waste disposal plant. One option is in a rural area that is previously undeveloped, but has a small white population. A second option is in an urban area with low property values and a primarily minority population. The final option is a site overseas in a developing country.

What are the two most relevant environmental issues generated by this scenario? Pick two.

- [ ] The placement of the waste disposal plant could damage wildlife habitat.
- [ ] The placement of the waste disposal plant will create an economic benefit to the community.
- [ ] The waste disposal plant could introduce toxins into a community.
- [ ] The waste disposal plant will create more solid waste.
- [ ] The waste disposal plant will harm groundwater and drinking water sources.
- [ ] The waste disposal plant will disproportionately affect disadvantaged communities.
- [ ] The waste disposal plant will create runoff issues.
- [ ] There are no environmental issues because of the waste disposal plant. (8)
- [ ] Other (9) _____

Page Break

Which of these strategies would you most likely use to remedy the issue(s) identified above? Drag and drop the options in the list to put them in rank order from 1 (most likely) to 6 (least likely).

_____ Eco-management (directly working with the environment to improve it – i.e. planting trees or picking up litter)
_____ Persuasion (discussing the issue in private or public conversations to convince others of your position on the issue.)
_____ Consumer (making an impact on the issue through purchasing or not purchasing products)
_____ Political (working within the local, state or federal government to change the outcome of an issue)
_____ Legal (using the enforcement of existing local state, or federal laws to remedy an environmental issue)
_____ Other

Page Break

Which factors would you take into account in deciding what action to take? Drag and drop the options in the list to put them in rank order from 1 (most important) to 4 (least important).

_____ Economic
_____ Social/cultural
_____ Environmental
_____ Other

Page Break

Which of these resources is most likely to be affected by leachate from waste disposal?

- ○ Air
- ○ Soil
- ○ Water
- ○ I do not know what leachate is

Page Break

The location of hazardous material sites can be an issue of environmental justice. Briefly explain what environmental justice is.

_____

_____

_____

The company decides to locate the waste disposal facility in a developing country. Click the bubble of the appropriate category to sort the following into social, economic and ecological impacts:

	Social	Economic	Ecological
Increased carbon emissions from shipping	○	○	○
Increased jobs in the locale of the waste disposal	○	○	○
Increased exploitation of the world's poor	○	○	○
Increased air and water pollution in the locale of the waste disposal	○	○	○
Supporting technological innovation	○	○	○
Preserve landscapes at home	○	○	○

Page Break

Scenario 3

The Harrison's deer, a small relative of the white-tailed deer that lives in mountainous areas, is being considered for the endangered species list. This would mean it can no longer be hunted, and its habitat may be preserved. International Logging wants to log a large area of land in the middle of the Harrison's deer's range. A group of local people want to preserve the land.
What are the 2 most relevant environmental issues generated by this scenario? Pick two.

- ☐ Logging the land could speed up the extinction of the deer.
- ☐ Preserving the land could damage the local economy.
- ☐ Air pollution from burning logging remnants.
- ☐ Listing the deer as an endangered species.
- ☐ Logging the area will disproportionately affect disadvantaged communities.
- ☐ There are no environmental issues because of the logging.
- ☐ Other _____

Page Break

Which of these strategies would you most likely use to remedy the issue(s) identified above? Drag and drop the options in the list to put them in rank order from 1 (most likely) to 6 (least likely).

_____ Eco-management (directly working with the environment to improve it – i.e. planting trees or picking up litter)
_____ Persuasion (discussing the issue in private or public conversations to convince others of your position on the issue.)
_____ Consumer (making an impact on the issue through purchasing or not purchasing products)
_____ Political (working within the local, state or federal government to change the outcome of an issue)
_____ Legal (using the enforcement of existing local state, or federal laws to remedy an environmental issue)
_____ Other

Which factors would you take into account in deciding what action to take? Drag and drop the options in the list to put them in rank order from 1 (most important) to 4 (least important).

