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Spot-On! Exploring Comprehension of Ecological Concepts with Abstract Art Analogies

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Abstract

Students enrolled in an online general studies course [GNM 2190: Extinct and Threatened Life] at Stockton University were presented with two different pieces of abstract art. They were asked to draw analogies from each piece of art to the ecological concepts studied in the course. Students provided written responses which were submitted as assignments in the learning management software, Blackboard [Bb]. This exercise was described as 'open-ended' by the instructor; no grading rubrics were used. Responses to each piece of art were collected from 47 students and were subsequently uploaded into Quirkosä software for qualitative analysis. Codes representing major concepts studied in the course were developed and applied to student responses. Codes were also developed which focused on the characteristics of the art used by students to create analogies. The major ecologically-related codes emerging from this study included 'endangered, extinct, and threatened'; 'species'; 'ecosystem'; 'vulnerability'; habitat/habitat loss; and wildlife trade. Major codes relating to characteristics of the art included 'color'; 'images'; 'features/techniques'; and 'qualities'. The results from this study confirm that students did incorporate major ecological concepts covered in the course in their analogies derived from abstract art. Moreover, this study revealed the characteristics of the art used by students to draw these analogies.

Keywords

ecology, abstract art, qualitative analysis

Cover Page Footnote

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Introduction

GNM 2190: Extinct and Threatened Life is a course designed to introduce students from many different backgrounds (scientific and non-scientific) to basic concepts of ecology as they relate to extinct and threatened species. Topics in the course include conservation and diversity; characteristics of extinct and threatened species; causes of species decline; the Endangered Species Act; politics of extinction; wildlife trade; climate change and others. Modules discussing the plight of individual species (e.g. gray wolves) are also included. These topics and issues reflect disciplines such as anthropology, politics, economics, biology, and ecology as well as sustainability. Hence, the course can be considered interdisciplinary in nature.

Providing activities which result in meaningful and creative student engagement with content in interdisciplinary and other science courses can be challenging. One approach to achieving depth of engagement, in general, has been suggested by the Arts Integration Network (Implement: Reflection, 2016). They indicate that reflection can help students put learning in perspective and that "reflection is learning". They encourage using reflection to make connections ***between the arts and other subject areas*** and suggest that questions for reflection be framed to "encourage, thoughtful, insightful answers, as opposed to reiterating a 'correct' response."

Making connections ***between the arts and science*** is the goal of STEAM initiatives which strive to integrate art into STEM education. Proponents argue that art can provide ways

for both scientists and laypeople to stretch their understanding of diverse concepts and phenomena (Integrating the arts and humanities into STEM learning, 2016). Art-centric skills such as "visual thinking; recognizing and forming patterns; modeling; getting a 'feel' for systems; and the hand skills learned by using tools, pens, and brushes" have all been considered valuable for developing STEM abilities (Root-Bernstein, 2011).

The author of this paper suggests that ***reflections on art*** can also be considered 'art-centric' and can contribute to the development of STEM/STEAM objectives. Art reflections have not been explored fully in many scientific contexts. However, reflections on art have been utilized in medical education settings. One example which utilizes abstract art is the work of Karkabi and co-workers (2014). They studied the development of reflective capacity in medical practitioners using this type of art. The subjects of this research were not encouraged to use the art as an analogy to ecological concepts (as is the case in this paper). However, these researchers felt that, "While the reaction of the viewer to abstract painting might vary widely (as with figurative art), the viewer is not directed to an image or subject, and she/he has the liberty to flow with her/his imagination and emotions." These properties of abstract art also support its use in reflections about diverse, interdisciplinary topics, such as ecology.

Budzise-Weaver (2016) has encouraged the examination of imagery (in digital art) through qualitative coding, or annotation, to reveal themes and visual stories to further unravel the layers of a visual object. She indicates that this type of detailed focus on art can strengthen student visual literacy skills and enhance their appreciation of art.

Similarly, the work described in this paper required students to reflect on digital images of abstract art. However, in this work, students were also asked to develop analogies from the art to the concepts studied in the course. Hence, the 'visual stories' produced by these students were

guided by the concept of analogy. Qualitative coding was then used to unravel the layers/details of the art used in analogy development ***as well as*** identify major themes involving course concepts.

Methods

Art

Two works of abstract art were chosen randomly by the instructor after doing Google searches using the phrase, 'abstract art'.

