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Using art to assess environmental education outcomes

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Construction of developmentally appropriate tools for assessing the environmental attitudes and awareness of young learners has proven to be challenging. Art-based assessments that encourage creativity and accommodate different modes of expression may be a particularly useful complement to conventional tools (e.g. surveys), but their efficacy and feasibility across diverse contexts has not been adequately explored. To examine the potential utility of integrating art into evaluations of environmental education outcomes, we adapted an existing drawing prompt and corresponding grading rubric to assess the environmental attitudes and awareness of children (ages 6–12) at summer camps in Athens, GA, USA (n = 285). We then compared children's drawings with scores on a more typical survey instrument that measured similar outcomes, the Children Environmental Perception's Scale. Results showed that a drawing prompt was a practical and unique learner-centered tool for measuring distinct components of environmental attitudes and awareness. Findings also revealed different response patterns across the two instruments, highlighting the value of using multiple approaches (e.g. art-based and survey-based) to assess cognitive and affective aspects of children's environmental orientations.

Keywords: art; assessment; children; environmental attitudes; environmental awareness

Introduction

Environmental education (EE) programs foster connections between children and nature, nurture positive environmental attitudes and awareness, and help children develop important knowledge and skills across a variety of disciplines (Bartosh et al. 2006; Carr 2004; Cutter-MacKenzie and Smith 2003; Meyers, Saunders, and Garrett 2004; Paterson 2010). Effective assessment methods and materials are also necessary to ensure that EE programs are achieving these goals (Athman and Monroe 2001; Inwood 2008a). However, evaluation of EE program outcomes is challenging for multiple reasons (Carleton-Hug and Hug 2010). First, specification of outcome variables can be difficult. Cognitive measures have always been an important element of EE program assessment, and a number of scales have been developed to assess concepts such as children's environmental knowledge and awareness (Carrier 2009; Ruiz-Mallen et al. 2009). Evaluation of affective components of children's connection with the natural world (e.g. attitudes, preferences) is

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less common, but a growing number have shown that EE has a positive impact on children's environmental attitudes (Ballantyne and Packer 2009; Bogner 1998; Dillon and Scott 2002; Dresner and Gill 1994; Mittlestaedt, Sanker, and VanderVeer 1999). Prudent approaches to EE program assessment should therefore consider both cognitive and affective aspects of the child–nature relationships as development of psychometrically sound tools, instruments, and scales that accurately capture young children's environmental perception outcomes has been particularly challenging.

Early investigations of children's environmental attitudes and awareness typically used program-specific instruments without considering the scale's psychometric properties (Gray, Borden, and Weigel 1985; Leeming et al. 1993). Though researchers have gradually produced more reliable instruments (Kaiser, Oerke, and Bogner 2007; Leeming, Dwyer, and Bracken 1995; Manoli, Johnson, and Dunlap 2007), concerns regarding comprehension and complexity continue to detract from the utility of these instruments with younger audiences (Evans et al. 2007; Oosterhof 2009).

Additionally, EE evaluation strategies have historically centered on traditional, survey-style, paper-and-pencil assessments (Carleton-Hug and Hug 2010). Instruments of this nature may be easier to standardize and quantify, and are typically more familiar to EE program staff. However, surveys can be difficult for educators to implement and analyze. Furthermore, children may be reluctant to complete surveys in non-formal EE settings, and not all children perform well on these survey-based metrics (Armstrong 1994; Cronin-Jones 2005). Innovative approaches that acknowledge children's creativity of expression and account for a plurality of learning tendencies could move beyond this limited approach (Gardner 2000), thereby capturing broader representations of environmental attitudes and awareness in more authentic teaching and learning contexts (Cronin-Jones 2005; Eisner 1999). For example, visual cues that appeal to spatial intelligence are an important form of communication for children that can be understood internationally, and their use can help to minimize cultural and linguistic barriers to expression (Lewis and Greene 1983; Rennie and Jarvis 1995; Van Manen 1990; Zoldosova and Prokop 2006). Art, therefore, represents a universally applicable tool that could help researchers and practitioners achieve assessment goals and measure certain types of EE program outcomes at age-appropriate levels (Carr 2004; Gardner 1999; Inwood and Taylor 2012; Meyers, Saunders, and Garrett 2004).

Art and EE: a natural fit

Linking art and EE

A fusion of art and EE could benefit young learners in a variety of ways. First and foremost, art enhances children's ability to engage with, understand, and comprehend complex subject matters (Burnaford, Aprill, and Weiss 2001; Wallen 2003). Art also fosters emotional attachments and affective connections to objects and places, making experiences become more personal, exciting, and memorable (Jacobson, McDuff, and Monroe 2006; Reinsborough 2008; Song 2012). Artistic forms of expression are also widely recognized as a building block for increasing creative problem-solving, critical thinking, communication, and subsequent environmental literacy (Inwood 2008a; Orr 1992). Additionally, art has a unique ability to connect children's minds with their hands, hearts, and the natural environments in

which they live (Bartram 2005; Carr 2004; Inwood 2008a; Malchiodi 2003). Given these clear theoretical and practical associations, recent efforts have attempted to formally integrate art and EE as 'environmental art education' or eco-art education (Inwood and Taylor 2012). Based on art's pedagogical value and inherent capacity to engage multiple intelligences through integrated skill sets (Gardner 1999), capture complex interactions, and resonate with diverse audiences, it could also be useful as a creative method for evaluating EE programs and learning outcomes (Song 2012).

Using art to assess EE outcomes

Though educators use informal drawings to assess EE lessons, the formal use of art to evaluate children's environmental attitudes and awareness associated with EE programs is still in the developmental stage, and studies supporting art-based assessments are emerging (Alerby 2000; Barraza 1999; Bowker 2007; Dentzau and Martinez 2014; Meyers, Saunders, and Garrett 2004). Many efforts to incorporate artistic approaches have focused on task-centered photo-elicitation studies, which allow children to lead the research process and express their own concepts and opinions about natural areas (Chawla 1986; Driskell 2002; James, Jenks, and Prout 1998; Tunstall, Tapsell, and House 2004). Results of these efforts highlight an important concept: visual arts represent a key form of communication, allowing children to freely express ideas they are sometimes unable to express verbally (Farnsworth 2011; Lewis and Greene 1983; Rennie and Jarvis 1995; Van Manen 1990).

