

PRE-SERVICE TEACHERS' USE OF IMAGES IN INTEGRATING ENVIRONMENTAL SUSTAINABILITY LESSONS

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Abstract

Environmental sustainability is a topic widely discussed in the field of science education, yet, few entities have committed to developing environmental sustainability education standards. The Washington State Department of Education has created K-12 Integrated Environmental and Sustainability Learning Standards (IESLS, 2009), which align with current research and practices in environmental and sustainability education. This study focuses on the perceptions of secondary pre-service teachers about the use of images to teach environmental sustainability topics integrated in their content area. The research explores the question what secondary pre-service teachers' perceptions of sustainability and using images to teach environmental sustainability topics in their content area are. The participants were comprised of secondary pre-service teachers enrolled in an instructional methodology course from a small university in the Pacific Northwestern United States. Teaching environmental sustainability and integrating lessons using images had a noticeable impact on pre-service teachers' perceived future teaching practices. Participants also changed beliefs over the course of the study about using images to teach environmental sustainability topics.

Key words: *environmental sustainability, environmental science education, integration, images, secondary pre-service teachers*

Introduction

Environmental sustainability (ES) is widely discussed in science education. However, the Washington State Department of Education in North America has actually made a commitment to the teaching and learning of sustainability in education through the development of specific learning standards. Washington State K-12 Integrated Environmental and Sustainability Learning Standards (IESLS, 2009) set a vision for how sustainability is to be an integral component in all subject areas, from social studies to science to physical education. In 1990, the Washington State Board of Education ruled ES was to be part of instruction at all levels,

K-12 (IESLS, 2009) and corresponding Grade Level Expectations (GLEs) were developed. Nationally, in 2008, the North American Association for Environmental Education (NAAEE) created sustainability learning standards together with the U.S. Partnership for Education for Sustainable Development (USPESD). Guidelines were included across the curriculum requiring environmental education (EE) instruction in grades K-12 (IESLS, 2009). The State of Washington in particular developed standards declaring ES to be integrated among all content areas.

Instruction about conservation, natural resources, and the environment shall be provided at all grade levels in an interdisciplinary manner through science, the social studies, the humanities, and other appropriate areas with an emphasis on solving the problems of human adaptation to the environment (IESLS, 2009, p. 2).

These state education standards, which align with current research and practices in environmental and sustainability education (SE), are making it feasible to be fully aligned with SE (Byrne, 2000; Bell & Morse, 2006; Manderson, 2006). Although EE is recognised among educators, a major problem is EE has never fully been integrated into the school curriculum (Palmer, 1998). Learning about ES in other subject areas through curricular integration may provide a vehicle for inclusion of this topic in K-12 education. One way of delivering environmental science may be through images. While a verbal explanation can provide valuable content about these topics, what is the impact when images are added? The internet offers teachers many visually motivating images. However, while teachers have an instant access to photos and graphics of environmental concerns, including readily available images of scientific phenomena, formal understanding of the use of images to enhance or facilitate knowledge is limited.

This study explores the perceptions of secondary pre-service teachers about the use of images to teach ES topics integrated in their content area. The questions driving this study are the following: 1) *What are secondary pre-service teachers' perceptions of teaching ES topics in their content area when connected to the Washington State K-12 Integrated Environmental and Sustainability Learning Standards (IESLS, 2009) and 2) How do using images in lessons effect pre-service teacher's decisions to integrate ES topics with lessons in their content area?*

The study begins by establishing a common language around the topics of ES, integrated curriculum and the use of images to support learning.

Images for instruction

The capacity for perceiving and recalling visual information is related to understanding abstract relationships through observation of diagrams and other visual representations (Tufte, 1983, 2006). The world perceived is made up of complex, interrelated collections of objects and backgrounds. However, few are able to completely assess all that is in an entire scene (Intraub & Bodamer, 1993). When observing a picture, the human eye typically perceives only a partial picture of the larger surroundings. Hochberg's (1978) theorised visual integra-

tion is based on the viewer's ability to understand pictorial displays. Since the eye can only focus on one area at a time, perception of the whole is attained by use of mental abstractions that translate and assimilate knowledge for future views of the visual world (Hochberg, 1978; Intraub & Bodamer, 1993).

