



Assessing Science Learning Objectives with Nature Journals

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Abstract

Nature journals are an easy way to get your students outside and to practice making observations of the real world around them. Teachers can formatively assess their student's understanding of learning objectives with nature journal prompts.

Every teacher has experienced something in their life that has sparked an idea in the classroom. For the authors, that has been the purpose of field notebooks through courses that were taken at Indiana University Southeast. Brooke Stewart, one of the authors and a life science teacher, took a field biology class as an undergraduate with Dr. David Taylor at IU Southeast where she studied abroad for two weeks in Australia and the South Pacific. It was in this course where she was first introduced to field notebooks and where she first felt like an actual field biologist.

For Kelly Book, an earth space science teacher and co-author of this article, she also first experienced field notebooks through IU Southeast. However, her course was as a graduate student with the late Dr. Glenn Mason for a weeklong geology field trip class to the Jurassic Coast of England. This was Kelly's first introduction to field work in general, and she got a taste for what it was like to experience learning outside of a traditional classroom setting. For both authors, the field work has provided inspiration to provide similar opportunities for authentic science activities in the classroom through nature journals. For Brooke, she uses them in her Biology and Environmental Science classes. Kelly uses them in her Earth Space 2 class.

Nature journaling has given us an engaging way to assess our students' understanding of the science concepts they have learned in class and their ability to tie those concepts to the real world. Also, by connecting these concepts to their own local environment and drawing them out, it aids in long-term retention of the information. "Studies have shown that the most effective means of retaining information and memory for the long term is through finding familiarity, relevancy, and meaning in an experience" (Muir Laws et. al., 2020, p. 4). Nature journaling can also be a form of scientific inquiry that gives opportunities to ask questions about the world around them and make hypotheses. Not only does it deepen the students' scientific thinking skills, but this cross-curricular approach also gives teachers the opportunity to highlight the individual strengths and interests of more students (Hobart, 2005).

NGSS emphasizes the integration of science and engineering practices. According to *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (National Research Council, 2011), scientists need to be able to communicate their findings in a scientifically literate manner. The book also states that to practice this, students should be using journals with written text to record observations to improve their ability to think and write like a scientist.

Full listing of authors and contacts can be found at the end of this article.



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Integration of Arts into the Sciences: Putting the A in STEAM

Many people do not realize that creativity is an important component of science; we maintain that this is one of the reasons that the STEM acronym has evolved to STEAM to include the arts. Creative scientists are more able to think outside the box and generate new ideas. Creativity comes in many forms, but the most common is in the form of art. Nature journaling often combines art and science through an open-ended process. They allow students to express themselves artistically through drawing, painting, and sketching, which enhances their creativity and self-expression (Coppens, 2022). When we take students outside into nature, each student has their own unique perspective, and we enjoy seeing students' creativity as they try to convey their own perspectives of nature in their own journals.

Nature journals can also be an opportunity for students to practice writing about something that interests them. After implementing nature journaling into language arts classrooms, McMillan and Wilhem (2007) saw evidence of their students using figurative language beyond their language arts classes. It helps students see the art of writing and making observations as more of an interdisciplinary skill that they should carry throughout their lives.

Psychological Benefits of Nature Journaling

Evidence suggests that if a child spends a lot of their time outside, then not only will they become adults who spend a lot of time outside, but also adults who have more positive attitudes towards their local ecosystems (Bollich, 2023; Wells & Lekies, 2006). Students are more easily able to see their role in nature and how nature impacts their lives. Nature journaling provides so many benefits beyond just allowing us to assess their understanding of NGSS. According to Hammond (2002, p. 35), "research has shown us that drawing and writing about something we have just experienced fixes that experience in long-term memory and stimulates relational thinking." Studies have also shown a decrease in symptoms of both attention deficit disorder (ADD) and depression after children spend time in outdoor settings (Snell et al., 2016). Nature journaling also encourages students to pay more attention to the environment and focus on the details of their surroundings (Bollich, 2023).