Building upon this effort, researchers are beginning to explore the possibility of using drawings to assess children's environment attitudes and awareness from local to global scales (Fisman 2005; Inwood 2008a, 2008b; Malchiodi 2003; Reinsborough 2008). For example, drawings have been used to characterize children's thoughts about the environment in Sweden (Alerby 2000), levels of environmental concern in the US and Mexico (Barraza 1999), knowledge of rainforest ecosystem dynamics in the UK (Bowker 2007), and knowledge and awareness of longleaf pine ecosystems in the US (Dentzau and Martinez 2014). These studies illustrate growing consensus among EE researchers that (1) drawings can provide a plethora of information regarding children's environmental attitudes and awareness, and (2) drawings (and art in general) may represent a useful strategy for evaluating learning outcomes associated with EE programs.

Despite this apparent utility, some critics have argued that art-based EE assessments are subjective, and difficult to grade (Gunstone 1992; Rieck 2002). The use of standardized quantitative scoring rubrics to assess drawings is one way to ameliorate this concern (Cronin-Jones 2005). Scoring rubrics provide a uniform assessment of drawings (or other art-based projects) and are adaptable to any environmental subject or component (Cronin-Jones 2005; Palmquist 1997). For example, drawing rubrics have been used to assess children's perceived relationship with animals (Smith, Meehan, and Castori 2003), children's perceptions of schoolyard habitats (Cronin-Jones 2005), children's understanding of ecological processes (Dentzau and Martinez 2014), and adult's mental models of the environment (Moseley, Desjean-Perrotta, and Utley 2010). This emerging research indicates that drawings and rubrics can serve as reliable, respondent-friendly mechanisms for evaluating various aspects of environmental orientations. However, more studies are needed to determine if drawings are an efficient means of documenting changes in children's environmental attitudes and awareness, how those changes might be captured, and

the relative utility of art-based measurements compared to more conventional strategies for evaluating EE outcomes.

Statement of purpose

This study explored the value of art in a mixed-methods approach for assessing children's cognitive (i.e. environmental awareness) and affective (i.e. environmental attitudes) relationship to nature. Specific objectives were to: (1) adapt an existing drawing prompt to measure different aspects of children's environmental attitudes and awareness, and (2) compare and contrast the efficacy and utility of this art-based assessment tool relative to a more conventional survey instrument.

Methods

Instrument selection and development

The mixed-methods approach used in this study employed adapted versions of two existing EE evaluation instruments, both of which were designed to measure environmental attitudes and awareness in an easy-to-comprehend, low-cost, and time-efficient manner. The first assessment method, an open-ended drawing prompt, was adapted from the schoolyard habitat drawing (Cronin-Jones 2005) and the similar Draw-An-Environment Test (Moseley, Desjean-Perrotta, and Utley 2010). In these earlier studies, environmental definitions and concepts were evaluated using drawn images and written words. This study employed a similar approach with a prompt that asked participants to: 'Draw (and label) a habitat or ecosystem that you see or play in almost every day.' The Draw-an-Ecosystem Test (DET) was designed to allow children to provide open artistic representations of ecosystem complexity, encouraging illustrations based upon personal experiences and observations. Environmental concepts and themes used in the survey were based on EE curricula at the facilities where the study was conducted, including specific topics such as habitat components (e.g. biotic vs. abiotic), interactions (e.g. predator vs. prey), and key ecological processes (e.g. nutrient cycles).

The drawing prompt was designed to capture different aspects of environmental attitudes and awareness. For example, children's general depictions of particular habitat types across an anthropogenic-to-natural spectrum (e.g. indoor habitats, backyard habitats, park/playground habitats, and natural outdoor habitats) provided a coarse measure of eco-affinity, or the extent to which children demonstrate positive attitudes toward and personal interest in natural settings (Larson, Green, and Castleberry 2011). Children who illustrated natural settings and minimized associations with human-built elements were assumed to display higher eco-affinity than those who did not. Specific drawing content also provided a more detailed look at eco-awareness, or children's cognitive grasp of environmental components and relationships (Larson, Green, and Castleberry 2011). To assess this knowledge and awareness, we adapted Moseley, Desjean-Perrotta, and Utley's (2010) scoring rubric to facilitate reliable evaluation of children's drawings among multiple raters, and used a randomly selected subset of 51 drawings from the larger sample. Three different researchers familiar with ecological and EE evaluation expertise examined content validity to refine the rubric that had been developed *a priori*. After review and recoding, researchers agreed on four factors representing key elements of

ecosystems and an interaction spectrum with five levels ranging from not present or no interaction to complex interactions (Figure 1). The factors included two natural (biotic, abiotic) and two anthropogenic elements (human, human built) which facilitated examination of children's connectedness to nature and the human–nature relationship (Bruni and Schultz 2010; Vining, Merrick, and Price 2008). Total scores ranged from 0 to 16, with higher scores representing higher levels of eco-awareness and knowledge of interactions and relationships (see Figure 2 e.g. drawings). Because some children elected to use words instead of pictures to convey their ideas, words and/or labels were interpreted in the same way as pictures when assessing ecosystem factors and their interactions. To add depth to the awareness assessment, we also measured the presence and number of 15 environmental components (e.g. natural elements such as wild animals, trees, water sources, etc.).

The second assessment method, a paper survey, was an adapted version of the Children's Environmental Perceptions Scale (CEPS), a tool specifically designed for young children (Larson, Green, and Castleberry 2011). The original CEPS instrument included 16 Likert-type statements that proved to be a reliable and valid method for evaluating children's eco-affinity, an affective domain (e.g. interest in nature, environmental stewardship); and eco-awareness, a cognitive domain (e.g. importance of nature, environmental awareness). This study used the original 16 Likert-type statements from the CEPS (eight based on eco-affinity, eight based on eco-awareness) modified with stronger adverbs such as 'very' and 'a lot.' Children responded by circling one of five responses (from one = 'strongly disagree'

Drawing Factors	**Not Present**	**Present**	**Basic Interactions**	**Complex Interactions**	**Explicit Interactions**
	0 Point	1 Point	2 Points	3 Points	4 Points
	Drawing **does not contain pictures or words** of this factor.	Drawing contains **pictures or words without any apparent interaction** with this factor.	Drawing contains **pictures or words interacting by only touching** this factor.	Drawing contains **pictures or words interacting by complex methods** with this factor.	Drawing contains **pictures and descriptions** (labels or arrows) with **deliberate emphasis** placed on the interaction with this factor.
DET Rubric Examples					
Human		Any humans	Human standing on bridge or ground	Human walking on bridge, human climbing tree	
Biotic		Animals, trees, grass, flowers, insects	Trees touching grass, animals on ground	Animal running on grass, bird perching in tree	
Abiotic		Mountains, rivers, sun, clouds, rain	Water touching ground	Wind blowing leaves, rain pooling on ground	
Human Built or Designed		Buildings, automobiles, brides, swing sets	House touching grass, car touching driveway	Smoke from chimney, car driving on road	

Figure 1. Rubric for scoring DET.