_____ Economic
_____ Social/cultural
_____ Environmental
_____ Other

Page Break

Harrison's deer is not listed as endangered, and International Logging logs the land in the middle of the Harrison's deer's range, but they must make land management decisions that promote genetic diversity in the species. Which are ways that they can achieve that goal?

- ○ Fund a zoo exhibit of the deer
- ○ Log only during certain hours of the day
- ○ Provide wildlife corridors across the logging areas
- ○ Move all the deer to one section of the range

Page Break

Logging International decided to move all the deer to half of the range and log the other half. What are some threats to the deer population in this smaller area?

_____

_____

_____

Page Break

The logging pushes the Harrison's deer to extinction. Which is a likely effect of the loss of the species?

- ○ A die-off of large trees in the area
- ○ A change in forest plant structure
- ○ An increase in flooding in the area
- ○ A change in wildlife structure

Page Break

Demographics

This final set of questions is for classification purposes only. As stated at the beginning of the survey, we have no way of linking your answers to these or any questions to your identity. This is the last set of questions.

Page Break

What is your gender?

- ○ Male
- ○ Female
- ○ Other
- ○ I prefer not to say

Do you identify as Hispanic, Latina/o, or of Spanish origin?

- ○ Yes
- ○ No

What race do you consider yourself to be?

- White
- Black or African American
- American Indian or Alaska Native
- Asian American / Pacific Islander
- Other/More than one race

What is the highest level of education you have attained?

- Less than high school
- High school graduate/GED/Equivalent
- Some college
- Associate's degree
- Bachelor's degree
- Some graduate or professional school
- Master's degree (MA, MS, MFA, MF, MSN, etc.)
- Doctoral degree (MD, PhD, DO, DVM, etc.) (8)

How would you describe yourself financially?

- ○ Struggling
- ○ Stable
- ○ Comfortable
- ○ Affluent

Which of the following categories best describes the area where you live?

- ○ Urban (city center with dense housing)
- ○ Suburban (just outside the city, with more spread out housing)
- ○ Rural (far away from a city, with very wide-spread housing)

Which setting do you teach in?

- ○ Public School
- ○ Private school
- ○ Afterschool program
- ○ Nonformal site (aquarium, museum, nature center, zoo, etc.)

What grades do you most often teach?

- ○ K-2
- ○ 3-5
- ○ 6-8
- ○ 9-12
- ○ Other _____

What subject(s) do you teach?

- [ ] Earth Science
- [ ] Life Science
- [ ] Physical Science
- [ ] Environmental Science
- [ ] English/ Language Arts
- [ ] Performing Arts
- [ ] Visual Arts
- [ ] Computer Science/Technology
- [ ] Health/Physical Education
- [ ] Social Studies/History
- [ ] Foreign Language
- [ ] Special Education
- [ ] Gifted Education

If you would be interested in participating in an interview about questions in this assessment, please leave your email below. Those people chosen to participate will be compensated with a $50 Amazon gift card for the 45 minute interview.

_____

Thank you for taking the survey!

Appendix B. TELA Demographics

Personal Demographics

Gender		
	n	Percent
Female	201	77.3
Male	55	21.2
Other	4	1.5
Hispanic		
	n	Percent
No	229	88.1
Yes	31	11.9
Race		
	n	Percent
White	200	76.9
Black/African American	29	11.2
Other / More than one	20	7.7
Asian America / Pac Islander	11	4.2
Highest level of education		
	n	Percent
Masters	107	41.2
Bachelors	90	34.6
Some grad school	26	10.0
High School	11	4.2
Associate	9	3.5
Some college	9	3.5
Doctorate	8	3.1
Financial status		
	n	Percent
Stable	131	50.4
Comfortable	88	33.8
Struggling	36	13.8
Affluent	5	1.9
Educator residence		
	n	Percent
Suburban	179	68.8
Urban	53	20.4
Rural	28	10.8