Assessment Examples using the IDOE Science Standards

At the beginning of the school year, the authors gave each student a '[Rite in the Rain](#)' notebook. First, students are taught how to properly organize field notebooks using a table of contents and page numbers. It was heavily emphasized to students that they need to write their name on the front cover of their nature journal and that they should not lose it. Students did not get a replacement notebook if they lost it during the school year. It is also explained to students that nature journals are not like other journals because they focus on science rather than their feelings. Students are reminded that this is a scientific tool for learning in the classroom, not a personal diary. The authors appreciated that Hammond (2002) allows his students to create a list of their own rules for their notebooks. With this idea in mind, it would be better practice to create field journal norms with our classes that they will follow throughout the upcoming school year.

Since Kelly and Brooke use the nature journals in different areas of study at different grade levels, they use them in ways that work for them as individuals in their own classrooms. Kelly likes to use her nature journals to emphasize concepts covered in geology, meteorology, and astronomy for her dual credit Earth Space 2 class, which is a junior-senior course. Because this class has no state standards, the "Main Course Learning Objectives" and "Learning Content" from Ivy Tech Community College are used in this course. Brooke uses nature journals in her biology classes, a freshmen course, and her Environmental Science class, which is taught to sophomores through seniors. She has a focus on reinforcing the state standards for both of these courses.

For Brooke, one of the most basic standards to teach in both her Environmental Science and biology courses is the difference between abiotic and biotic factors. For this reason, she found it difficult to get students to engage with the material enough for them to commit the terms to memory. Therefore, she believed that a nature journal entry could be the key. After covering the definitions and doing an in-class activity, she assessed their understanding by taking them outside with their notebooks. They were instructed to look in one direction and draw what they saw like they were looking out a window. Then they were supposed to list



Figure 1. Example from teacher’s sample notebook *HS-ENV1-5* - Evaluate, measure, and communicate biological, chemical, and physical (abiotic and biotic) factors within an ecosystem.

all the abiotic and biotic factors within their view. A representation along with the correlating IDOE standard is shown in Figure 1.

Sometimes students struggle to understand that almost everything around them in the natural world (and a lot of the unnatural parts) are part of the carbon cycle. Brooke wanted to create a nature journal task that would help students connect the dots between the scientific principles they learn in the classroom and the world around them. At the start of the activity, she took students on a short walk outside and had them identify

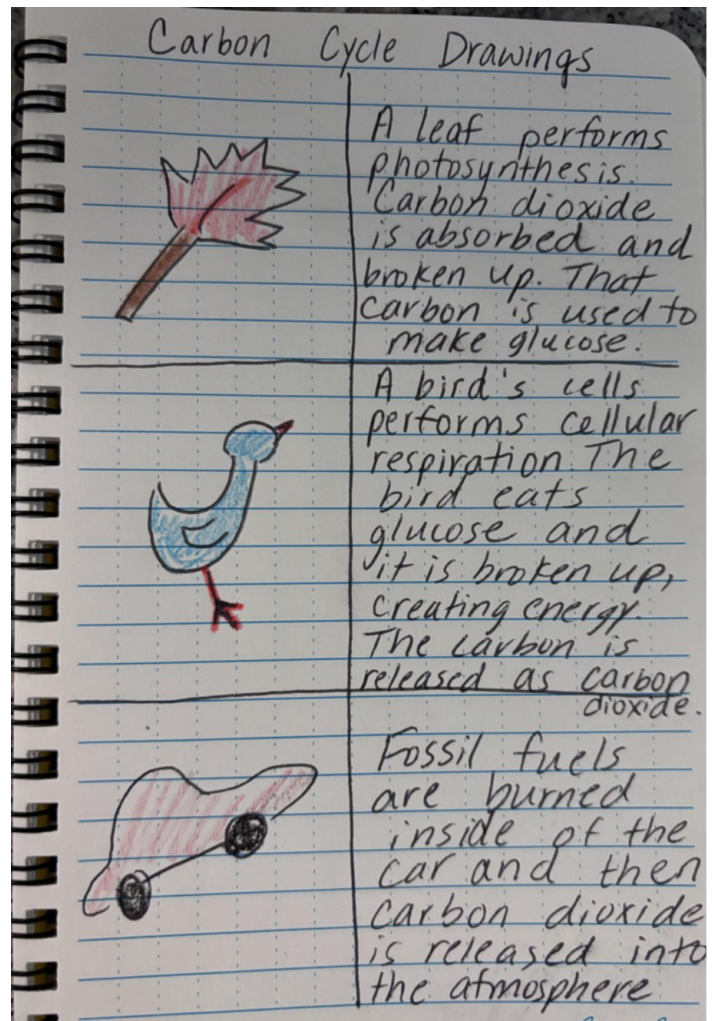


Figure 2. Example from teacher’s sample notebook *HS-LS2-5* - Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

at least three different items that participate in either the long or short carbon cycle. They had to draw the item and then explain how it is part of the carbon cycle. For example, some students drew a car and explained that it burned fossil fuels and released carbon dioxide into the atmosphere (Figure 2). While the class was outside, they were excited about the meaningful conversations that were kindled. Students started to realize almost everything around them was part of the cycle.