Clark and Paivio (1991) used illustrations alongside instruction to help learners retain information by facilitating dual coding in a rich network of modality specific verbal and non-verbal representations. Dual coding is a cognitive method that provides more than one way to understand. For instance, dual coding can be experienced through observation and interpretation of pictures as well as verbal description, giving students greater options to recall information (Clark & Paivio, 1991; Mayer & Sims, 1994). The dual coding model typically describes relationships of a scientific system related to verbal explanations and visual animations through the use of more than one sensory modality. This model can construct visual images using verbal material and conversely can evoke verbal representations using visual material (Mayer & Sims, 1994).

Integrating environmental sustainability

Although integration has been vigorously pursued in both science and mathematics since the 1930s (McBride & Silverman, 1991), there has been a wide range of definitions for integration. Marsh (1993) suggests the various forms of curriculum integration can be placed on a scale, from 'discipline-based options' with separate subjects taught at different times to 'internal orientation' where students incorporate activities that are planned and implemented by both students and teachers. Integrated curriculum introduces students to the problems, issues and concerns of life as it is lived in the real world. Martin (1995) asserts integration allows curricula to educate through the experiences of diverse races, genders and classes, therefore, creating a place of meaning for each child. According to Beane (1997), the term 'curriculum integration' appeared in scholarly literature. However, the expression became confused with a constrained definition based around the correlation of thematic, teacher-driven curriculum (Beane, 1997). Hirst (1974) rationalised a subject-specific approach restricted students' thinking and development by making the process of learning artificial and alien compared with their life experiences.

SE offers a rich and meaningful context for using images for integration in teaching and learning of multiple disciplines. Nolet (2009) provides a definition where the interdisciplinary and holistic nature of sustainability lends itself to being integrated in the whole curriculum and not as a separate subject. Understanding integration requires acknowledgment that the curriculum is embedded in social and natural environments (Sobel, 1995). Integrative teaching practices connect current issues to the curriculum, drawing on historical situations and incorporating problem-solving skills with real world problems (Jacobs, 1989; Kirkby, O'Keefe, & Timberlake, 1995). These practices mirror the current global nature of society, considering consequences for not addressing the interdependence of society, economy and the natural world (Venville, Wallace, Rennie, & Malone, 2001). Hungerford (1998) argues for integrating

EE with other subjects, considering it a multidisciplinary and collaborative topic. Integrating environmental topics may also prove relevant when presented through multidisciplinary and experiential practice (Gruenewald, 2003).

A case study with pre-service teachers

The purpose of this descriptive case study is to uncover the perceptions of secondary pre-service teachers about the use of images to teach ES topics integrated in their content area. A descriptive case study approach is appropriate, as it is a bounded system, a ten-week secondary methods course where the interactions are completed within the site (Lincoln & Guba, 1985). All pre-service teachers enrolled in the course were seeking state certification to teach their subject at the secondary school level. Table 1 indicates the subject areas.

Table 1. Participants' undergraduate content areas

Subject area	Number of pre-service teachers per subject	Number of pre-service teachers interviewed
Art	1	0
Chemistry	1	1
History	5	1
Mathematics	1	1
Music	4	1
Languages/Spanish	1	0
Physical education	2	1
Religion	1	0

Participants

The participants were 16 secondary pre-service teachers enrolled in an instructional methods course from a small university in the Pacific Northwest. They were all undergraduate junior and senior secondary education students, eight males and eight females. All students were given a pre- and post-survey inquiring about their perceptions of sustainability as a topic to be integrated with their subject area.

Data sources and procedures

Data for this study came from three major sources: 1) a five-point Likert-scale questionnaire about pre-service teachers' attitudes towards sustainability, images and integrated teaching; 2) videotaped interviews from five participants following the integrated sustainability lessons; 3) artefacts, including journal reflections and lesson samples. All 16 secondary pre-service teachers were surveyed regarding their beliefs about the use of images and their perceptions of sustainability in a lesson directly related to their subject area. From the pool of 16 pre-service teachers, five were chosen from five separate subject areas to participate in one 30–40 minute structured one-on-one video-taped interview. Table 2 provides sample survey statements.