DET Rubric	Score
Human	0
Biotic	2
Abiotic	2
Human Built	2
Total Rubric Score	6
Habitat Type	1
Environmental Component	2

Drawing by girl, age 7

DET Rubric	Score
Human	0
Biotic	0
Abiotic	0
Human Built	2
Total Rubric Score	2
Habitat Type	0
Environmental Component	0

Drawing by boy, age 9

DET Rubric	Score
Human	0
Biotic	3
Abiotic	3
Human Built	3
Total Rubric Score	9
Habitat Type	1
Environmental **Component**	**4**

Drawing by girl, age 11

Figure 2. Examples of responses and corresponding rubric scores on DET.

to five = 'strongly agree') that were written and visually cued through the use of thumbs-down and thumbs-up symbols associated with each response category. Four additional statements pertaining directly to children's enjoyment of nature-based art activities (i.e. art appreciation) were also included in the survey portion of the instrument (Table 1). The art appreciation items were designed to assess children's art-related proclivities and passions, which might influence performance on the drawing prompt.

Table 1. Mean scores (*M*, SD, and factor-loading coefficients for three factors extracted in Principal Axis Factor analysis for Likert-type items on survey-based assessment tool: the Children's Environmental Perceptions Survey[a] (n = 285).

Factor/Item[b]	Pattern		Structure		Factor	*M*	SD
	A	B	A	B	C		
A. Eco-affinity[c]						**3.93**	**1.07**
# 17 – I like to learn a lot about nature.	**0.779**	−0.175	**0.732**	0.034		4.00	1.08
# 7 – I like to read a lot about plants and animals.	**0.716**	−0.068	**0.698**	0.125		3.59	1.18
# 13 – I would spend time after school working to fix problems in nature.	**0.695**	−0.180	**0.647**	0.007		3.71	1.14
# 5 – I like to learn a lot about plants and animals.	**0.674**	−0.081	**0.653**	0.100		3.81	1.15
# 9 – I want to learn ways to help protect plants and animals.	**0.631**	0.087	**0.654**	0.257		4.22	0.93
# 18 – I would help to protect plants and animals in my neighborhood.	**0.614**	−0.058	**0.599**	0.107		4.26	0.85
# 15 – I like to spend a lot of time in places that have plants and animals.	**0.594**	0.017	**0.599**	0.177		4.10	1.06
# 12 – I would give a lot of my own money to help plants and animals.	**0.556**	0.051	**0.569**	0.200		3.74	1.18
B. Eco-awareness[d]						**4.32**	**0.97**
# 20 – My life would change a lot if there were no plants and animals.	−0.119	**0.689**	0.066	**0.657**		4.46	1.08
# 11 – My life would change a lot if there were no trees.	−0.130	**0.606**	0.033	**0.571**		4.46	1.07
# 19 – Nature is very easily hurt by people.	0.312	**0.410**	**0.422**	**0.494**		4.11	1.07
# 14 – People need to take much better care of nature.	0.394	0.193	**0.446**	0.299		4.58	0.67
# 6 – Plants and animals are very important to people.	0.294	0.225	0.355	0.304		4.53	0.84
# 8 – Plants and animals are very easily hurt by people.	0.291	0.148	0.331	0.226		4.03	1.14
# 10 – People really need plants to survive.	0.276	0.248	0.343	0.323		4.59	0.72
# 16 – Building new homes and stores are bad for nature.	0.173	0.307	0.255	0.354		3.83	1.21
C. Art-appreciation[e]						**3.79**	**1.17**
# 4 – I like to make arts and crafts.					**0.767**	3.67	1.21
# 3 – I like to draw and color plants and animals.					**0.706**	4.07	1.11
# 2 – I like to make arts and crafts about nature.					**0.528**	3.58	1.22
# 1 – I like to spend time drawing and coloring.					**0.442**	3.82	1.16

Note: Major factor-loading coefficients (≥0.400) for each item are in bold. Pattern and structure coefficients for Factor A and B are based on oblique rotation with two factors. Loadings for Factor C are based on a single-factor extraction (based on item content, Factor C was analyzed independently).

[a]Scale adapted from the CEPS (Larson, Green, and Castleberry 2011). The original instrument did not include the four art-appreciation items.

[b]Cronbach's α for 20 Likert-type items was 0.842.

[c]Cronbach's α for eight eco-affinity items was 0.851.

[d]Cronbach's α for eight eco-awareness items was 0.643.

[e]Cronbach's α for four art-appreciation items was 0.700.

Instrument implementation

To compare the feasibility and utility of the art-based and survey-based assessment tools for EE program participants, the instruments were administered to a diverse group of 6–12-year-old children (n = 285) participating in one-week, day camp, summer programs at two facilities (Sandy Creek Nature Center and Memorial Park) in Athens, GA, during June and July of 2010–2011. Participating camps were systematically selected because of their similar program curriculum (e.g. EE and outdoor recreation) and representation of racial/ethnic and socioeconomic diversity in the Athens, GA area (Table 2).

Trained camp counselors administered the instruments at the beginning of each weekly summer camp session to groups of 10–15 similar-aged children. Children were given a basket of crayons with the drawing and survey instruments; then counselors read aloud the specific directions. Each Likert-type statement was slowly read out loud by counselors twice, allowing time for children to write down their answers and for clarification of questions if needed. This approach required 10–15 min for completion. Drawing prompts were then read aloud and approximately 8–10 min were allotted for children to complete the drawing. Overall, the combined instrument took 20–30 min to administer, with some older children (ages 10–12) completing the instrument in less time.

Study limitations

Although enrollment data suggested that camper distribution reflected demographics of the local area, random selection of participants was not possible due to the nature

Table 2. Demographics of study participants from one-week, day camp summer programs in Athens, GA (2010 and 2011).