The works of art chosen were as follows:

Figure 1. '*Summer Peony*' – Reprinted here with permission from Caroline Ashwood (https://carolineashwood.co.uk/collections/large-original-abstract-wall-art/products/original-abstract-wall-art-summer-peony) (Referred to as Q1 in this paper)

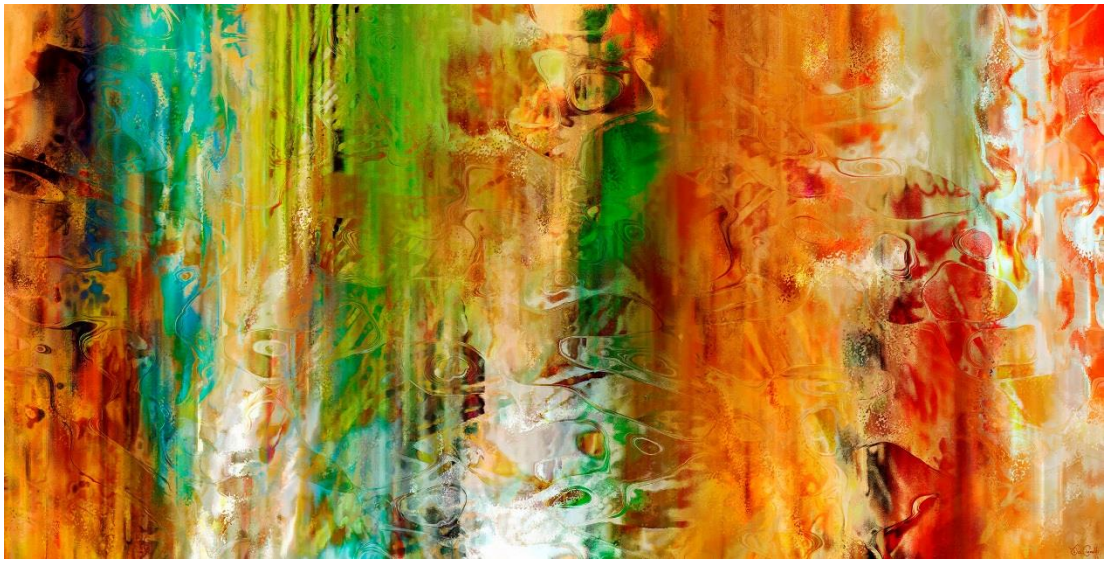

Figure 2. '*Just Being*' – Reprinted here with permission from Jaison Cianelli (http://www.cianellistudios.com/blog/just-being-abstract-art-painting) (Referred to as Q2 in this paper)

Reflection Exercise

Students were asked to reflect upon each piece of artwork and provide responses to the question, 'Utilizing this representation of abstract art, describe/draw an analogy from it that is applicable to the characteristics of extinct and threatened species.' for each artwork. For the purposes of this activity; the titles of the artwork were not revealed to the students prior to the development of their analogies to avoid bias based on title.

Data Collection

Reflective responses to the two pieces of artwork were collected from 47 students who represented the combined enrollment of two online sections (Spring and Fall 2017) of GNM 2190: Extinct and Threatened Life. Data files containing these responses were downloaded

from Blackboard and converted into .docx files. Filenames were changed to ensure student anonymity.

Qualitative Coding/Analysis

Quirkos™ software (www.quirkos.com) was used to code and analyze student responses. Data files containing student responses were uploaded into Quirkos™. Coding was based on the subject matter expertise of the instructor and developed as responses to each artwork were reviewed. No codes were defined prior to review of the responses to either artwork. Codes were also based on the words students chose to write their reflections. On average, 90 to 95% of each student response was coded; the smallest 'fragment' coded was one sentence. Codes applied to each response were reviewed three to four times for accuracy and consistency. Codes for each artwork from each course section were then organized into categories and sub-categories of related concepts. Section categories and sub-categories were then combined for each artwork, re-reviewed and edited where appropriate.

Results

Coding

Eighty (80) and eighty-sex (86) codes were developed from student responses to Q1 and Q2 artworks, respectively. The frequencies with which these codes were applied to student responses to Q1 and Q2 were 730 and 758, respectively. Figures 3 and 4 contain images from Quirkos™ which show the codes and categories developed from student responses to Q1 and Q2. Codes and categories are similar between the two figures but not identical. Colors in Figures 3 and 4 are not related.

Figure 3. Quirkos™ canvas view of codes and categories for Q1 artwork.

Figure 4. Quirkos™ canvas view of codes and categories for Q2 artwork.

Codes, Categories, and Frequencies

Tables 1 and 2 contain codes and categories ***combined*** from responses to Q1 and Q2 artworks. Frequencies of these codes and categories found in responses to Q1 and Q2 individually are also represented and differences are displayed. Table 1 presents data about ecological concepts; Table 2 presents data about art-related features/techniques. Code frequencies do not represent number of students; but rather the frequency with which the code was applied to student responses. Coding frequencies of zero (0) are highlighted in yellow.