Table 2. Sample Likert-scale survey statements from the case study

Beliefs about images	Environmental sustainability
Images are import to making sense of things	ES is a topic I consider to be part of my subject area
<i>Role of images</i> Images are necessary for teaching in my subject area	<i>Ease of teaching ES</i> Teaching issues of sustainability in my subject would not be difficult
	<i>Impact of ES images on teaching</i> Images of sustainability issues will enhance my teaching and student learning

After completion of the survey, the students were assigned the task of choosing images to include in an integrated lesson combining the ES standards with standards in their secondary subject areas as well as those of another classmate. Table 3 depicts integrated topics. For the lesson presentations, the pre-service teachers were asked to specifically choose environmental images according to these criteria: 1) appropriate content and context; 2) ability to encourage causal reasoning; 3) scientific and historical integrity of the image source itself. After presenting the integrated lesson to their classmates, participants were asked to provide a one to two page journal reflection on the process of creating the integrated lesson, choosing the images and the likelihood of using this lesson and creating similar integrated lessons in their own classroom.

Table 3. Secondary subject lessons integrated with sustainability factors

Secondary subjects	Sustainability factor
Art and languages/Spanish	Recycling trash in Spain into artistic creations for decorative purposes
Chemistry and music	Chemical make-up of instruments recycled into useful objects
History and physical education (1)	Historic look at local environmental issues combined with a bike tour
History and physical education (2)	Impact of baseball field installation on local environmental concerns
History and mathematics	Correlation between population and resource exploitation in the Pacific Northwest
History and music	Effects of the industrial revolution on art, music, the environment and society
Mathematics and music	Music genres encouraging environmental awareness while graphing trends in sustainability
Religion and music	Connecting key spiritual concepts via musical expression to themes of sustainability

Surveys. In the first week of the 10-week secondary methods course, pre-service teachers were given a five-point Likert-scale pre-survey containing twenty-five questions – twenty scaled and five open-ended. The questions covered beliefs about using images in teaching, the role of choosing and viewing images in lesson presentations and how images may influence integrated ES lessons. A post-questionnaire was distributed to the participants two days following in-class presentations of integrated lessons using images.

Pre-service teachers' responses to the pre- and post-surveys were based on pre-service teachers' beliefs about sustainability, perceptions of their ability to teach ES topics, the ability to integrate ES with their subject area and the value of images for teaching integrated ES lessons. To maintain reliability considering the participants' wide variety of content areas, all participants were asked the same questions relating to images and ES in both surveys. The survey contained 25 scaled and five open-ended items related to images and ES. Of these, five scaled and one open-ended item were chosen to best represent the themes of this study.

Journal reflections. Reflective practice, as described by Dewey (1902), is an endeavour that is essential to critical thinking. Rogers (2001) offers four criteria for reflective practice: 1) as a form of meaning-making; 2) systematic, rigorous and disciplined thinking; 3) in interaction with others; 4) an attitude of value for personal and intellectual growth in oneself and others. These criteria were encouraged in this study, as a minimum of three journal responses were used to reflect on questions posed about the meaning of the activity undertaken both personally and in a collaborative community of pre-service teachers. The researcher provided questions for reflection such as: *How did adding images impact the integration of sustainability in your lessons?* These reflections were collected and searched for themes of meaning.

Interview responses. From among the 16 secondary pre-service teachers, five were purposefully chosen from a variety of subject areas for one-on-one interviews (Table 1). The purpose of both the reflective journaling and one-on-one interviews was to get at the participants' thinking about ES as related to their content and the use of images to express those thoughts. Each videotaped interview followed the researcher-scripted protocol and lasted for approximately 30 minutes. Interview transcripts were typed and coded searching for themes in the data.

