Waterfowl and Watercolors: Enhancing Undergraduate Students’ Waterfowl Identification Skills

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Abstract

Accurately identifying waterfowl species can help students understand principles of waterfowl ecology and appreciate biodiversity. Acquiring these skills can be challenging, and effective pedagogies are needed to enhance student learning. I tested if watercolor painting assignments could enhance students’ waterfowl identification skills. Students enrolled in the Waterfowl and Wetlands Management course at Kansas State University were instructed how to identify waterfowl species and their sex using traditional teaching methods (e.g., study specimens, photos) for 4 weeks. I measured baseline knowledge of students’ waterfowl identification skills by administering an unannounced quiz (pre-test). Immediately after the pre-test, students were provided with foundational watercolor training and given a take-home assignment that involved creating four paintings of seven waterfowl species (two of each sex). I administered an unannounced quiz (post-test) immediately after students completed their painting assignments. Average post-test scores increased 13.19 points (range = −15 to 35) and there was a significant difference in the distribution of pre- and post-test scores ($P = 0.06$). My results suggest that lessons involving student-generated watercolor paintings may enhance student learning. This technique may be useful for other undergraduate science courses (e.g., mammalogy, dendrology) that require identification of species or phenotypes.

Core Ideas

- Species identification skills are challenging to develop, necessitating effective pedagogies.
- Watercolor painting may enhance students’ ability to learn challenging scientific material.
- Art-based nature identification assignments may provide enhanced student learning opportunities.

Identifying waterfowl species can be challenging for undergraduate students. However, this skill is necessary to understand principles of waterfowl ecology (Baldassarre and Bolen, 2006; Baldassarre, 2014) and to comprehend and appreciate biodiversity. Traditional pedagogy regarding this topic includes incorporating taxidermy specimens, photography, videos, and field identification into lessons. These tools present challenges for instructors including aged and misshapen taxidermy specimens, unfavorable field conditions to observe waterfowl (e.g., bad weather, no birds), and passive learning of photographs. Although these teaching media are useful, they generally fail to engage students in active-learning approaches. Active-learning teaching techniques can enhance student-learning relative to traditional teaching approaches (e.g., Hake, 1998) while also providing learner benefits for underrepresented students (Haak et al., 2011). Thus, identifying learner-centered ways to effectively teach science, such as flora and fauna identification, is timely and necessary (Duschl and Grandy, 2005).

Humans have used drawings and sketches to describe flora and fauna for millennia (e.g., Lewis, 1806; Darwin, 1868; Chauvet et al., 1996). Additionally, many artists have derived their inspiration from nature (e.g., Harper and Caras, 1994; Magee, 2009). Drawing can enhance scientific thinking (Garramon Merkle, 2018) and is an effective learning strategy (Van Meter and Garner, 2005; Ainsworth et al., 2011) to improve learner memory and observational processes (Van Meter and Garner, 2005). It is plausible that painting may also provide, or enhance, these learner benefits to science education. For instance, creating and applying color hues to replicate complex species- or sex-specific phenotypic characteristics may engage learners’ observation and memorization processes. This active learning approach may be well suited for helping students learn to identify birds (Class: Aves) representing a diverse fauna characterized, in part, by vibrant phenotypic differences in color and morphology (Sibley, 2000; Baldassarre, 2014). To my knowledge, however, no studies have empirically linked science-based student learning with teaching approaches that involve painting.

Using a pre- and post-test study design, I tested if incorporating a watercolor painting assignment into a teaching module could enhance undergraduate students’ waterfowl identification skills. I hypothesized that if students actively painted species- and sex-specific phenotypic traits for hard-to-learn species, they could recall these...
key identification markers in the future. Thus, I predicted that students would have greater post-test scores after completing an active-learning watercolor painting assignment.

**MATERIALS AND METHODS**

I used students (n = 18) enrolled in the Waterfowl and Wetlands Management course at Kansas State University (KSU; Manhattan, KS, USA) to test the effectiveness of a watercolor painting assignment. Students were notified that participation in the study was voluntary and that this assignment was being used as an additional tool to teach waterfowl identification skills. The KSU Institutional Review Board (IRB) approved all methods used in this study (IRB Approval no. 9060).

I used traditional pedagogies to teach waterfowl identification to students for 4 continuous weeks during the fall 2017 semester. These methods included physically inspecting taxidermy specimens, watching videos, studying high-quality images of waterfowl (both species and sex), and field identification. After 4 weeks of instruction, I administered an unannounced test (75 possible points) to assess students’ baseline waterfowl identification knowledge (pre-test). This short-answer pre-test included high-quality photographs of both sexes of various waterfowl species, and students were required to report the common name of each species. All species present on the pre-test were covered in lessons during the prior 4 weeks.

Immediately after the pre-test, I supplied students with watercolor painting tools (i.e., watercolor paint [Color Swell], brushes [Prime Brush, round pointed tips with various sizes], and watercolor paper [Canson, cold-pressed, 11 x 14 cm]). Students were given a foundational watercolor painting lesson by an artist from KSU (H. Ahlers), then provided with stencils portraying heads of seven different waterfowl species (ring-necked duck [Aythya collaris], surf scoter [Melanitta perspicillata], common merganser [Mergus merganser], hooded merganser [Lophodytes cucullatus], redhead [Aythya americana], common goldeneye [Bucephala clangula], and long-tailed duck [Clangula hyemalis]). I chose these species because students indicated difficulties identifying one or both sexes of these species that semester. Additionally, I wanted students to focus on phenotypic variation in head and bill morphology and color to highlight differences in feeding ecology and natural history.