Variable	Count	Percentage (%)
Gender		
Male	166	58.2
Female	119	41.8
Age		
6–7	90	31.6
8–9	103	36.1
10–12	92	32.3
Ethnicity		
African American	82	28.8
Asian	30	10.5
Hispanic/Latino	19	6.7
White	154	54.0
Grade		
K-1	77	27.1
2–3	108	37.9
4–6	100	35.0
Scholarship level[a]		
0%	160	56.1
20–60%	17	6.0
80–100%	108	37.9

Note: Information obtained from camp registration forms provided by parents/guardians.
[a]Scholarship levels (based on 20% increments) indicate portion of camp registration fee paid by Athens-Clarke County Leisure Services Department based on household size and annual income.

of the registration process and limited number of children the camp could accommodate. Furthermore, despite standardized training, different camp counselors helped to administer instruments with each group. Therefore, some differences in participant scores might be attributed to facilitator effects. All responses were self-reported with the expectation that children would respond honestly. This is a common limitation associated with self-reported data collection, particularly with children (Leeming et al. 1993). Although children were encouraged to respond to the survey questions and drawing prompt independently, it is also possible that their responses and drawings were influenced by those of neighboring peers'. Additionally, though great effort (e.g. focused discussion of rubric factors, inter-rater reliability tests) was taken to minimize the subjectivity of rubrics and potential scoring discrepancies, some score differences could be attributed to rater error. Finally, the rubrics and scales used in this study only depict certain aspects of environmental attitudes and awareness that could be impacted by EE programs. Different drawing prompts or Likert-type items could be used to address and assess a broader range of potential outcomes. Even slight changes to the current instruments might stimulate other cognitive and affective domains and elicit very different responses. Similarly, the incorporation of different coding strategies (e.g. eco-affinity rubrics, biodiversity recognition based on environmental components, concept mapping, etc.) could provide a more comprehensive look at children's environmental perceptions. Despite these limitations, this study provided one of the first systematic comparisons of art-based evaluation metrics relative to other more conventional EE assessment tools.

Data analysis

Inter-rater reliability on drawing rubrics was analyzed using the Kappa Measure of Agreement and Pearson's product-moment correlations. Reliability among Likert-type items and subscales was measured using Cronbach's α. After using Kaiser–Meyer–Olkin and Bartlett's test of sphericity to confirm data were appropriate for factor analysis, exploratory factor analysis using Principal Axis Factoring (PAF) with oblimin rotation was used to assess discriminant and convergent validity of the Likert-type statements. To assess relationships between children's scores on the various components of the art-based and survey-based instruments, we used two types of non-parametric statistical techniques to compare the ordinal data. Kruskal Wallis tests were used to examine score differences among various response groups (e.g. habitat type for the DET drawings), and Spearman's rank correlation coefficients (i.e. Spearman's rho) were used to examine score differences among subscales that did not involve categorical groupings (e.g. eco-affinity, eco-awareness, DET rubrics).

Results

Art-based components: drawings and rubrics

After several iterations of rubric construction and review, inter-rater reliability scores across each of the drawing rubric factors were high (Table 3). Scores ranged from 1 to 13, with a mean total rubric score of 4.48 (SD = 2.43) and a mean adjusted rubric score (based on the 5-point rating scale) of 1.12 (SD = 0.61) (Table 4). The environmental component mean score was 4.51 (SD = 4.31). Example drawings with associated scores are presented in Figure 2. Children drew biotic factors (75.4%) more often than abiotic factors (47.7%), and most children did not

Table 3. Inter-rater reliability scores (Kappa and Pearson Correlations) for drawing rubric factors of art-based assessment tool (n = 51).

	Reviewer 1 vs. Reviewer 2		Reviewer 1 vs. Reviewer 3		Reviewer 2 vs. Reviewer 3		Mean across all reviewers	
Factor	Kappa	Pearson	Kappa	Pearson	Kappa	Pearson	Kappa	Pearson
Draw-an-ecosystem test rubric								
Human	0.893	0.985	0.963	0.992	0.926	0.983	0.927	0.987
Biotic	1.000	1.000	0.853	0.944	0.884	0.949	0.912	0.964
Abiotic	0.797	0.917	0.660	0.835	0.641	0.807	0.699	0.853
Human built	0.871	0.976	0.827	0.942	0.745	0.910	0.814	0.943
Habitat type	0.835	1.000	0.889	1.000	0.835	0.889	0.869	0.912

Table 4. Mean scores M and SD for the art-based assessment tool: DET (n = 285).

Drawing rubric factor	*M*	SD
DET rubric[a]		
Human	0.54	1.12
Biotic	1.60	1.10
Abiotic	0.97	1.12
Human built	1.39	1.19
Average rubric score	4.48	2.43
Environmental component[b]	4.51	4.31

[a]Factor scored based on five levels of interaction: zero = not present, one = present, two = basic interaction, three = complex interaction, four = explicit interaction.
[b]Environmental Component scored based on presence and number of 15 natural elements.

explicitly incorporate humans into their drawings (21.4%) (Table 5). Although many children acknowledged different elements of ecosystems, few children depicted interactions among these components. Backyard habitats were most commonly drawn (43.2%), followed by natural outdoor settings (29.5%). Children included a variety of natural elements in their drawings, with plants (e.g. trees, grass, bushes, and flowers) depicted in 70.0% of drawings. Wild animals were depicted in 20.0% of drawings, with mammals drawn the most (27.0%) followed by birds (8.1%). Fish (3.5%) and Herptofauna were drawn the least (2.8%) (Table 5). The presence of water (18.2%), sun (16.5%), and clouds (11.9%) were other natural elements commonly depicted within the DET drawings.

Survey-based component: Likert-type statements

Overall, reliability scores for Likert-type items on the survey-based portion of the assessment were high (Cronbach's α = 0.842). The PAF revealed an optimal two-factor solution that accounted for 33.76% of the total scale variance. Factor one had an eigenvalue of 4.17 (explaining 26.1% of the total variance) and factor two had an eigenvalue of 1.23 (explaining 7.7% of the total variance). Based on factor scores and item content supported by previous iterations of the CEPS instrument (Larson, Green, and Castleberry 2011), two distinct factors emerged: eco-affinity (M = 3.93, SD = 1.07) and eco-awareness (M = 4.32, SD = 0.97, Table 1). A total of eight items loaded strongly on the eco-affinity construct (an aspect of environmental

Table 5. Presence of drawing rubric elements on the DET of the art-based assessment tool (n = 285).