This next prompt Brooke gave was part of an introduction to the biodiversity unit. Her goal was for the students to think about local biodiversity before they discussed it on a global scale. Before the class went outside, she had students create a small chart for each of the locations they would be observing (parking lot, forest edge, and crop field). While the class walked through each area, the students marked a tally every time they saw a new type of living species (Figure 3). Then before they moved on to the next area, they wrote a summary of their observations. The last page contained the summary, and the students were instructed to explain which area they thought had the most and least biodiversity. Students were also expected to explain how they thought human intervention affected the biodiversity in each area. One of her students stated, "The field has less biodiversity than the woods because the field is continuously mowed." This led to a conversation about other things the class does at their own homes that can threaten local biodiversity.

Kelly kicks off her year in Earth Space 2 by covering meteorology, one of the four main topics covered in any earth science class. By introducing students to the basic concepts of weather, students are then expected to incorporate each new prompt's daily weather conditions for the entire year. The first prompt of the year starts with students taking a walk around the school's campus and recording any weather conditions that they might observe such as cloud coverage, humidity, temperature, and wind speed (Figure 4). Students then come back

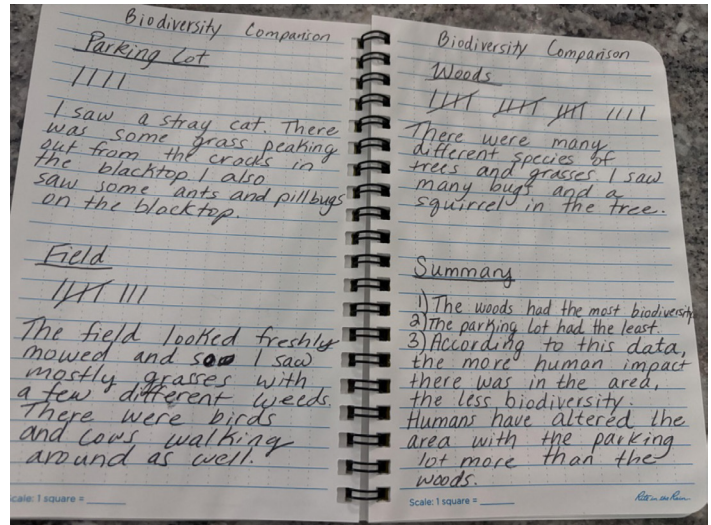


Figure 3. Example from teacher's sample notebook HS-ENV5-5 - Identify the indirect and direct threats to biodiversity.

into the classroom and fill in any missing quantitative data by utilizing local weather reports and websites.

Geology is another core topic of earth science that is also covered in Kelly's Earth Space 2 class. Throughout the year, some of the geology topics the students studied included fossils, minerals, and rocks. Students had already experienced hands-on learning activities with these materials in class, and at this point they are familiar with identifying local specimens. When these nature walks were completed during class time, students would be given instructions to write and draw