Lesson samples. The pre-service teachers were assigned a lesson planning assignment over a three-week period. The instructor presented an exemplar lesson that included discussion about integration techniques and criteria for choosing preferred images. Resources distributed by the researcher/instructor for preparation of the lessons included a Washington State Integrated Environmental Sustainability Learning Standards (IESLS, 2009) document, assignment parameters (one integrated lesson plan, a minimum of five images, guidelines for choosing images, a PowerPoint presentation and one-page reflection) and the university departmental lesson plan templates. After discussion regarding each of these pieces, each pre-service teacher was paired with another in a different content area (for instance, mathematics with music or history with science). The students' pairs were assigned to create a sustainability lesson using the state standards combined with their two content disciplines. These submitted final lessons were used to inform the themes of this study.

Study implementation

This study took place during the autumn 2012 quarter in a general secondary methods course at a small liberal arts college in the Pacific Northwest. Once Institutional Review Board approval was obtained, the students' views and perceptions regarding the inclusion of photographic images in an integrated lesson were explored. To meet the requirements for state

teaching certification, pre-service teachers are required to develop effective lesson plans, beginning with choosing objectives and appropriate assessments. They develop learning activities based on their content area selection, identify groupings of classroom students and plan how to make connections from classroom to the home. Once the lesson is given in a classroom, the pre-service teachers collect students' evidence, such as quizzes, drawings and reflections. These assessments were then analysed by the pre-service teachers for students' understanding of the learning objectives chosen for the lesson. The pre-service teachers used these analysed lesson components to plan follow-up lessons. Participants continued planning lessons in this method for their coursework with the addition of choosing images appropriate for an assigned integrated ES lesson (Table 3).

Case study findings

The pre-service teachers reviewed the Washington State K-12 Integrated Environmental Sustainability Education Standards (IESLS, 2009). Although they were familiar with state standards and objectives in their major content area such as mathematics or history, they were surprised to learn of this additional integrated standard. The State of Washington standards document explains that the "Integrated Environmental and Sustainability Education Learning Standard is distinct unto itself, they are interrelated and ideally would inform teaching and learning concurrently" (IESLS, 2009, p. 3). Though not widely integrated by classroom teachers, the topic of ES is advanced and typically supported by educators as well as a majority of the general population in the Pacific Northwest of the United States.

Pre-service teachers' beliefs about the role of images

People are bombarded with images of all kinds seen in homes, schools and even in their cars with smart phones. It is no wonder pre-service teachers reported images as important to their teaching. At the beginning of the study, the students indicated an overall belief about the importance of images and the role of images in instruction. As compared to later themes, a large majority of students began the study indicating their valuing images before as well as after the study. Responses for both pre- and post-survey question were consistently high concerning the overall importance of images to making sense of the world and for use in teaching (Table 4).

Table 4. Mean scores from pre-/post-survey questionnaire

Survey question topic	Pre-survey mean	Post-survey mean
Importance of images	4.40	5.00
Importance of images to teaching	3.75	4.70
ES part of content area	1.55	4.05
Ease of integrating ES into content area	1.55	4.40
Impact of ES images on teaching	1.55	3.75

Initial questions posed prior to discussion of images asked about levels of enjoyment from

viewing images and how important they are to making sense of the world. Following the experience of choosing images, the students said, “I believe more and more that images are a key in conveying messages where words fail” (Samantha, journal entry) and “I think [a picture] can engage people in a way simple words do not” (Karly, journal entry).

The next belief about using images for teaching to specific content areas was in response to the question: *Are images necessary for teaching in my subject area?* As a result of the project, many believed that images would be beneficial to their teaching practices. Stan reported, “Images are very powerful and help to cement the topics into student’s minds” (journal entry). In history, images were seen as bringing “a whole new level of understanding to historical events that would most likely seem dry and uninteresting otherwise” (John, journal entry). Elaine described images as “especially important when new information is presented or when a specific point is being made that is not something I have thought about before” (journal entry). Though images were initially reported as important, the degree of importance was raised through this experience (Table 4).