Rubric factor	DET Count[a]	Percentage (%)
DET rubric		
Human	61	21.4
Biotic	215	75.4
Abiotic	136	47.7
Human built	186	65.3
Habitat type		
Indoor	28	9.8
Backyard	123	43.2
Park or playground	50	17.5
Natural outdoor	84	29.5
Environmental components		
Wild animals	57	20.0
Domestic animals	21	7.4
Mammals	77	27.0
Birds	23	8.1
Herptofauna	8	2.8
Fish	10	3.5
Insects	11	3.9
Plants	200	70.2
Bushes	16	5.6
Grass	139	48.8
Trees	150	52.6
Flowers	21	7.4
Water	52	18.2
Sun	47	16.5
Clouds	34	11.9

[a]Number of children's drawings depicting these rubric factors.

attitudes) and three items loaded strongly on the cognitive eco-awareness construct (Table 1). Although low loadings (<0.4) and cross-loadings were obtained for two eco-awareness items, all items with relevant content were retained for further assessment. For instance, despite their low factor-loading scores, items addressing the importance of plants and animals represented an important component of the eco-awareness construct (Larson, Green, and Castleberry 2011). The oblique rotation strategy used in the factor analysis accounted for correlations among the factors, supporting the idea that each construct was related to the other. An independent PAF analysis with the four art-related Likert-type statements revealed an optimal one-factor solution that accounted for 39.0% of the total scale variance, with an eigenvalue of 1.56 (Table 1). As previously mentioned, this unique factor was defined as art appreciation (M = 3.79, SD = 1.17).

Comparing survey-based and art-based evaluation components

The art-based and survey-based components of our instrument were designed to assess similar elements of environmental attitudes (i.e. eco-affinity) and awareness (i.e. eco-awareness), but analyses did not reveal statistically significant similarities between the drawings and Likert-type scales. Although children who depicted natural or somewhat natural habitats in the DET (e.g. parks, backyards) generally

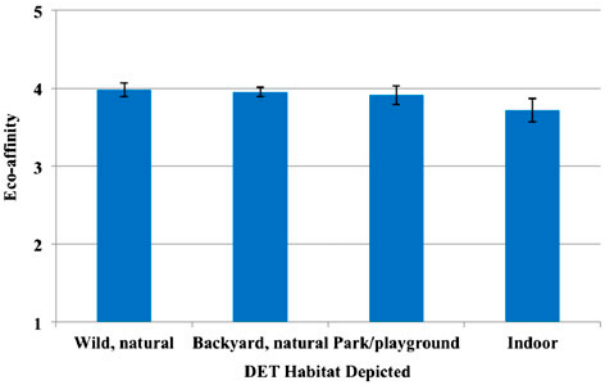

Figure 3. Relationship between children's scores on the eco-affinity survey construct and habitats depicted in the DET.

displayed higher eco-affinity scores on CEPS than children who portrayed developed or indoor settings, these differences were not statistically significant, Kruskal–Wallis $\chi^2(3) = 2.51$, $p = 0.474$ (Figure 3). Similarly, children who demonstrated higher mean eco-awareness on CEPS tended to earn slightly higher overall DET rubric scores ($\rho = 0.08$, $p = 0.186$) and environmental component scores ($\rho = 0.06$, $p = 0.355$), but these correlations also lacked statistical significance (Figure 4). Overall, results suggested that, despite efforts to align the drawing prompt and Likert-type items, each assessment strategy appeared to be measuring somewhat distinct aspects of children's environmental attitudes and awareness.

Although correlations *between* the art-based and survey-based instrument components were minimal, correlations among different constructs *within* the drawing and CEPS were substantial. For instance, children's scores on the eco-affinity and eco-awareness scales of CEPS were highly correlated ($\rho = 0.413$, $p < 0.001$). Similarly, DET rubric and environmental component scores were also strongly linked

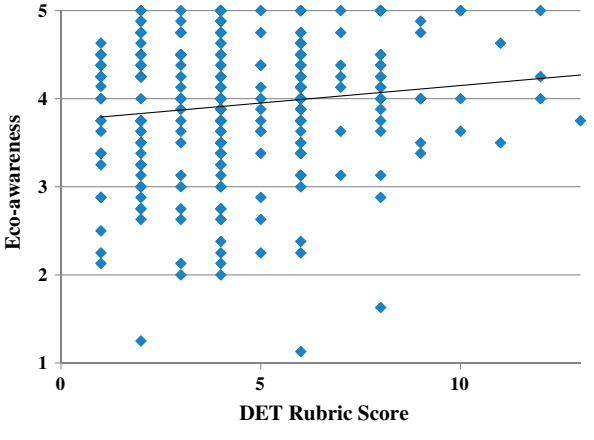

Figure 4. Relationship between children's scores on the eco-awareness survey construct and the DET rubric.

(ρ = 0.387, p < 0.001). Children with higher scores on the art-appreciation items scored higher on the eco-affinity (ρ = 0.497, p < 0.001) and eco-awareness (ρ = 0.195, p = 0.001) subscales. Art appreciation scores were loosely associated with DET habitat type [Kruskall–Wallis $\chi^2(3) = 2.87$, p = 0.412], DET rubric scores (ρ = 0.10, p = 0.102), and environmental component scores (ρ = 0.14, p = 0.055), but these relationships were not statistically significant.

Discussion

Art-based components: drawings and rubrics

What children draw and how children think are closely connected (Vygotsky 1971), and children are often more adept at thinking in images and mental representations than in words (Gunstone 1992). For these reasons, drawings may offer unique insight into children's environmental orientations (Alerby 2000; Barraza 1999; Bowker 2007; Dentzau and Martinez 2014). Drawing prompts therefore represent a valuable alternative to conventional survey-based EE assessments, and an effective means of evaluating both affective and cognitive ways of knowing. From photographs to simple pencil drawings, art-based evaluations allow children to explore their creativity and express their ideas and opinions in a low-stress, hands-on, task-centered activity (James, Jenks, and Prout 1998; Tunstall, Tapsell, and House 2004).

The art-based component of this study demonstrated how the use of drawings with scoring rubrics is an efficient and developmentally appropriate means of measuring children's environmental attitudes and awareness. Results of the DET suggested children viewed their local ecosystem as being comprised mainly of biotic factors (e.g. plants and animals) and human-built structures (e.g. houses, cars, and playgrounds). Humans were rarely depicted in drawings, underscoring a perceived disconnect between humans and the natural world that has been examined and documented elsewhere (Bruni and Schultz 2010; Vining, Merrick, and Price 2008). In the DET, children often portrayed backyard settings. This insight is not surprising considering the majority of children sampled were from a relatively urban–suburban environment, and it emphasizes the important connections between children and nature that develop based on local experience, a key tenet of the place-based education theory that drives many EE programs (Inwood 2008a; Reinsborough 2008). According to place-based theory, if children develop strong physical, emotional, and spiritual bonds with their place and community, they are more likely to care for it (Inwood 2008a). Art may foster these connections, helping children to understand and express the interdependence and interconnectedness of all things (Blandy and Hoffman 1993).