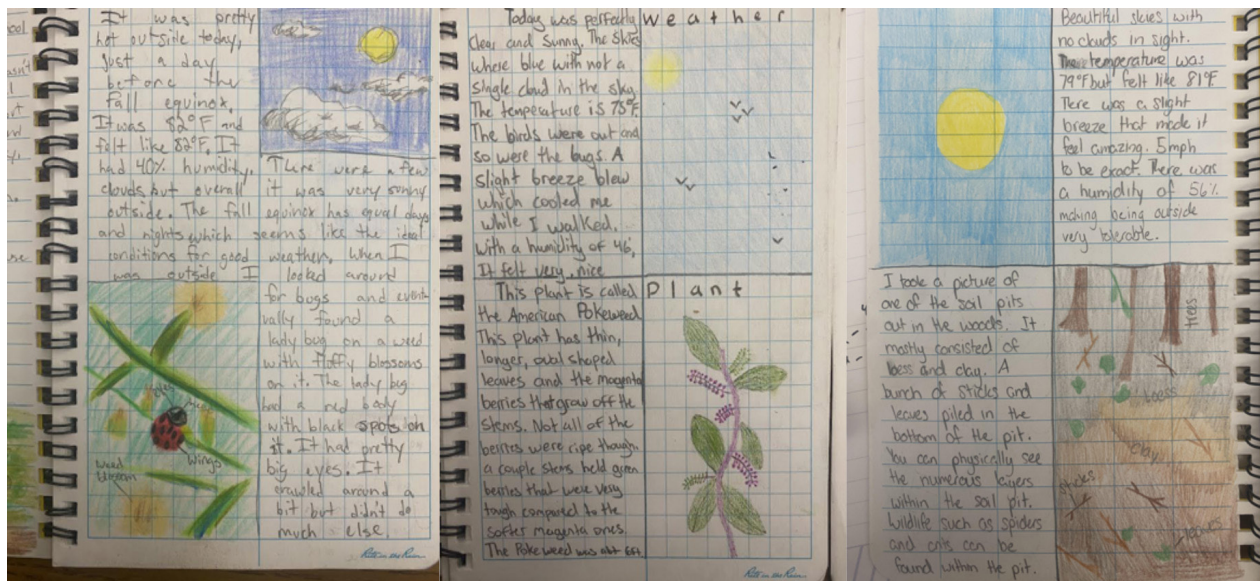


Figure 4. Early examples from student notebooks. Ivy Tech Community College SCIN-100 Major Course Learning Objective #12 - Discuss concepts related to Meteorology and climate processes.



about any geologic feature that they come across (Figure 5). They could often be seen picking up rocks to look for embedded mineral crystals or fossilized remains of Southern Indiana’s prehistoric past. Students then had to not only identify the substance, but they had to make inferences of how that material ended up in that location and what geologic processes have occurred. The amount of excitement and enthusiasm around finding certain fossils lead to some interesting and purposeful conversations when the class discussed their findings. Making connections to the “real world” has inspired students to view the significance of their education differently, and it has led to many days of class time making great memories together.

Perhaps the most exciting nature journal prompt of the 2023-2024 school year occurred on April 8, 2024, during the Great American Eclipse. After learning all that they could in class about the total solar eclipse, Kelly’s Earth Space 2 class came up with their own prompt to fill out in their nature journal on eclipse day. Students were very thorough and included in their prompt the location, percent of totality, shadow observations, weather conditions, animal behavior, contact times, structures of the Sun such as the corona, and so much more. Students were told to write and draw as much as they could observe during the eclipse at their particular location (Figure 6).