Defining sustainability. Although many students are aware of environmental issues and the term ‘sustainability’, the meaning is not easily explained. Sustainability is a broad construct (Nolet, 2009) with meaning varied in relation to context. In ecology, it is more closely related to maintaining a balance in an ecosystem. In a broader sense, it refers to the balance between systems, both human and, naturally, in the environment. In this study, the participants were asked about their definition of sustainability and the notion that ES could provide a meaningful context for integrated teaching and learning. “Pre-service teachers exhibited discomfort and some even grew frustrated when grappling with these questions” (the researchers’ journal entry). When answering the pre-survey question regarding the essence of the notion ‘sustainability’, most of the participants, in this study, could not give an accurate definition of sustainability, and, of those, a portion provided no answer at all. One participant said he was uncertain [about sustainability] and couldn’t “put words to it” (John, pre-survey response). Karly thought that “sustainability is the ability for something to remain”. Though the definition of sustainability is varied, it is generally accepted to include maintenance to keep a balanced level of resources and avoiding the depletion of natural resources.

Following the ES lesson presentation and a participant’s own study into the topic while searching for appropriate images, over eighty percent had a viable understanding of the concept. In an open-ended post-survey response, John described sustainability to be “how we use what we have and not waste what we have. We only have limited amounts of material on the earth. We as humans are pretty wasteful of that”. Other descriptions included:

Getting a good definition of sustainability down, that was, probably, the best part [of creating the integrated image lessons] for me. I sit there and say “okay, I need to do something on sustainability” but, really, what is it? It’s a political issue, it’s a social issue, but I didn’t really know [before this] what it means (Kelli, interview transcript), and ...

I’d define it as how we take care of our environment in order to last, continue to be available to us. The resources that we have, the stewardship that we have, what, basically,

we do in order to make sure that we still have the things in 50 years that we have today (Lindsay, post-survey response).

Teaching ES in various content areas. Currently, education is considered an integral component of sustainability (Onwueme & Borasi, 2007), yet the idea of ES as an integrated teaching and learning topic is uncommon. The greatest change in viewpoints among the participants in this study came when responding to queries about ES as a topic relating to their own subject area, ease of teaching ES and ES topics enhancing their teaching practices (Table 4). Initially, only a small portion of the participants believed ES could be taught within their content, and most believed it could not be part of their subject area. Change over the course of this study was influenced by several factors, including a better understanding of sustainability, integrating their subject content with a sustainability topic and purposefully choosing images to teach their lessons. After teaching the integrated lesson, nearly all participants expressed that not only did they see ES connections with mathematics, art and history, for instance, but found it easier to integrate than initially thought and found ES valuable to their content area. In music, for instance, Lindsay found that “the connection [between music and sustainability] gave very pronounced focus for the lesson” (post-survey response). Related to integrating sustainability with history, John reported:

I never really associated environmental sustainability with history before, as far as teaching is concerned. It intrigued me, and I realised that it actually matches quite well, thinking about the subject that I would already be teaching but have those issues in them and pulling it so that students are aware that what they are doing has to do with environmental sustainability. In other words, it's already there, just identifying it and studying it consciously. So, thinking about that was interesting (journal entry).

Teaching ES with mathematics was seen as having a high value for Kevin.

Looking back on it now, this is, probably, the best lesson I've put together [...] like, all of a sudden, it wasn't just a math standard how you are going to teach, like a lecture with a worksheet, it's, like, don't do any of that because now it's going to be about sustainability and the environment and how are you going to work those together. And then, all of sudden, I was, like, Oh, a project sounds fun or some research, and we are going to change it up ... this is going to be fun! I think a lot of us in the class, too, were like, I want to teach this lesson. I'm going to save this and one day teach it (journal entry).

Valuing the integration of sustainability and other secondary subject content and using appropriate images to teach those concepts was seen as a way to deepen students' thinking. “Integration of multiple subject areas [such as art or foreign languages] in lesson planning is an excellent way to broaden students' minds and teach more material outside of the core curriculum” (Karly, journal entry). Andrew believed that “integrating the sustainability standards for environmental content with historical content was, actually, not difficult. It is fairly easy to demonstrate environmental destruction that human beings have caused when about any aspect of history is considered” (post-survey response).