Watercolor painting is challenging to master compared with other methods, such as colored pencils. I chose watercolor as an artistic medium so students would create their own color hues to accurately represent breeding plumage colors present in different species of waterfowl (as opposed to simply choosing a colored pencil or marker that could only approximate the species plumage colors). I did not grade painting assignments or make inference about student learning based on the quality of paintings. However, to alleviate the potential for student angst over unfamiliarity with watercolor painting, they received a short watercolor painting demonstration before starting their own painting assignments (see above). I also conveyed that I was not assessing students on the quality of their work; I wanted students to repetitively focus on creating colors and patterns specific to phenotypes present in different waterfowl species.

I assigned each student a take-home assignment that included creating four paintings for each of seven species (two drakes and two hens for each species, 28 total paintings; Fig. 1). Students had 7 days to complete the assignment and turn in all paintings. Students were allowed to use photographs or other media as models for their painting assignments. Regularly scheduled class periods were cancelled for the duration of the assignment, and the only work students were assigned was this project. After students turned in their assignments, I immediately administered an unannounced quiz to the class (post-test). The post-test had the same design (same species and length, high-quality photographs, short-answer) but included different photographs.

I used a one-tailed Mann–Whitney test (SAS v 9.4, SAS Institute, Cary, NC) to test my null hypothesis that student pre- and post-test scores would not be significantly different. Because of my moderate sample size, I established an a priori cutoff of P ≤ 0.10 for statistical significance. I examined effect size with a Cohen's d statistic (0.2, 0.5, and 0.8 represent small, medium, and large effect sizes, respectively; Cohen, 1998).

**RESULTS**

Eighteen students (3 female, 15 male) completed the pre-test, watercolor assignment, and post-test. Post-test scores were greater than pre-test scores (average increase = 13.19, range = –15 to 35, Fig. 2). The difference in pre-test and post-test score distributions was significant (z = –1.53, P = 0.06) and there was a moderate effect size (d = 0.56).

**DISCUSSION**

My results suggest that incorporating watercolor painting into flora and fauna identification coursework may enhance student learning. These results concur with other studies that have described learner identification benefits of incorporating art into science-based lessons (Van Meter and Garner, 2005; Ainsworth et al., 2011; Garramon Merkle, 2018). Paris et al. (1983) considered drawing a strategic process that was goal oriented and an effective way to improve learning. In some cases painting may also enhance learner benefits gained from...
Active-learning approaches can sometimes fail to enhance student learning largely because instructors lack constructivist approaches to teaching or exercises are poorly designed (e.g., Andrews et al., 2011). Learners can also resist active-learning approaches (Tharayil et al., 2018) because of perceptions of poor instruction quality or reduced learning (Lake, 2001). In my study, students’ post-test scores significantly increased following a watercolor painting assignment, suggesting this may be an effective learner-centered teaching approach. After turning in their assignments, some students remarked that creating appropriate color hues to replicate breeding plumage feathers in some species required multiple attempts and strict concentration. Creating representations of species can affect processes that dictate task performance (Van Meter, 2001) and it is likely that students who created multiple versions of their paintings were better prepared to recall these phenotypic traits when tested on them later. Future studies should quantify how students’ perceptions of this particular assignment may have affected their learning. Although students were not graded on their ability as artists, it is plausible that learners who perceive that their technical painting skills are poor would not benefit from this assignment.

Although these results apply only to waterfowl identification, they will likely extend to other disciplines of science and natural history. For example, students studying dendrology, herpetology, horticulture, ichthyology, mammalogy, mycology, or ornithology may also benefit from generating paintings as an active learning approach to study taxa-specific identification. Additionally, students interested in the physical sciences (e.g., soil science, geology, chemistry) may also benefit from incorporating watercolor painting into soil identification or chemical reaction lessons. Collaboration with experienced artists may be necessary to enhance the effectiveness of painting assignments. It is likely that students would be apprehensive if unfamiliar with watercolor painting. By collaborating with skilled artists to demonstrate use of this artistic medium, instructors may alleviate potential student angst allowing learners to focus on the assignment. Additionally, similar collaborations may reduce the probability of failure associated with learner-centered teaching approaches (e.g., poor instruction design and quality; Lake, 2001; Andrews et al., 2011). These cross-disciplinary partnerships can likely be forged with faculty and graduate students in academic art departments or within local community artist groups.

There are potential caveats associated with my interpretation of these results. This study only included undergraduate students enrolled in one course. Thus, observed effects may only be significant to this class during this semester. Future studies including undergraduate students enrolled in additional nature identification courses across multiple years are needed to investigate evidence for similar patterns. Additionally, my sample may not reflect the true population of undergraduate students enrolled in other colleges and universities. Although this sample size was small, it should be large enough to detect moderate to large effect sizes and may be important for developing hypotheses for subsequent studies (Bissonette, 1999). Future studies should expand this work to include undergraduate students enrolled in classes focused on multiple disciplines (e.g., dendrology, herpetology) and across diverse student populations.

CONCLUSIONS

Instructors should strive to find effective ways to teach science-based knowledge. There is implicit art in nature (Haeckel, 1974; Harper and Caras, 1994; Magee, 2009; Peterson and Peterson, 2013). Leveraging this relationship, through painting, has potential to enhance student-learning outcomes in nature-based undergraduate courses. Painting should be used as an additional active-learning tool rather than replace traditional methods of teaching waterfowl identification. Further, learner-generated painting should be considered a teachable strategy and not just an adjunct aid in science classrooms (Van Meter and Garner, 2005). These strategies will likely be more effective if science instructors include trained artists in the design and implementation of art-based lessons.

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REFERENCES