Animals were only depicted in about one-fourth of the drawings. Despite the fact that most children were from an urban–suburban background, wild animals were drawn more often than domestic animals. Most of these wild animals depicted were drawn in natural outdoor habitats. The absence of animals in many drawings was surprising considering previous research that shows young children express an inherent appreciation of animals and the places they inhabit (Kellert and Wilson 1993; Meyers, Saunders, and Garrett 2004; Owens 2005). Their passion for the natural environment often begins with a focus on individual animals' needs, then expands into concern for species, populations, communities, ecosystems, and ultimately, the

human actions that may affect them (Meyers, Saunders, and Garrett 2004). An explicit focus on animals in art-based evaluation strategies might therefore contextualize children's knowledge by focusing on a specific source of fascination (i.e. animals), perhaps providing an alternate route to exposing and assessing environmental concepts that might not be otherwise obtained through drawing prompts such as the one used in this study. Regardless of these limitations, overall data demonstrate how alternative forms of expression such as drawing may help children activate mental schema and concepts less accessible through survey-based evaluation strategies.

Survey-based component: Likert-type statements

Previous research has demonstrated the utility of Likert-type statements as an efficient and effective means of measuring children's environmental orientations (Larson, Green, and Castleberry 2011; Leeming, Dwyer, and Bracken 1995; Manoli, Johnson, and Dunlap 2007). This study confirmed the efficacy of one particular scale (i.e. CEPS) for measuring two components of environmental orientations often seen as desired outcomes of EE programming: eco-affinity and eco-awareness. Mean eco-affinity scores suggested children generally displayed high levels of personal interest in nature and enjoyed engaging in activities that support environmental protection. Mean eco-awareness scores suggested that most children recognized nature as an important component to human survival and were concerned about threats to environmental integrity. Survey results support other findings indicating that, from a young age, children value and have an appreciation, interest, and concern for animals and their environments (Kellert and Wilson 1993; Meyers, Saunders, and Garrett 2004; Owens 2005). This inherent passion for nature progresses toward a more sophisticated understanding of ecosystem-level connections as children age (Leach et al. 1996).

Children's responses to the art-appreciation survey items revealed a preference for drawing, coloring, and creating crafts centered on plants, animals, and nature, reinforcing the importance of art in nature-based programming. Art-based activities that allow for creative exploration and self-expression provide opportunities for hands-on experience, making the evaluation process more personal, memorable, and enjoyable (Alerby 2000; Bowker 2007; Jacobson, McDuff, and Monroe 2006; Zoldosova and Prokop 2006). Given children's enthusiasm for art and the pedagogical value of art-based activities, these survey results reiterated the potential value of art activities in EE programming evaluation. Although both the art-based and survey-based instruments independently provided useful insights about children's environmental attitudes and awareness, we were most interested to examine the efficacy and utility of the drawing-based approach in conjunction with the survey-based assessment strategy.

Comparing art-based and survey-based evaluation components

Comparisons of DET and CEPS revealed relatively weak inter-instrument correlations among the different components designed to measure environmental attitudes and awareness. In other words, efforts to cross-validate children's eco-affinity and eco-awareness using drawing and survey scores were generally not successful. Children that displayed high eco-affinity did not necessarily depict natural settings in their drawings, and children that displayed high eco-awareness did not always score

well on the DET rubric designed to measure knowledge of important environmental interactions and ecosystem complexity. These observed discrepancies may exist for several reasons and highlight challenges associated with each type of assessment tool:

- *Though art fosters affective modes of expression, evaluating this affect is challenging.* It may be difficult to effectively capture eco-affinity and other attitudinal components through drawings. Assessment often depends on interpretation of the image by an observer, and the observer may not fully understand or articulate children's actual values and environmental orientations without additional explanation. Improved rubrics and art-assessment strategies that target affective outcomes are needed, and might include strategies such as brief interviews that allow children to explain drawings.
- *Though surveys facilitate quantitative assessment, they are generally subjective and one-dimensional.* Surveys based on self-reports of eco-awareness are particularly problematic because these assessments are subject to a range of respondent biases (i.e. expectancy bias, social desirability, etc.). Open-ended drawings provide a more concrete, performance-based measure of awareness – though still subject to interpretation. The drawing approach may also create opportunities for more complex forms of expression that capture dynamic ecosystem interactions (e.g. life cycles, nutrient cycles, prey–predator interaction, etc.). Survey questions tend to be more one-dimensional and static.
- *Children's preferences and proclivities for various approaches can lead to measurement bias.* As the similar within-assessment tool scores suggest, biases associated with each measurement strategy and participant preferences likely impacted scores. Some children perform better on surveys; some perform better on drawings. While survey performance is affected by reading and listening comprehension skills, drawing performance may depend on artistic aptitude, proclivity for creative expression, and developmental proficiency (i.e. children may be hesitant to portray things they cannot draw well). Performance on both assessment types are influenced by children's skills, confidence, and age-based levels of cognitive development. These factors might mask true environmental attitudes and awareness expressed through surveys and drawings, and should be considered when interpreting results.

It is important to consider these potential limitations when implementing either type of instrument. Recent research has called for an increasing diverse array of mixed-method approaches to evaluate EE programs (Carleton-Hug and Hug 2010). Overall, this study's findings suggest that both art-based and survey-based assessment tools represent independently useful strategies for measuring two key outcomes of children's EE: environmental attitudes and awareness. Utilization of a single assessment tool may generate an incomplete picture of children's environmental perceptions and the effect of EE programs on targeted outcomes.

Conclusions and recommendations

Based on current limitations, there is clearly a need for novel forms of assessment that allow researchers and practitioners to integrate existing approaches *and* measure

complex elements of children's environmental perceptions in new ways. Drawing prompts represent a promising strategy for accomplishing this goal, and the use of scoring rubrics to evaluate drawings is a reliable and valid method for generating a quantitative score of a qualitative work (Barraza 1999; Bowker 2007; Cronin-Jones 2005; Dentzau and Martinez 2014; Moseley, Desjean-Perrotta, and Utley 2010). Drawings create a learner-centered method for evaluating environmental attitudes and awareness and the efficacy of EE programs – helping researchers and practitioners better understand children's cognitive grasp of complex environmental issues through creative expression. Despite these inherent advantages over types of assessment tools, our results suggest that an approach that integrates both innovative (i.e. art-based) and conventional (i.e. survey-based) strategies might be the most effective means of evaluating children's environmental attitudes and awareness. Such a mixed-methods model could effectively capture a broad range of cognitive and affective EE program outcomes, encourage multiple forms of expression and stimulating participant engagement, and minimize misinterpretation associated with potential measurement bias.

