ONLINE ARTICLE

Using Profile Projects To Pull Together Concepts

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Traditionally, students learn about complex living systems in a step-wise fashion that progress up the hierarchy of biological organization from molecules to ecosystems. The hierarchy serves as an excellent framework to anchor important concepts because context is provided on the higher levels of scale for understanding mechanisms at the lower levels of scale. This reductionism is mirrored in the organization of textbooks and in the sequence of topics in many general biology courses. For experts who know how the pieces fit together, this sequential approach makes sense. Biology teachers understand how the chemistry of nitrogen on the molecular level connects to aspects of the nitrogen cycle on the ecosystem level. However, students often view concepts in isolation. Unifying concepts presented on separate and abstract levels of organization into a unified understanding of a whole system—a whole complex or dynamic organism—represents a higher order thinking process that we strive to impart in our students (Mayer, 2003; Fink, 2003). Instructors are challenged to anchor concepts learned early in the semester and connect them to concepts learned at a later time. By making connections more explicit to learners, teachers build a mental scaffold that supports future learning.

The National Research Council (1996) has challenged teaching faculty at all levels to develop activities that promote student inquiry while integrating all aspects of science education. Groups such as the National Science Teachers Association have seized this challenge and supported a wide array of classroom-based support materials designed to promote exemplary science (Yager, 2005). In support of these broad-based efforts, we have developed an organizational framework called the Profile Project that promotes intellectual curiosity, connects biological concepts, and enhances student visual and information literacy skills. Specifically, this project supports National Science Education Standards by promoting the development of self-directed learners and providing faculty a unique classroom assessment technique in science education.

Profiles arrange and summarize information on a single object, whether it is the career statistics of a player on a baseball card or the aliases, fingerprints, and information on a criminal on an FBI Most Wanted poster. Profiles, by their nature, synthesize and display a body of information in a condensed form. Through the past 10 years, we have guided students to create profiles on dinosaurs (Figure 1), plants, microorganisms, cells, viruses, animals, molecules, and diseases. We routinely use the Profile Project as a semester-ending student project, culminating in the production of a one-page profile of an organism.

Figure 1. An excellent example of an organismal profile illustrating many of the key aspects of student learning using a Profile Project.

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Profile projects are effective ways for learners to structure their knowledge using the processes of generalization, enumeration, comparison, and classification (Mayer, 2003). They represent a clear example of the constructivist approach to learning. Students apply generalizations using classification schemas to the biology of their specific organism. For example, in producing a profile of a grass plant in a unit on plant structure and function, students will apply the following classification and generalization processes to relate the taxonomy to stem structure: "My plant (Kentucky bluegrass) is a grass, grasses are classified as monocots, monocot stems have scattered vascular bundles, therefore Kentucky bluegrass stems have scattered vascular bundles." Students use the power of classification to generalize, make predictions, and compare organisms.

In our classes, we have had students profile whole organisms because they are familiar and concrete. The organism level of the hierarchy requires students to integrate abstract concepts such as macromolecules, cells, tissues, and metabolism. Organisms are placed into context by understanding the habitats, communities, and ecosystems in which they live. Moreover, we find that students easily relate to organisms and can move up and down the hierarchy of organization using the organism as the anchored reference.

In structuring knowledge into a profile, students actively engage in selecting, organizing, and integrating information. These cognitive processes essential for active learning (Mayer, 2003) are at the very heart of the profile building process. Students focus on relevant words and images as they search for information and build these internal connections to form a strong and enduring mental model of the organism or profile object.

Profile Construction: Overview

In this article we'll describe the construction of a Profile Project that served to bring together course content in an end-of-semester assignment from a lower division undergraduate Biology of Dinosaurs course, profiling a dinosaur as a whole organism.

In the first days of the course the names of dinosaurs are put into a hat and students draw a name. Dinosaur species placed in the pool met two criteria:

1. They possessed well-known attributes to be discussed over the course of the semester.
2. They are common enough to have a range of published materials available for students to work with.

Over the course of the semester, as major concepts are developed in class, students collect information, synthesize it, and apply it to their specific dinosaur. In the assignment package we include part of a list of profile elements and their point values (Figure 2). The list of content boxes provides students explicit guidance of required elements they need to seek out and present. In each instance, students will have to search online or use the library to find specific pieces of information and in other cases students can deduce the information from the animal's classification or from generalizations made in class.