Table 1.

Table 1: Ecology-Related Codes, Categories and Frequencies for Q1 and Q2 Artwork					Δ[Q1,Q2] (> or = 5)	
Code	Parent	Grandparent	Q1 Code Frequency	Q2 Code Frequency	Q1	Q2
Endangered, Extinct, Threatened			70	75		Y
Survival	Endangered, Extinct, Threatened		11	15		
Death*	Endangered, Extinct, Threatened		6	3		
Human	Endangered, Extinct, Threatened		18	30		Y
Blood	Human	Endangered, Extinct, Threatened	4	0		
Power	Human	Endangered, Extinct, Threatened	1	0		
Hunting, Overhunting, Overfishing	Human	Endangered, Extinct, Threatened	17	12 [no Overfishing]	Y	
Retaliation Against Animals	Human	Endangered, Extinct, Threatened	0	2		
Overlogging	Human	Endangered, Extinct, Threatened	0	2		
Grand TOTAL			127	127		
Species			85	83		
Beauty [Species]	Species		6	1	Y	
Uniqueness [Species]	Species		4	0		
Plants	Species		19	6	Y	
Flowers [Plants]	Plants	Species	3	0		
Hemlock	Plants	Species	1	0		
Trees	Plants	Species	3	22		Y
Animals	Species		32	38		Y
Mammals*	Animals	Species	3	21		Y
Birds*	Animals	Species	18	15		
Amphibians*	Animals	Species	0	5		Y
Invertebrates*	Animals	Species	3	1		
Fish	Animals	Species	1	2		
Reptiles*	Animals	Species	3	0		
Fungi	Species		0	2		
Grand TOTAL			181	196		
Ecosystem			6	7		
Rainforest	Ecosystem		1	8		Y
Tropics	Ecosystem		1	0		
Great Barrier Reef	Ecosystem		4	0		
Forest	Ecosystem		5	7		
Desert	Ecosystem		0	6		Y
Grand TOTAL			17	28		
Vulnerability			11	12		
Community*	Vulnerability		16	18		
Restriction*	Vulnerability		18	6	Y	
Island	Restriction*	Vulnerability	9	0	Y	
Endemic	Vulnerability		13	7	Y	
Specialization	Vulnerability		4	5		
Altruism*	Vulnerability		3	4		
Slow-Moving, Flightless	Vulnerability		2	4		
Reproductive Rate	Vulnerability		2	10		Y
Grand TOTAL			78	66		
Habitat			10	19		Y
Habitat Loss	Habitat		19	20		
Invasive Species	Habitat Loss	Habitat	2	1		
Fire	Habitat Loss	Habitat	4	7		
Pollution	Habitat Loss	Habitat	1	7		Y
Deforestation	Habitat Loss	Habitat	9	7		
Grand TOTAL			45	61		
Wildlife Trade *			3	2		
Ceremonial Objects	Wildlife Trade*		6	2		
Poaching	Wildlife Trade*		3	2		
Exotic Pets*	Wildlife Trade*		3	1		
Fur [Wildlife Trade*]	Wildlife Trade*		0	2		
Feathers [Wildlife Trade*]	Wildlife Trade*		9	4	Y	
Grand TOTAL			24	13		

*Category name may not reflect words in student responses; Y = Yes, the difference between Q1 and Q2 is greater than or equal to 5.

Table 2.

