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Development of an innovative method for analyzing the presence of environmental sustainability themes and an ecological paradigm in science content standards

Michelle Tenam-Zemach [a,*], Mandy Kirchgessner [b], John Pecore [c], Leanne Lai [d], Steven Hecht [a]

[a] Nova Southeastern University, Abraham Fischler School of Education, 1750 NE 167th Street, North Miami Beach, FL 33162, United States
[b] Temple University College of Education, 1301 Cecil B. Moore Avenue, Philadelphia, PA 19122, United States
[c] University of West Florida School of Education, 11000 University Parkway, Pensacola, FL 32514, United States
[d] Nova Southeastern University, Department of Sociobehavioral and Administrative Pharmacy, College of Pharamcy, 3200 South University Drive, Fort Lauderdale, FL 33328, United States

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ABSTRACT

An iterative process for developing a method for analyzing Florida's K-12 Next Generation Sunshine State Standards science content was described. For this study, the researchers developed an innovative approach for analyzing the presence of environmental sustainability themes and an ecological paradigm within science content standards. The findings illustrate that detecting ecological thinking within the content standards is a complex and unwieldy process, even when the coders are experts in the content area. Despite this limitation, our expert coders rated the standards document with an overall agreement of 81%. Future research was discussed in terms of how our method could be used to further stakeholders' understanding about how and to what extent ecological thinking is covered within science content standards.

How do we determine what students should know and be able to do? Who should determine the outcomes of students' learning and the experiences they have throughout their education? Curriculum design and development often begin with philosophical questions such as these. Today, our current context of education embodies standards that are developed by various groups of people with specific agendas. As Gorlewski, Porfilio, and Gorlewski (2012) point out, "like anything socially constructed, standards themselves manifest the values and beliefs of their developers" (p. 2). Standards are the foundation from which curriculum design and development begin (Estes, Mintz, & Gunter, 2011; Hale & Dunlap, 2010). It is critical, therefore, to determine what the content standards demand of students and teachers. What exactly are students required to learn? How does the discourse of standards, in this case Florida's K-12 Next Generations Sunshine State science content standards (NGSSS), convey that requirement?

According to Reuters, President Obama proposed "$80 million in new government funding for a program to boost science and math education in U.S. schools" (http://www.reuters.com/article/2012/02/07/us-obama-education-idUSTRE8161IQ20120207). Echoing the president's policies, there are a number of sources emphasizing the importance of science education and 21st century skills (National Research Council, 2012). Presently, the National Research Council (NRC, 2012) has developed a proposed framework for K-12 science education stating that this is "the first step in a process to create new standards in K-12 science education" (p. ix). Content standards, defined as what students should know (Korn, 2004; Taubman, 2009), are the body of knowledge that students will cover throughout the K-12 academic years. Like all adopted standards, in the state of Florida, the current science standards provide a body of evidence for science knowledge that is most valued and considered of greatest worth (English, 2010; Gorlewski et al., 2012). It is also important to remember that standards also teach beyond the 'what' of content; standards also speak to the skills students are to develop as they learn. Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) offers a framework for the way many standards are written and competencies are assessed (Kennedy, 2008), and "mastery of academic standards requires an alignment of both content and cognition" (Manthey, 2005, p. 14). Establishing a knowledge base of the content of these standards is critical if all stakeholders are to

* Corresponding author. Tel.: +1 954 254 1344; fax: +1 954 262 3826.
E-mail addresses: mt656@nova.edu, micheletz@gmail.com (M. Tenam-Zemach).

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thoroughly understand what students are expected to know and do, especially given the high-stakes assessment students must take throughout their education (Au, 2007). Texts can impact change; for instance, Fairclough (2003) argues that "texts can bring about changes in our knowledge. . .our beliefs, our attitudes, values and so forth" (p. 8). Those texts that wield influence on educational systems and determine the content of the written curriculum are the object of the analysis of this study, principally NGSSS science content standards that decree what science content is taught in Florida's public schools. Thus, in the context of a standards-based approach to knowledge acquisition, the purpose of this paper is to present the methodological findings of an analysis of science content in Florida's K-12 Next Generation Sunshine State Standards (http://www.cpalms.org/Standards/FLStandardSearch.aspx).