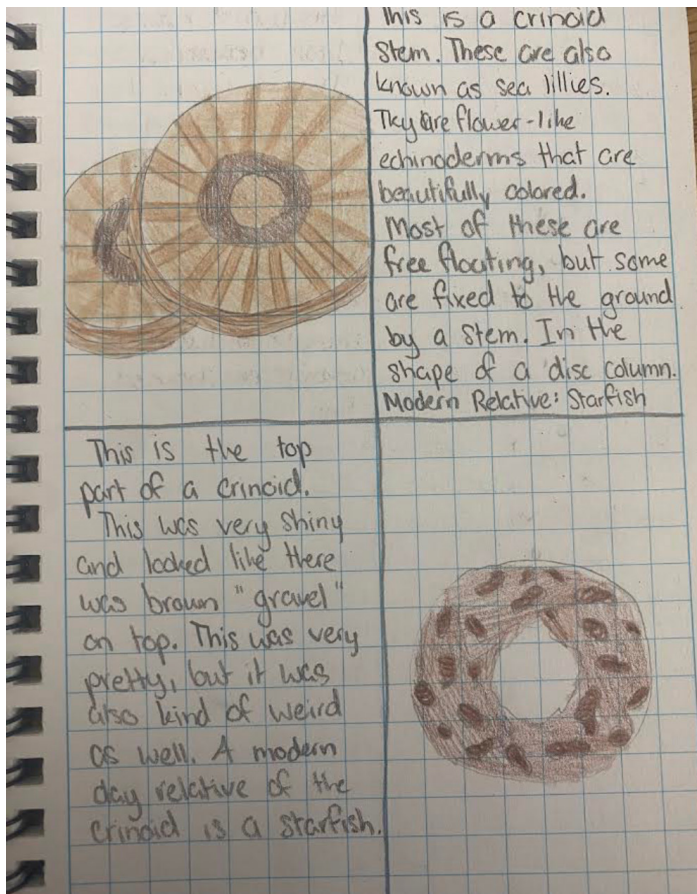


Figure 5. Example from a student notebook introduces concepts of Geologic Time through fossil identification. *Ivy Tech Community College SCIN-100 Major Course Learning Objective #10* - State the age of the earth and explain how earth science measures and organizes the geologic time frame.

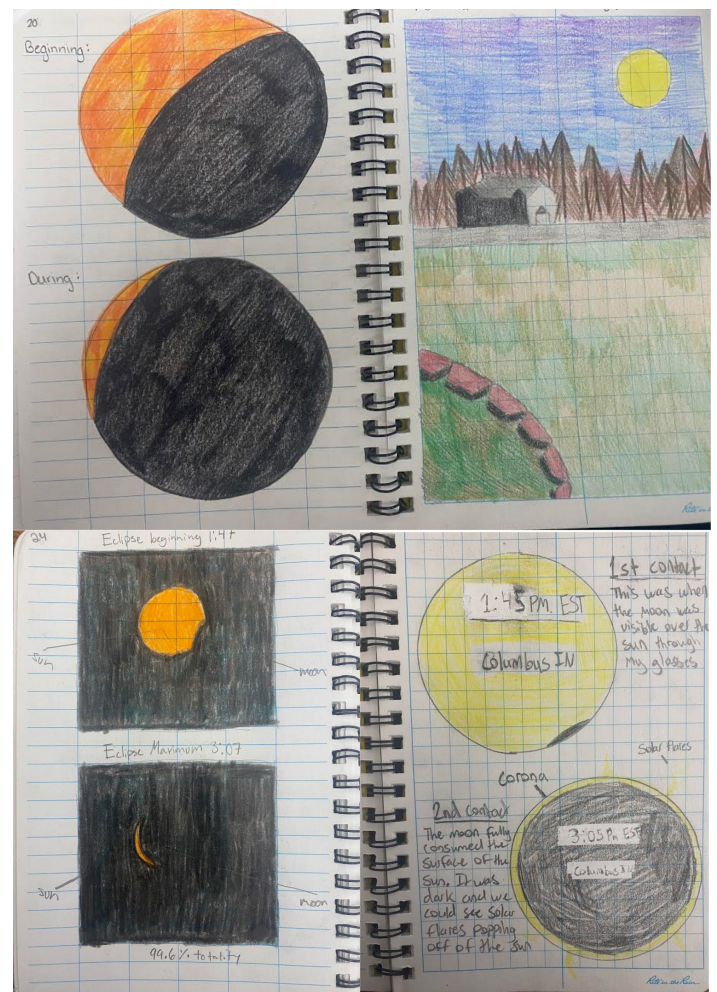


Figure 6. Partial examples from several student notebooks over the total solar eclipse on April 8th, 2024. *Ivy Tech Community College SCIN-100 Course Content - Solar System.*



Technology Integration

Whether we want them to or not, high school students are always trying to find ways to use their cell phones in the classroom. Need a calculator? Get out your cellphone. Need to know the time? Get out your cell phone. We try to occasionally integrate the use of their cell phones for educational, purposeful reasons. Considering this, our classes have integrated the new Look Up iPhone tool, which allows students to take a picture of a plant and reverse image search to identify the plant (see Figure 7). Brooke extended the biodiversity entry mentioned earlier and had students use the Look Up tool to identify a couple of different plants from each of the locations that her class visited. Then when they got back to the classroom, the students were given the opportunity to research the best growth conditions for each plant and learn more about the abiotic components for that area.” In their journals, they were instructed to hypothesize the correlation between the plant’s requirements and where they were found and then relate that back to the biodiversity of each location.