The profile's structure described in the student guidance may include:

- the kinds of information (what we call content blocks) and images you want students to include
- how that information is arranged and presented in the final product (the design template).

The structure you impose will fall along a spectrum from one extreme where a common template is used (easily created as a single PowerPoint slide) to the other extreme where the project is flexible and students are permitted great latitude in what information to include and how to display it. Each produces wonderful profiles, however, as a general rule, the stricter the control over the profile structure, the easier it is to create a grading rubric and score the project. Our example template (Figure 2) illustrates one used in our Biology of Dinosaurs class to guide profile construction. In this example, specific content blocks are required and point values assigned for each.

Figure 2. Students are guided in their research, collection, and synthesis of information using this assignment outline which specifies point values for general content blocks.

Profile Elements and Point Values

1. Name and Naming Information 5
   - common name (s)
   - Latin binomial
   - meaning of the Latin binomial

2. Taxonomy and Cladistics 8
   - taxonomy Kingdom to species
   - cladogram illustration
   - timeline of when it lived

3. Physical traits 10
   - height, length, weight
   - scale comparison
   - age to maturity
   - stance, locomotion, speed
   - hip structure

4. Discovery 6
   - when discovered
   - by who and where
   - illustrate the estimated range

5. Fossil Evidence 8
   - body fossil evidence
   - pictures of fossils (if available)
   - trace fossil evidence

6. Illustration or Picture (s) 8
   - colorful central image or images

While we use the dinosaur profile as our example for this discussion, the potential for application in a middle or high school science class is readily accomplished. In collaboration with secondary education science teachers, we have seen several creative ideas develop. Following a unit on nutrition in one 10th grade general biology class, students were asked to profile one of the major biomolecules in their diet (carbohydrates, lipids, or proteins). Students were required to research and synthesize information on a range of items such as molecule construction, size, chemical energy, and bonding patterns. They had to find pictures or illustrations of their molecule, find foods that contain high amounts of it, discuss human synthesis and use of the molecule, and how it is stored and moved in the body. A similar project was adopted in a high school chemistry class that asked students to create a similar molecular profile that focused on inorganic molecules and their characteristics. In another example, following an ecology unit, high school students were asked to develop

profiles of organisms that formed a food web in a pond ecosystem. This project was combined with a laboratory activity where students collected and viewed microbes from a local pond with a microscope, completed some basic identification, and researched those microbes outside of class. The laboratory activity was used as the foundation for students to build a profile of an aquatic food web. At the center of the profile was the illustration of the food web and in boxes surrounding that were content blocks for the organisms that comprised the food web.

Planning & Utilization: Building the Profile Project Assignment

As with any new assessment tool, there are many elements to consider in constructing a profile assignment to meet your learning goals. One of the most important planning considerations is how you see this assignment placed in your course design. Are you interested in connecting concepts from a lesson, unit, or entire course? While we often use this assignment at the end of a course, we've had students pull together concepts to create profiles of cells and diseases after only a single lesson.

There are several important items to consider when developing a set of student instructions or guidelines for completing a profile project. What content blocks do you want students to include? Consider the content that is essential and what content is considered to be enrichment. Completing a profile template that sketches out content blocks that represent general themes or key concepts provides students critical direction. In our example assignment, students are guided in their project by both the Profile Elements and Point Value instructions (Figure 2) and the visual cues provided by the template (Figure 3). The template can be made available as a PowerPoint slide for the students to use along with classroom examples from previous assignments.

A difficult element in developing instructions is the level of guidance to provide. What will you choose to include? What decisions will you allow your students to make? How easy is it for students to obtain the information? Do you want it to be holistic, or only include specific content? Space allocation is crucial in a one-page profile, where you will need to confront the trade-off between space for content and space for images.

Consider Your Students

The Profile Project is an opportunity for students to learn independently and at their own pace. How independent are your students? How persistent are they in searching for information or thinking problems through? Answers to these questions will direct you toward the amount of guidance you provide. By providing a highly-structured set of directions, dependent learners will feel less anxiety. Providing samples of excellent, average, and unacceptable profiles illustrates the level of quality you expect in the construction of student Profile Projects.