Future research should continue to examine the potential role of art as an interdisciplinary teaching, learning, and evaluation tool for EE across a variety of contexts by explicitly considering audience (e.g. children vs. adults), type of program (e.g. formal or classroom science-based vs. non-formal or outdoor place-based), and specific learning objectives (e.g. stimulate interest in nature, encourage cognitive growth). Future studies could also explore the relative efficacy of various art media (e.g. music, theatre, writing) within EE programming and assessment. Because art represents a unique form of expression that typically transcends language and cultural barriers, art-based assessment tools may be an effective way to bridge gaps between children from different socioeconomic and intellectual backgrounds. For these reasons, art-based approaches are very adaptable and could be particularly useful in an international context (Carleton-Hug and Hug 2010). As an added benefit, art is viewed as a key enrichment activity and communication medium for at-risk youth and those struggling to cope with learning disabilities and other challenges (Brown, Benedet, and Armistead 2009; Mitchell 2008). Future EE evaluation work could also capitalize on the unique benefits of art by employing longitudinal studies that allow children to use artistic forms of expression to depict their evolving views of the natural world as time progresses.

As innovative approaches to art-based evaluation create new possibilities for EE assessment, more research is needed to explore the reliability and validity of these novel measurement tools. This study demonstrated how drawing prompts might be used to assess two key EE outcomes (i.e. environmental attitudes and awareness) and highlighted opportunities for enhancement through integration with more conventional survey-based instruments. Future studies should continue to explore the utility of art-based approaches to EE programming and evaluation and the influence of these strategies on the complex relationship between children and nature.

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References

Alerby, E. 2000. "A Way of Visualizing Children's and Young People's Thoughts about the Environment: A Study of Drawings." *Environmental Education Research* 6 (3): 205–222.

Armstrong, T. 1994. *Multiple Intelligences in the Classroom*. Alexandria, VA: American Society for Curriculum Development.

Athman, J., and M. Monroe. 2001. "Elements of Effective Environmental Education Programs." In *Defining Best Practices in Boating and Fishing Education*, edited by A. Fedler, 37–48. Washington, DC: Recreational Boating and Fishing Foundation.

Ballantyne, R., and J. Packer. 2009. "Introducing a Fifth Pedagogy: Experience-Based Strategies for Facilitating Learning in Natural Environments." *Environmental Education Research* 15 (2): 243–262.

Barraza, L. 1999. "Children's Drawings about the Environment." *Environmental Education Research* 5 (1): 49–66.

Bartosh, O., M. Tudor, L. Ferguson, and C. Taylor. 2006. "Improving Test Scores through Environmental Education: Is It Possible?" *Applied Environmental Education and Communication* 5: 161–169.

Bartram, R. 2005. "Nature, Art, and Indifference." *Cultural Geographies* 12: 1–17.

Blandy, D., and E. Hoffman. 1993. "Toward an Art Education of Place." *Studies in Art Education* 35 (1): 22–33.

Bogner, F. X. 1998. "The Influence of Short-Term Outdoor Ecology Education on Long-Term Variables of Environmental Perspective." *Journal of Environmental Education* 29 (4): 17–29.

Bowker, R. 2007. "Children's Perceptions and Learning About Tropical Rainforests: An Analysis of Their Drawings." *Environmental Education Research* 13 (1): 75–96.

Brown, E. D., B. Benedet, and M. E. Armistead. 2009. "Arts Enrichment and School Readiness for Children at Risk." *Early Childhood Research Quarterly* 25: 112–124.

Bruni, C. M., and P. W. Schultz. 2010. "Implicit Beliefs About Self and Nature: Evidence from an IAT Game." *Journal of Environmental Psychology* 30: 95–102. doi:10.1177/0013916511402062.

Burnaford, G., A. Aprill, and C. Weiss. 2001. *Renaissance in the Classroom: Arts Integration and Meaningful Learning*. Mahwah, NJ: Lawrence Erlbaum Associates & Chicago Arts Partnerships in Education (CAPE).

Carleton-Hug, A., and J. W. Hug. 2010. "Challenges and Opportunities for Evaluating Environmental Education Programs." *Evaluation and Program Planning* 33: 159–164. doi:10.1016/j.evalprogplan.2009.07.005.

Carr, D. 2004. "Moral Values and the Arts in Environmental Education: Towards an Ethics of Aesthetic Appreciation." *Journal of Philosophy of Education* 38 (2): 221–239.
Carrier, S. J. 2009. "Environmental Education in the Schoolyard: Learning Styles and Gender." *The Journal of Environmental Education* 40 (3): 2–12.
Chawla, L. 1986. "The Ecology of Environmental Memory." *Children's Environments Quarterly* 3 (4): 34–42.
Cronin-Jones, L. 2005. "Using Drawings to Assess Student Perceptions of Schoolyard Habitats: A Case Study of Reform-Based Research in the United States." *Canadian Journal of Environmental Education* 10: 225–240.
Cutter-Mackenzie, A., and R. Smith. 2003. "Ecological Literacy: The 'Missing Paradigm' in Environmental Education (Part One)." *Environmental Education Research* 9 (4): 497–524.
Dentzau, M. W., and A. J. G. Martinez. 2014. "The Development and Validation of an Alternative Assessment to Measure Changes in Understanding of the Longleaf Pine Ecosystem." *Environmental Education Research*. doi:10.1080/13504622.2014.930728.
Dillon, J., and W. Scott. 2002. "Editorial: Perspectives on Environmental Education-Related Research in Science Education." *International Journal of Science Education* 24 (11): 1111–1117.
Dresner, M., and M. Gill. 1994. "Environmental Education at Summer Nature Camp." *Journal of Environmental Education* 25 (3): 35–41.
Driskell, D. 2002. *Creating Better Cities with Children and Youth: A Manual for Participation*. Paris: United Nations Educational, Scientific and Cultural Organization & Earthscan Publications Ltd.
Eisner, E. W. 1999. "The Uses and Limits of Performance Assessment." *Phi Delta Kappan* 80 (9): 658–660.
Evans, G. W., G. Brauchle, A. Haq, R. Stecker, K. Wong, and E. Shapiro. 2007. "Young Children's Environmental Attitudes and Behaviors." *Environment and Behavior* 39 (5): 635–658.
Farnsworth, B. E. 2011. "Conservation Photography as Environmental Education: Focus on the Pedagogues." *Environmental Education Research* 17 (6): 768–787.
Fisman, L. 2005. "The Effects of Local Learning on Environmental Awareness in Children: An Empirical Investigation." *Journal of Environmental Education* 36 (3): 39–50.
Gardner, H. 1999. *The Disciplined Mind: What All Students Should Understand*. New York: Simon and Schuster.
Gardner, H. 2000. *Intelligence Reframed: Multiple Intelligences for the 21st Century*. New York: Basic Books.
Gray, D. B., R. J. Borden, and R. H. Weigel. 1985. *Ecological Beliefs and Behaviors: Assessment and Change*. Westport, CT: Greenwood Press.
Gunstone, R. 1992. *Probing Understanding*. London: Falmer Press.
Inwood, H. J. 2008a. "At a Crossroads: Situating Place-Based Art Education." *Canadian Journal of Environmental Education* 13 (1): 29–41.
Inwood, H. J. 2008b. "Mapping Eco-Art." *Canadian Review of Art Education* 35: 57–73.
Inwood, H. J., and R. W. Taylor. 2012. "Creative Approaches to Environmental Learning: Two Perspectives on Teaching Environmental Art Education." *International Electronic Journal of Environmental Education* 2 (1): 65–75.
Jacobson, S. K., M. D. McDuff, and M. C. Monroe. 2006. *Conservation Education and Outreach Techniques*. Oxford: Oxford University Press.
James, A., C. Jenks, and A. Prout. 1998. *Theorizing Childhood*. Cambridge: Polity Press.
Kaiser, F. G., B. Oerke, and F. X. Bogner. 2007. "Behavior-Based Environmental Attitude: Development of an Instrument for Adolescents." *Journal of Environmental Psychology* 27: 242–251.
Kellert, S. R., and E. O. Wilson. 1993. *The Biophilia Hypothesis*. Washington, DC: Island Press.
Larson, L. R., G. T. Green, and S. B. Castleberry. 2011. "Construction and Validation of an Instrument to Measure Environmental Orientations in a Diverse Group of Children." *Environment and Behavior* 43 (1): 72–89.
Leach, J., R. Driver, C. Scott, and C. Wood-Robinson. 1996. "Children's Ideas about Ecology: Ideas Found in Children Aged 5–16 about the Interdependency of Organisms." *International Journal of Science Education* 18 (2): 129–141.