Kelly also utilized the Look Up tool in her Earth Space 2 classroom for the first couple nature journal prompts of the year. Since earth science was a new topic to many of her students, they were first more comfortable implementing their nature journals with familiar life science topics such as plants. Another app other than the Look Up tool that students were encour-



Figure 7. A student using the Look Up iPhone tool to identify a plant.

aged to use to identify plants was the Indiana Wildflowers app. This app had students identify flowering plants found in Indiana by putting in the plant type, flower color, petals, flower size, leaf arrangement, and habitat. Students had to identify plants using one of these digital tools while on a nature walk. After identifying, they looked up what type of soil and climate those plants grow best to tie the assignment back to geology topics. This also helped familiarize students with identifying unknown objects, which became a required skill with geological samples such as rocks and minerals later in the course.

Living in a digital world, there are a plethora of other apps available for students to identify living things outside using their phones or computers. A study was done by Unger et al. (2001) in which undergraduate biology students were asked to identify the taxonomic classifications of organisms they saw in the field with the iNaturalist app. According to their results, the iNaturalist app was accurate 92.3%-97.3% of the time. Brooke thought it was cool that her students could have access to technological tools that experienced scientists use in their own research. Kelly found that the idea of integrating technology with nature gave students a truly subversive experience in their learning.

Plants and fossils are not the only things students can identify using apps. Sometimes looking towards the heavens can generate excitement of new possibilities and discoveries. Perhaps one of the most anticipated topics students learned about in Kelly’s Earth Space 2 is astronomy. Because the students live in a rural community, they have an ease of access to view a clear sky at night. The best part about viewing the night sky or going along any of these nature walks is that they can often be done for free either at school or at students’ homes. As part of Ivy Tech Community College’s Course Content requirement for Earth Space 2, students need to learn about the Solar System. What better way than downloading an app and viewing some visible planets firsthand? The Star Chart app is free to use to find and locate planets in the night sky, and as an added bonus, students can learn about different constellations and be able to spot them throughout the seasons.

With the new announcement of Senate Bill 185 recently being passed, many Indiana teachers might be skeptical of instructing their students to time” (A.B. 185, 2024). Cell phones can be productive in the classroom (or in nature) when given an educational purpose.

Differentiation and Inclusivity

Nature journals can appeal to many types of learners because of the mixed media approach. Students can show their understanding through writing, drawing, graphing, etc. Taking students outside in nature provides opportunities for students and the teacher to have deeper conversations about the classroom concepts they have learned. According to Zurek et al. (2013), during outdoor activities such as nature journaling, “teachers can provide feedback, hints, or assistance to scaffold children’s learning about their environment”.

Nature journal activities can be differentiated by modifying the prompts to require students to perform a higher order thinking. For example, if the goal was to increase the rigor of the carbon cycle activity listed above, students could be challenged to predict the effects on the environment if they removed one of the components of the cycle they drew.

To assist students who struggle with the open-ended prompts, sentence starters can be given as a scaffolding strategy to give them a foundation. John Muir Laws (2020) provides an array of nature journal prompts and sentence starters in his book, *How to Teach Nature Journaling: Curiosity, Wonder, Attention*.

Nature is a global experience shared across many cultures. To incorporate more inclusivity, students

could be introduced to underrepresented voices in the scientific community such as BIPOC and/or female scientists. They could next research their contributions to the topic they are currently studying and include that in their nature journal prompt.

Another way of adding cultural awareness could involve students researching how other countries, cultures, and societies utilize certain materials or ideas that they are currently studying. For example, students could study the cultural significance of constellations across different civilizations. Perhaps this could be done by comparing the constellations of the indigenous peoples of the Americas to those of the Ancient Greeks. They could in turn look for these constellations in the night sky as an activity and write and draw about their findings in their nature journal.