Initially, we suggest a highly-structured Profile Project. Carefully select the *elements* (such as a cladogram, an illustration) and content blocks (such as physical traits, fossil evidence, and taxonomy) for students to include. This will reduce your frustration in developing an objective grading rubric and eliminates student frustration with ill-defined assignment instructions. We have often elected to guide student research, requiring a distinct mix of research materials that include: peer-reviewed scientific material, popular press, textbook, library reference materials, and limited Internet references.

Scoring the Profile Project

Developing a grading rubric for any Profile Project is a challenge. In our classes we have developed a number of scoring sheets from the very general to fairly specific. Depending upon the degree of direction, you may specify values for content blocks or for specific information elements (Figure 2). Our scoring sheets have been modified through the years as we have graded hundreds of profiles and altered the level of direction.

Regardless of the degree of specificity in your profile instructions, there are three key considerations when constructing your grading rubric:

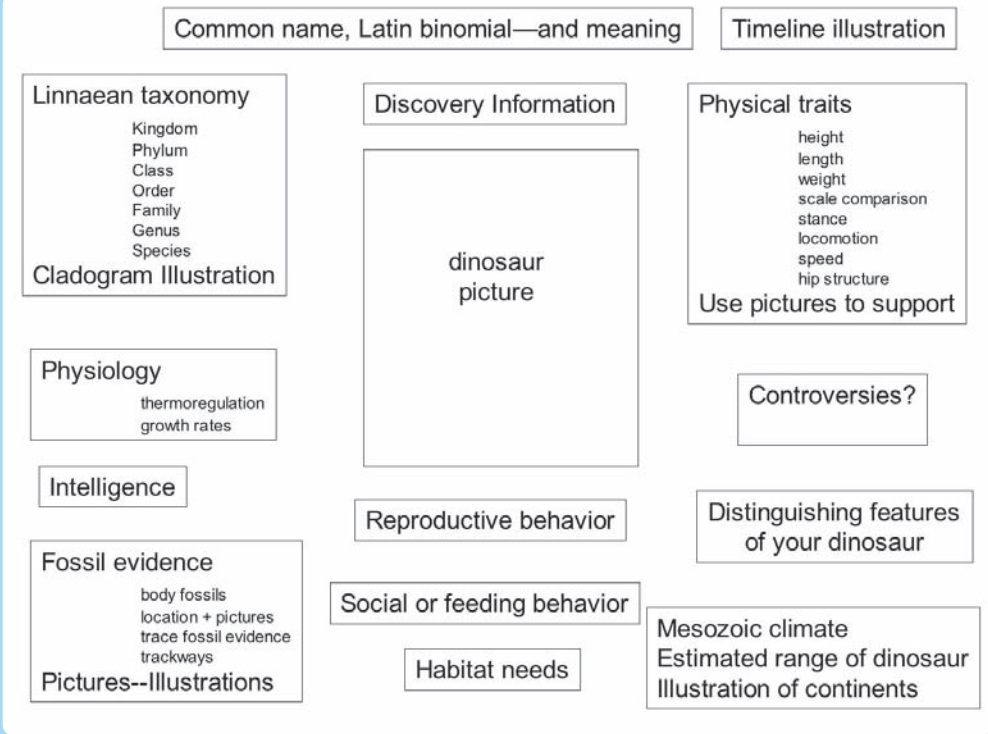

Figure 3. An example template like this helps students visualize the layout for their Profile Project. When combined with examples, like Figure 1, students have a clear idea of what the expectations are for the assignment.

1. Recognize that not all information is equal. Depending upon your requirements for research, many pieces of information are easy to obtain and reflect low levels of information assembling and processing by the student. Other elements require more time and effort to obtain. Consider the level of synthesis and the degree of difficulty that goes into each of the content blocks when weighing its point value.
2. Show students how information in the profile is connected. For example, an organism's location on a cladogram must be consistent with its anatomical structures.
3. Separate meaningful content from flashy images. Images and information should directly support learning goals. As you make the project more open and provide students greater latitude, be prepared to see profiles with shallow content and colorful graphics. Finally, by sharing the grading rubric with students early, they can begin to assess their own work and other students' profiles.