Leeming, F. C., W. O. Dwyer, and B. A. Bracken. 1995. "Children's Environmental Attitude and Knowledge Scale: Construction and Validation." *Journal of Environmental Education* 26 (3): 22–31.

Leeming, F. C., W. O. Dwyer, B. E. Porter, and M. K. Cobern. 1993. "Outcome Research in Environmental Education: A Critical Review." *Journal of Environmental Education* 24 (4): 8–21.

Lewis, D., and J. Greene. 1983. *Your Child's Drawings Their Hidden Meaning*. London: Hutchinson.

Malchiodi, C. A. 2003. *Handbook of Art Therapy*. New York: The Guilford Press.

Manoli, C., B. Johnson, and R. E. Dunlap. 2007. "Assessing Children's Environmental Worldviews: Modifying and Validating the New Ecological Paradigm Scale for Use with Children." *Journal of Environmental Education* 38 (4): 3–13.

Meyers, O. E., C. D. Saunders, and E. Garrett. 2004. "What Do Children Think Animals Need? Developmental Trends." *Environmental Education Research* 10 (4): 545–562.

Mitchell, D. 2008. *What Really Works in Special and Inclusive Education: Using Evidence-Based Teaching Strategies*. New York: Routledge.

Mittlestaedt, R., L. Sanker, and B. VanderVeer. 1999. "Impact of a Week-long Experiential Education Program on Environmental Attitudes and Awareness." *Journal of Experiential Education* 22 (3): 138–148.

Moseley, C., B. Desjean-Perrotta, and J. Utley. 2010. "The Draw-an-Environment Test Rubric (DAET-R): Exploring Pre-Service Teachers' Mental Models of the Environment." *Environmental Education Research* 16 (2): 189–208.

Oosterhof, A. 2009. *Developing and Using Classroom Assessment*. Columbus, OH: Allyn & Bacon.

Orr, D. W. 1992. *Ecological Literacy: Education and the Transition to a Postmodern World*. Albany, NY: State University of New York Press.

Owens, P. 2005. "Children's Environmental Values in the Early School Years." *International Research in Geographical and Environmental Education* 14 (4): 323–329.

Palmquist, B. C. 1997. "Scoring Rubric for Interview Assessment." *The Physics Teacher* 35 (2): 88–89.

Paterson, J. 2010. "Integrating Environmental Education." *Principal Leadership* 10: 47–51.

Reinsborough, L. 2008. "This Revolution Can Dance: Environmental Education through Community Arts." *Canadian Journal of Environmental Education* 13 (1): 42–56.

Rennie, L. J., and T. Jarvis. 1995. "Children's Choice of Drawings to Communicate Their Ideas about Technology." *Research in Science Education* 25: 239–252.

Rieck, W. A. 2002. "Putting Assessment to the Test." *The Science Teacher* 69 (2): 46–49.

Ruiz-Mallen, I., L. Barraza, B. Bodenhorn, and V. Reyes-Garcia. 2009. "Evaluating the Impact of an Environmental Education Programme: An Empirical Study in Mexico." *Environmental Education Research* 15 (3): 371–387.

Smith, M. H., C. L. Meehan, and P. Castori. 2003. "Children's Drawings: An Alternative Assessment Strategy." In *North American Association for Environmental Education Educators' 2003 Annual Conference*, Anchorage, AK.

Song, Y. I. K. 2012. "Crossroads of Public Art, Nature and Environmental Education." *Environmental Education Research* 18 (6): 797–813. doi:10.1080/13504622.2012.670208.

Tunstall, S., S. Tapsell, and M. House. 2004. "Children's Perceptions of River Landscapes and Play: What Children's Photographs Reveal." *Landscape Research* 29 (2): 181–204.

Van Manen, M. 1990. *Researching Lived Experience: Human Science for an Actions Sensitive Pedagogy*. London: State University of New York.

Vining, J., M. S. Merrick, and E. A. Price. 2008. "The Distinction between Humans and Nature: Human Perceptions of Connectedness to Nature and Elements of the Natural and Unnatural." *Human Ecology Review* 15 (1): 1–11.

Vygotsky, L. S. 1971. *The Psychology of Art*. Cambridge, MA: The MIT Press.

Wallen, R. 2003. "Of Story and Place: Communicating Ecological Principles through Art." *Leonardo* 36 (3): 179–185.

Zoldosova, K., and P. Prokop. 2006. "Education in the Field Influences Children's Ideas and Interest toward Science." Journal of Science Education and Technology 15 (3–4): 304–313.