Evaluation of Journals

For each entry, a grading rubric (see Table 1) is used that has categories similar to the one presented by Hammond (2002) in his article titled, *The Creative Journal: A Power Tool for Learning*. According to Farnsworth et al. (2014), the rubric should be flexible if the goal is to encourage student engagement and creativity. Nature journals are graded at every midterm and/or at the end of every nine weeks depending on the teacher. It is emphasized that written feedback from the teacher

Table 1. Nature Journal grading rubric

Nature Journal Grading Rubric			Comments
Quality	5 The entry is easy to read, all pages are numbered, all prompts begin on a new page and have a title on the top of the page, and there is a filled out table of contents.	0-4 The entry lacks readability, pages aren’t numbered, titles aren’t written on the top of the page of each entry on a new page, and/or the table of contents is not completely filled out.	
Creativity	5 There is evidence of student effort with detailed and labeled colored drawings.	0-4 There is little to no evidence of student effort	
Content	5 Mastery of content and detail are recorded through written text and visual drawings. The prompt was answered fully and completely. (Weather conditions are recorded. - Earth Space 2 class only)	0-4 The entry lacks written text and/or visual drawings. The prompt is not completely answered and/or misinformation is present. (No weather conditions are recorded. - Earth Space 2 class only)	

into the nature journals should be taken into consideration, and improvements to future entries are expected with each round of grading. Written feedback for the authors is typically written directly onto the pages of the student work in red ink that stands out on the page for easy viewing. Typically, a few sentences are written on a page after the latest student entry that highlights the successes and improvements of each student, the date that it was graded, and the final score. In the authors' classrooms, nature journals are used as a formative assessment that helps students improve their understanding of the standards and/or learning outcomes before a final summative assessment.

Limitations and Expectations

One of the biggest benefits of nature journaling is that it gets students outside and interacting with nature. Depending on your location, this can be difficult during certain seasons of the year. In Indiana, it is sometimes too cold throughout the second and third quarters of the school year to take students outside. Brooke tried to combat this issue by utilizing a variety of websites with live nature recordings. For example, the website for the National Park Services has hundreds of live video cameras that are located all around the country. She's found several videos that are close enough to her location that allowed students to study their local ecosystems.

Kelly had a somewhat different approach to battling the cold months in Indiana by setting out samples of different fossils, minerals, rocks, etc. that students were currently learning about. They were then given a prompt over these to journal about including identification, formation, and composition. She required the use of stereomicroscopes for most of these prompts so students could see samples at a deeper level. The idea was to view these items at the microscopic scale before observing them at the macroscopic scale. The overall goal for students was to take their knowledge that they learned in class and eventually identify many of these fossils, minerals, and rock samples in a field setting during the warmer spring months. Regardless of what time of year or what the prompt involves, safety should always be stressed throughout the entire year. When students can go outside during school time, it is always important to emphasize with students how long they are expected to be outside, what time and where they should meet up with the teacher, what items they are allowed to collect and bring back to the classroom, and what boundaries and trails on their

school campus they should stay within. Have students set an alarm on their phones to know when they should head to the meeting spot, and have students travel in groups of at least two to three. The teacher should also be walking around during this time and meeting up with various groups of students to offer instructional assistance and to keep an eye on behavior. Informing the office of where the class will be located and providing them with the teacher's cell phone information is also important in case there is an emergency, or a student is called to the office for various reasons.

Students should also know what their behavior expectations are, and what the consequences are for not following those expectations. Not following expectations typically results in a loss of one or more students going outside, messages sent home to guardians, and consequences with administration.

Conclusion

With the NGSS standards being phenomena-based, it can be a struggle for science educators to find phenomena that are cognizant of where the students live and their backgrounds (Sharma et al., 2023). As stated by Lee (2020), "using local phenomena is critical when working with students who have not experienced science and engineering as real or relevant to their lives for future careers". Through nature journaling, students can develop a personal connection to their local environment and can also form an appreciation for its ecological history.

In the future, it would be beneficial to give our students more opportunities to share their nature journals with their peers. Not only is it an empowering experience for them, but it helps them think in new or different ways. Inviting students to voluntarily share their journals with others will also make their journals feel more valuable (Farnsworth et al., 2014).

Nature journals can be empowering and a source of pride for students because it gives them the opportunity to be an author (Hammond, 2002). They can be a cheap and engaging way to enrich your current curriculum. They can also make for a nice memento for graduating seniors who complete a nature journal for a class. Several graduated students have given feedback to Kelly saying they sometimes look back at their field notebook and have great memories of the class, which is something every teacher wants to hear. The authors believe that science education is most effective when students are doing the same practices as what scientists are



doing in the field. Nature journals are an easy way to get your students outside and to practice making observations. As science teachers we have the unique opportunity to take our classroom outdoors and let it enrich our curriculum (Cormell & Ivey, 2012).

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