Content selection

One of the most pressing issues for current and future generations is clearly environmental sustainability (ES). In 1972, the first international community met to discuss sustainability as a matter of importance (Fabricatore & López, 2012), but it has taken until recent years for the pertinence and urgency of this matter to be seriously addressed by society in general and the educational establishment in particular (Tilbury & Wortman, 2004). In the past two decades, undergraduate programs have revamped their coursework to include sustainability issues (Aurandt, Lynch-Caris, Borchers, El-Sayed, & Hoff, 2012) and this movement spirals downward through primary grades (Brown, 2010; Frantz, 2010) and even crosses into outdoor adult adventure programs (Mullins, 2011). While many may think traditional science classrooms are the main stakeholder in ES issues, a diverse range of schools, including business, engineering, and family and consumer sciences, have found vital relevance in teaching sustainability within their respective disciplines (Aurandt et al., 2012; Schwering, 2011; Thompson, Harden, Clauss, Fox, & Wild, 2012).

Today's ideal of sustainability is one that promotes the security of both human and ecological futures (Adams, 2013). Effective teaching to this extent supports higher level thinking that incorporates economic, environmental, and social issues (Fabricatore & López, 2012). This means that sustainability education involves personal values, social issues and foresight on complex subjects (Fabricatore & López, 2012). Having ES standards that incorporate reflective opportunities for students to weigh values, see relationships, evaluate situations, and predict outcomes is important. Without explicitly tying critical thinking skills to environmental education, curriculum would be bereft of any level of personal buy-in as students would choose to believe or disregard the content as meaningless propaganda (Seatter, 2011). Some people argue that proper ES development "cannot be integrated into existing. . .frameworks, but requires a transformation of the educational system" (Venkataraman, 2009, p. 8). For example, many of the decision-making processes involving ES require processes that contradict common practices of graduate business programs (Schwering, 2011). Consequently, the next generation of decision-makers needs to be wholly informed on the social and environmental repercussions of decisions as well as the economic ones (Halsey, 2009). Furthermore, educating for ES is a practice that complements the development of the types of creative thinkers and problem-solvers for which governments, corporations and organizations around the world advocate (Stables, 2009). For this and other reasons, some suggest that ES education must break old paradigms and can only be effectively taught as humanized content standards (Strife, 2010). As Frantz (2010) indicates, however, schools are stretched to incorporate sustainability initiatives into their curriculum. When discussing the Science Content Standards for California's Public Schools, Saylan and Blumstein (2011) argue that "the standards do not provide enough of the tools necessary for students to practically understand the environmental processes that will likely change their world and their lives" (p. 29). There is a consequential need to consider how and to what extent standards writers are embedding ES concepts into existing curriculum (Stone & Barlow, 2005).

Irrespective of the type of change that may occur to science content standards, how do we measure the presence of environmental sustainability's – or any other new initiatives – integration within existing curriculum? Sterling (2001) developed a conceptual framework that provides a blueprint for analyzing the extent to which science content standards present a systemic, value-laden, and problem solving approach to teaching ES concepts. Sterling's (2001) framework provides defining characteristics for teachers, standards writers and other educational stakeholders concerning essential elements of ES knowledge and ecological thinking. In light of this inquiry, our research seeks to establish a reliable system to analyze the presence of overarching ES concepts into curriculum standards. In a time of nation-wide educational reforms and initiatives, it is important to develop a system to analyze standards, their content, their targeted skill development, and their interpretation in light of underlying priorities. To respond to these concerns, the researchers developed a research design to systematically address Florida's K-12 NGSSS science content in order to determine the extent to which they present ES themes and an ecological paradigm as defined by Sterling (2001). It should be noted that the researchers make no claims about the enactment of the science curriculum in the classroom, but rather offer this methodological approach as one way for researchers, educators, and policy makers to rigorously review local, state, and national science education standards.

Purpose of the current study

The purpose of the current research is to report on the development of a methodological approach to analyzing the ES themes and ecological framework present in Florida's K-12 NGSSS for science. The project involved an iterative approach for the development of a method that began with using key terms to identify the presence of ES themes and an ecological paradigm. The first step in this iterative approach was the identification of key terms that facilitate the development of ES themes. Key terms were categorized and four ES themes emerged: (a) environmental impacts (EI), (b) biodiversity (BD), (c) population dynamics (PD), and (d) energy transformation (ET). Key terms were also used as a novel approach for focusing raters' attention to the presence of potential ES content that might be found within the standards' document. Subsequent iterations of the method were needed to enhance the reliability and usability of this method with ES expert analysts.

Theoretical framework

The theoretical framework used by the present researchers in their analysis of Florida's NGSSS for science derives from Sterling's (2001) ecological paradigm. The ecological paradigm recognizes humans as one aspect of a multifaceted, dynamic, and intensely interconnected world. Sterling (2001) describes three dimensions in the paradigm: perceptual, conceptual and practice. Sterling's (2001) framework encourages a relational view of the world focusing on people's ability to recognize patterns of influence between systems that at first appear fragmented. Practice is the dimension of action arguing that the whole is greater than the sum of its parts; synthesis and purpose are fundamental components in the search for healthy relationships.