Impact of images for future environmental sustainability teaching practices

The direction for SE involves training teachers to understand a changing world in the larger context of where one's teaching and learning is located (Darling-Hammond, Banks, Zumwalt, Gomez, Sherin, & Griesdorn, 2005). How will lessons using images of ES affect future teaching practices? Participants were asked whether images about sustainability issues would enhance future teaching practices. Using images to teach ES in their content area had a great impact on pre-service teachers. After completing the lesson, the majority showed a marked change on the survey responses in journal reflections and one-on-one interviews regarding the use of images to integrate sustainability topics with their subjects (Table 4). "This lesson took quite a bit of creativity and effort, I feel it was well worth it with the dynamic lesson plan created, and I will definitely be employing this integration technique [for choosing images] in my future lessons whenever and wherever possible" (Conner, journal entry).

I absolutely will use [images]. For many students, history is not relevant or interesting, and I now see that images can change that. They can either make or break a history lesson. And whether using pictures or media, I think [images] will play a huge role in my lesson planning, the units I give (John, journal entry).

Though many see sustainability as a segment of science and not a novelty combination for teaching an integrated lesson, adding images as a result of this study was deemed invaluable.

I think integrating images into my subjects is important, especially since the forces that my students will be studying are not really able to be captured on camera. For chemistry, images of models or diagrammes portraying chemical principles are necessary because reactions occur at the nanolevel. For physics, I will need images picturing effects of certain forces or diagrams of different mechanical systems to help the students understand the material. ... Regardless of what I am teaching, I will want to use images, not just for the students who are visual learners, but for all students because pictures will help them start to construct mechanisms in their minds or difficult concepts (Lindsay, interview transcript).

Crafting lessons to encourage interest in sustainability topics impacts future attitudes and practices of both students and teachers. "Finding images that catch the viewers' attention makes them ask questions and establishes an emotional connection, students are even more interested in participating in the lesson" (Karly, interview transcript).

Conclusions

This study surveyed pre-service teachers' perceptions of ES topics as well as beliefs about future teaching practices using images to teach ES topics. Pre-service teachers' definitions of sustainability revealed a lack of initial understanding and ability to explain its purpose in education. After the creation of an integrated lesson, most participants came to understand sustainability in terms of not wasting what we have, recognising limited resources and the responsibility as stewards of the earth. When queried concerning their beliefs about images,

they indicated positive attitudes toward using images for teaching in a variety of content areas. Most of the pre-service teachers indicated they would definitely integrate ES lessons similar to those created for this study with their various subject area content and were eager to do so. Pre-service teachers considered images important, engaging, powerful and ultimately valuable to future teaching practices.

Teaching ES in integrating lessons using images had a noticeable impact on pre-service teachers' perceived future teaching practices. The criteria for choosing images impacted their decision to use those pictures of ES to teach integrated lessons, as evidenced in increased survey responses. Though initially, few participants believed ES standards aligned with their content area, after preparing and presenting the integrated lessons, the vast majority found connections giving a pronounced focus to their lessons, making it easy to demonstrate environmental damage in connection to topics found in mathematics, history, art, among others. The majority of participants also changed beliefs over the course of the study about using images to teach ES topics. While preparing the lessons took time and energy, many believe images added to ES lessons create dynamic lessons preparing their students for higher-order thinking as well as making emotional connections to the subject.

The process of choosing images for some participants came after choosing the topics for integration while other participants chose the ES images first and then connected those to a specific standard within their subject area. Both approaches showed many benefits as well as pointed to some difficulties depending on the subjects being integrated. Since novice teachers lack experience teaching ES, they need practical examples that provide a vehicle to present an integrative lesson into their own teaching practices and content areas. Using images of ES while integrating lessons aid these teaching practices.

Preparing for and becoming a teacher includes understanding the place in which one lives. Educating about ES prepares people to sustain the cultural and ecological components of the places they inhabit (Darling-Hammond et al., 2005; Hungerford, 2010). Further research is needed to determine if pre-service teachers are communicating awareness of these environmental issues as in-service practitioners to their own elementary students. Following these 16 pre-service elementary teachers into their teaching experiences could provide rich data and insight to address this question.

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