Instructional Demographics

Instructional setting		
	n	Percent
Public school	183	70.4
Nonformal	45	17.3
Private school	28	10.8
Afterschool	4	1.5
Grade(s) taught		
	n	Percent
9-12	75	28.8
3-5	60	23.1
6-8	53	20.4
K-2	39	15.0
K-12	17	6.5
Multiple grades < including 6	8	3.1
other	5	1.9
K-8	3	1.2
Subject(s) taught		
	n	Percent
Multiple Sciences	72	27.7
Multiple subjects incl Science	68	26.2
English / Language Arts	24	9.2
Special Education	15	5.8
Life Science	14	5.4
Environmental Science	13	5.0
Earth Science	12	4.6
Computer Science / Technology	9	3.5
Physical Science	6	2.3
Visual Arts	6	2.3
Social Studies / History	6	2.3
Foreign Language	5	1.9
Performing Arts	4	1.5
Health / Phys Ed	4	1.5
Gifted Education	2	.8

Appendix C. Interview sample demographics

Interview sample individual demographics

	n	Percent
Gender		
Female	34	73.9
Male	12	26.1
Other	0	0
Hispanic, Latina/o		
No	43	93.5
Yes	3	6.5
Race		
White	39	84.8
Other/More than one race	4	8.7
Black or African American	3	6.5
American Indian or Alaska Native	0	0
Asian American / Pacific Islander	0	0
Education		
Bachelor's	13	28.3
Master's	24	52.2
Some graduate	8	17.4
Doctoral	1	2.2
Less than high school	0	0
High school /GED	0	0
Associate's	0	0
Some college	0	0
Financial		
Stable	25	54.3
Comfortable	11	23.9
Struggling	8	17.4
Affluent	2	4.3

Residence		
Suburban	27	58.7
Urban	13	28.3
Rural	6	13.0

Interview sample instructional demographics

Instructional Setting		
Public	23	50.0
Nonformal	19	41.3
Private	4	8.7
Afterschool	0	0
Grade(s) taught		
3-5	11	23.9
6-8	11	23.9
9-12	10	21.7
K-12	7	15.2
K-2	6	13.0
K-5	1	2.2
Subject(s) taught		
Multiple sciences	20	43.5
Multiple subjects including science	11	23.9
Foreign language	3	6.5
Life science	2	4.3
Environmental science	2	4.3
Multiple subjects, no science	2	4.3
English/language arts	2	4.3
Social studies/history	2	4.3
Physical science	1	2.2
Special education	1	2.2

Interview sample demographics, by setting

	Nonformal	K-12	Total
Gender			
Female	16	18	34
Male	3	9	12
Hispanic, Latina/o			
No	18	25	43
Yes	1	2	3
Race			
White	16	23	39
Other/More than one race	2	2	4
Black or African American	1	2	3
Am Indian or Alaska Native	0	0	0
Asian American / Pacific Islander	0	0	0
Education			
Master's	5	19	24
Bachelor's	10	3	13
Some graduate	4	4	8
Doctoral	0	1	1
Associate's	0	0	0
High school /GED	0	0	0
Less than high school	0	0	0
Some college	0	0	0
Financial			
Stable	12	13	25
Comfortable	3	8	11
Struggling	4	4	8
Affluent	0	2	2

Residence			
Suburban	9	18	27
Urban	6	7	13
Rural	4	2	6
Grade(s) taught			
3-5	8	3	11
6-8	0	11	11
9-12	1	9	10
K-12	7	0	7
K-2	2	4	6
K-5	1	0	1
Subject(s) taught			
Multiple sciences	10	10	20
Multiple subjects including science	6	5	11
Foreign language	0	3	3
Life science	1	1	2
Environmental science	2	0	2
Multiple subjects, no science	0	2	2
English/language arts	0	2	2
Social studies/history	0	2	2
Physical science	0	1	1
Special education	0	1	1