Table 2: Art-Related Codes, Categories and Frequencies for Q1 and Q2 Artwork					Δ[Q1,Q2] (> or = 5)	
Code	Parent	Grandparent	Q1 Code Frequency	Q2 Code Frequency	Q1	Q2
Color [Art]			62	56	Y	
Red	Color [Art]		12	16		
Orange	Color [Art]		8	11		
Blue	Color [Art]		20	17		
Green	Color [Art]		9	27		Y
Yellow	Color [Art]		15	6	Y	
Black	Color [Art]		1	1		
Purple	Color [Art]		1	1		
White	Color [Art]		3	11		Y
Tan	Color [Art]		1	1		
Brown	Color [Art]		0	19		Y
Grey	Color [Art]		0	1		
Grand TOTAL			132	167		
Images* [Art]			4	0		
Mammals* [Art]	Images* [Art]		2	0		
Fish [Art]	Images* [Art]		6	0	Y	
Flowers [Art]	Images* [Art]		5	0	Y	
Birds [Art]	Images* [Art]		5	3		
Feathers [Art]	Birds [Art]	Images* [Art]	9	4	Y	
Rainforest [Art]	Images* [Art]		0	5		Y
Ocean* [Art]	Images* [Art]		0	4		
Faces* [Art]	Images* [Art]		0	1		
Fur [Art]	Images* [Art]		0	3		
Freshwater* [Art]	Images* [Art]		0	3		
Man [Art]	Images* [Art]		0	1		
Felines* [Art]	Images* [Art]		0	4		
Forest [Art]	Images* [Art]		0	8		Y
Grand TOTAL			31	36		
Features/Techniques* [Art]			0	10		Y
Central Focus - Dispersion* [Art]	Features/Techniques* [Art]		30	0	Y	
Sections [Central Focus - Dispersion]	Central Focus - Dispersion* [Art]	Features/Techniques* [Art]	1	0		
Flowers [Central Focus - Dispersion]	Central Focus - Dispersion* [Art]	Features/Techniques* [Art]	17	0	Y	
Feathers [Central Focus - Dispersion]	Central Focus - Dispersion* [Art]	Features/Techniques* [Art]	2	0		
Fish [Central Focus - Dispersion]	Central Focus - Dispersion* [Art]	Features/Techniques* [Art]	5	0	Y	
TOTAL			55	10		
Brush Strokes [Art]	Features/Techniques* [Art]		3	2		
Sections* [Art]	Features/Techniques* [Art]		5	17		Y
Layers [Art]	Features/Techniques* [Art]		3	1		
Blots [Art]	Features/Techniques* [Art]		0	1		
Blotches [Art]	Features/Techniques* [Art]		0	3		
Patterns [Art]	Features/Techniques* [Art]		0	4		
Dilution* [Art]	Features/Techniques* [Art]		0	3		
Blending* [Art]	Features/Techniques* [Art]		0	5		Y
Bleeding [Art]	Blending* [Art]	Features/Techniques* [Art]	0	3		
TOTAL			11	39		
Grand TOTAL [Features/Techniques]			66	49		
Qualities* [Art]			0	0		
Coolness [Art]	Qualities* [Art]		3	0		
Organization [Art]	Qualities* [Art]		2	1		
Chaos [Art]	Qualities* [Art]		4	1		
Warmth [Art]	Qualities* [Art]		4	0		
Uniqueness [Art]	Qualities* [Art]		2	1		
Beauty [Art]	Qualities* [Art]		3	1		
Emotion* [Art]	Qualities* [Art]		2	4		
Anger, Hostility [Art]	Emotion [Art]	Qualities * [Art]	1	0		
Harmony [Art]	Qualities* [Art]		0	1		
Diversity [Art]	Qualities* [Art]		0	1		
Complexity [Art]	Qualities* [Art]		0	1		
Vibrance [Art]	Qualities* [Art]		6	1	Y	
Life [Art]	Qualities* [Art]		0	1		
Grand TOTAL			27	13		

*Category name may not reflect words in student responses; Y = Yes, the difference between Q1 and Q2 is greater than or equal to 5.

Examples of Student Responses to Q1 and Q2 Artworks

This paper explores analysis of multiple student responses to an essay question involving art and ecology. Hence, the data presented in the tables above is representative of a ***group*** of students and summarizes the group's expression of main themes and concepts. The following examples are presented as representative of ***individual*** student responses evaluated in this study.

Student Response to Q1

"To me, the piece of art looks like it is from the perspective of someone, or something, lying down and looking up. The brush strokes coming in from the sides look like other individuals standing over and looking down. This relates to the characteristic of extinct and threatened species concerning altruism or unselfish care for members of one's own species. When an individual animal is killed or injured, others often come to care for it. This frequently leads to those animals being killed or harmed as well. Looking at the piece of art as being from a species' perspective, it appears that it is looking up and seeing others who have come to help it. This is reinforced by the red paint resembling blood around the edges of the work."

(Presented with permission from author, Brooke Bowman)

Student Response to Q2

In this piece of abstract art, I see beautiful colors and patterns blending together. I relate this to characteristics of extinct and threatened species because all animals in danger contribute to the ecosystem they share. When a specific species goes extinct in a forest, other species in that area are directly affected by it. The way the colors blend in the painting represents the way the animals and plants blend in the wild. An example would be bears need salmon to eat in order to digest and create fertilizer for the plants to grow. This complete circle proves that each species relies on another to survive. (Presented with permission from author, Anna Waters)

Discussion

Deep engagement with the subject matter by students of any course presented in the sciences, humanities, or other disciplines remains a primary goal for most instructors. Methods (tools) through which to attain that engagement have been varied, with varying degrees of success. Perhaps one of the most important questions to ask in this quest for deep engagement is, 'How do you measure (evaluate) it?'.