Using Profile Projects in Your Classroom

Imagine the power in a classroom composed of students who have a foundational base of knowledge about a specific organism. The directions you could take the class are many and varied. You could facilitate a rich discussion connecting concepts such as bacterial cell walls to the Gram stain reaction. You could probe student understanding and knowledge about general concepts or expose and correct misconceptions. We have found that profiles serve as excellent "question generators" challenging students to think, to search, and find answers. Socially, students work together to complete their profile assignments, often discovering that their organisms are closely related and therefore have many characteristics in common. Profiles can provide the focal point for working individually, in pairs, or in small groups. In all cases, students are working on similar problems, making similar choices in an organized manner.

The Profile Project as Evidence of Learning

Students display tangible evidence of their learning with their profiles (Figure 1). Evidence of learning is captured in the students' capacity to move beyond the ability to simply assemble information; they reveal which information they considered to be important, appropriate, and relevant. For example, in creating a dinosaur profile, our students must consider and present information on topics as diverse as geology, evolution, ecology, reproduction, systematics, anatomy/physiology, behavior, biomechanics, natural history, and extinction. Depending upon the means by which students communicate the profile (i.e., electronic submission, poster session, or oral presentation to peers and faculty), they must consider their audience and their visual literacy skills in developing their profile. We often include the challenge of communication by having students present their profiles to other student groups, faculty, and staff. This causes them to consider ways of explaining technical information in laymans' terms. For today's generation of students, the profile assignment allows them to parlay their familiarity with multimedia presentations and information search skills to create a vibrant, visual learning product (Figure 1).

In addition to evaluating broad areas of student learning, you can assess student research skills. Where and how they collect information can be enlightening. One aspect related to student research stressed in our course is the requirement to present complete documentation and attribution for information used in their profile. Students don't often recognize the value of intellectual property and the need to provide proper attribution for ideas and information gleaned from a range of resources. We see a strong trend in students who have perfected the art of "cut-and-paste" assignment production. In requiring appropriate documentation, students are forced to consider both the quality of the information source and the degree to which they have copied that material.

If profiles are used to show relationships among concepts from an entire course, they can provide information regarding the strengths and weaknesses of student learning, as well as the course as a whole. We've used the results from similar analysis to strengthen our syllabi and build on elements where we've clearly succeeded.

Figure 4. Evidence of ownership and creativity—Ms. Kali M. Leitheiser poses next to a fossil leg replica for "her" dinosaur. She used this picture in her Profile Project to illustrate scale and the dinosaur's unique anatomical features.

Conclusion: The Profile Project as a Significant Learning Experience for Students

Fink (2003) describes a significant learning experience as one that contains foundational knowledge, application, integration, human dimension, caring,

and learning how to learn. The design of the Profile Project is intended to reflect these attributes of the learning experience in a summary visual format. Through the profiling process, students research and build a visible and organized display of connected knowledge as it specifically applies to the assigned organism or object. Thus they make their learning useful and powerful.

Fink (2003) describes the human dimension and caring aspects of learning as students gaining insights into themselves or about other people that is reflected in new, deeper feelings, interests, or values. It has been our experience that these affective aspects of the Profile Project are the most rewarding. Through caring and valuing their organism, many students generated the energy to create very impressive profiles (Figure 1). Student ownership is evident when they see or discuss "my dinosaur." Students frequently take advantage of the project's opportunity to inject themselves, their personalities, and creativity into the learning process (Figure 4). Interestingly, some the highest quality Profile Projects have been submitted by some of the academically weaker students. In these cases the profile assignment provided a creative outlet for their visual learning style. Adapting a Profile Project in your classroom fosters the idea of learning with understanding–having your students connect and organize important concepts in the context of "their" organism (Bransford et al., 2000). Finally, one of the most potent pieces of evidence that our Profile Project has had a positive impact occurs years later when students visit and recall the specific plant, microbe, or dinosaur they profiled.

Acknowledgments

The authors would like to thank the editor and two anonymous reviewers for their assistance in improving our article. We would also like to thank Ms. Kali M. Leitheiser for permission to present her picture and her Utahraptor Profile Project.

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