One index of engagement depth is an accurate understanding of the concepts presented in the course. Another is the ability to relate concepts to one another (i.e. to weave them together) in a meaningful manner. A third can be the development of new concepts and relationships based on core concepts and connections to them.

The tool presented in this paper, student-centric analogy development based on abstract art, can yield evidence that students have an accurate understanding of the concepts presented in the course and that they can relate these concepts together meaningfully. Comparison of two

disparate objects, ecological concepts and abstract art, for similarities also stimulates student creativity. In this exercise, the apparent differences between these two objects seem extreme. However, these disparities were reduced with the application of student understanding of basic concepts of ecology as well as their creativity.

The ecology-related codes, categories, and sub-categories presented in Table 1 (from Q1 and Q2 responses) represent numerous major concepts presented in the course. Topics involving endangered, extinct, and threatened species including the effect of human-related actions on these species (e.g. overhunting, overfishing, overlogging, retaliation against animals) were prevalent. Causes of endangerment (threat) as well as extinction were well-represented (e.g. habitat loss). The characteristics of species (e.g. altruism, slow-moving animals, flightless birds) which render them vulnerable to threat or extinction as well as the wildlife trade were also integral components of student analogies. Various species and ecosystems were also included. Overall, students developed analogies or 'visual stories' based on these topics and their relationships. Inclusion of these topics in their analogies substantiates the fact that students understood the themes and concepts as well as their relationships as presented in course materials.

The art-related codes, categories, and sub-categories presented in Table 2 represent the components of each piece of artwork used to derive the analogies presented by students. Abstract art has been defined as being composed of color and form primarily. Boddy-Evans (2018) describes abstract art as, "… (an art form) without a recognizable subject, which doesn't relate to anything external or try to 'look like' something. Instead the color and form are the subject of the abstract painting. It's completely non-objective or non-representational." Color and form inform most, if not all, of the student-derived analogies presented for both Q1 and Q2

artworks. The plethora of colors chosen as well as details of design presented suggest that students scrutinized the art carefully and thoroughly to find ‘tools’ for their analogies.

While the ecological topics (Table 1) chosen by students for this analogy work are similar between Q1 and Q2 artworks; they are not identical. These differences emphasize the influence of the colors and forms of Q1 and Q2 artworks on student responses.

The ecological topics presented in responses to Q1 emphasize uniqueness of species (e.g. plants); the negative effects of overhunting and overfishing; and, the vulnerability exhibited by endemic species which may be restricted on an island. Collection of feathers for the wildlife trade is also mentioned frequently.

The ecological topics presented in responses to Q2 emphasize the negative actions of humans on other species; multiple species, such as trees, animals, mammals, amphibians; rainforest and desert ecosystems; and the vulnerability of species which have low reproductive rates. Habitats and the pollution of habitats were also mentioned frequently.

Art-related codes (Table 2) which reflect the ‘tools’ chosen by students to write their analogies also reflect differences between artworks, Q1 and Q2.

Major codes, categories and subcategories reflecting the colors and characteristics of Q1 include ‘color’ (in general) as well as ‘yellow’; ‘flowers’, ‘birds’, and ‘feathers’, as images; ‘central-focus – dispersion’ (in general) and ‘sections’, ‘flowers’, and ‘fish’ as components of the central-focus – dispersion feature. While ‘vibrance’ was the quality most frequently associated with Q1.

Colors and characteristics highlighted in Q2 include ‘green’, ‘white’, and ‘brown’ as colors; ‘rainforest’ and ‘forest’ as images; ‘features/techniques’ (in general) as well as ‘sections’ and ‘blending’ as feature subcategories.

Student responses to Q2 included no mention of the ‘central-focus – dispersion’ feature present in responses to Q1. Moreover, the sum of Q2 subcategories: ‘brushstrokes’, ‘sections’, ‘layers’, ‘blots’, ‘blotches’, ‘patterns’, ‘dilution’, ‘blending’, and ‘bleeding’ was much larger than the sum of the same categories for Q1. These findings suggest that students found the form of Q1 more well-defined than that of Q2 and utilized the ‘central-focus – dispersion’ theme from Q1 as a basis for many of their analogies. Q2 required more extensive scrutiny of artwork features for effective analogy development.

In summary, the research presented in this paper highlights the value of reflection on abstract art as an instructional tool in an interdisciplinary science course. Results indicate that this method can foster deeper engagement with the subject matter as evidenced by an understanding of major concepts as well as their relationship(s) to one another. Moreover, a greater appreciation of art, in general, was also observed.

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