

Using Creative Expression as a Tool for Increasing Scientific Communications and Understanding

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Summary: In order to more fully engage students and encourage the development and use of critical thinking skills, an astronomy professor implements a project that gives students creative freedom in order to effectively communicate scientific knowledge.

Background

Contemporary Astronomy (ASTR 191) is an undergraduate-level course that provides students with an overview of the field of astronomy. As a course that fulfills a general university science requirement, it attracts a large number of non-majors, with enrollment generally around 150 students from diverse disciplines.

There are three general course goals:

- To understand the nature of science, as viewed through the lens of astronomy.
- To understand the fundamental concepts and “big picture” ideas in astronomy.
- To develop a lifelong interest in astronomy and current events in the area and be able to successfully communicate these ideas to peers.

Despite the large class size, I have avoided structuring class time solely as lectures, instead combining short mini-lectures with various in-class activities and discussions. This structure helps engage the students and make them active participants in their own education. It also helps them to confront and overcome their own deep-rooted misconceptions about how the universe works. Nonetheless, come test time, I found that they still lacked the skills to synthesize and analyze multiple pieces of information. Therefore I needed to find a way to engage the students while at the same time helping them to develop and exercise critical thinking skills that would allow them to better use their knowledge. Tied into this was the question of how to help them learn methods to share their knowledge, particularly in a way that friends and family (or non-scientists) could understand.

Therefore my teaching question is: is there a way to creatively engage students (particularly those who may not perform well on standard tests and traditional written assignments) while at the same time asking them to think critically, synthesize various pieces of information, and communicate their knowledge in a way best suited to their individual strengths?

Implementation

In Spring 2009 I assigned a project based on measuring the brightness of the night sky as part of a global light pollution-monitoring project (“Globe at Night”), with a creative communication element included. The communication element felt somewhat tacked on though. While I liked that many students worked hard on the creative side, I felt that the project as a whole had not allowed for much synthesis and analysis of information. Therefore, I wanted to keep the creative aspect but channel it toward something more focused on critical thinking.

When I next taught the course in Fall 2009 I assigned a project that, I hoped, would bridge the critical thinking/creativity gap while, at the same time, allowing students to communicate their knowledge. The students had to read a set of four articles related to extrasolar planet discovery. Then they had to answer a set of questions that required them to synthesize and analyze what they had read; they also had to draw their own conclusions using at least two additional articles that they were to find. The last element involved communication; they had to share the information in a way that their family and friends would understand. They were given complete freedom to choose whatever medium they liked.

The project had two parts: a one-page proposal and the completed project. In the proposal stage students would not only describe their project (including why it was best suited to their personal strengths and any possible obstacles in implementation) but would also include a list of their additional references. By including this step, students had to think about the project in advance before realizing too late that their ideas might not be feasible. As previously indicated, for the second part of the project, students could use any medium they liked (electronic or physical). I did allow teamwork, but teams had to have prior approval and had to submit a clear description of each member’s contributions.

For each part of the project, I created a four-level rubric adapted from the American Association of Colleges and Universities’ (AACU) metarubrics, which provides a framework for how to evaluate work based on general criteria, e.g. problem solving, critical thinking, and communication. Since this was a science project, the most weight was given to content, with only 25% given to effectiveness of communication. Students received a copy of the rubrics along with the assignment description.

Student work

I received 118 projects, which included five team efforts. While the quality varied, many of the projects impressed me, especially those that most effectively used non-traditional media. For example, Student 1's assignment epitomized the quality that I was hoping to receive as a result of this project. He chose to write this assignment in the form of a play and, judging from his work, he obviously had some experience as a playwright. He also showed that he took this assignment very seriously. He was able to use his writing skills to effectively communicate the course content, as well as to entertain. While the play included seemingly superfluous content, such as dance scenes, these only served to demonstrate the care that he had put into the assignment. Using the properties of his medium, he was able to compare and contrast the techniques through character interactions. Despite working within a non-traditional medium he nonetheless was able to include all elements of the assignment and cite them properly.

Similarly, Student 2's web page was a great example of how to use an online media to present information. Her use of links allowed for a somewhat non-linear presentation of information but one that was easy to navigate with appropriate explanations on how to use the site. In its content, the web page is similar to that of a traditional paper, but adds dimensions of cross-linked graphics and references. Student 2 presented comparisons of each technique and thus demonstrated that she had absorbed how the different techniques complemented each other.

Although some projects were creative, they did not receive the highest points, mostly because they did not meet the criteria outlined in the rubric. Such was the case with Student 3's project. The student chose to utilize the villanelle poetic form and talked to me at several points about how to use this medium to effectively communicate the necessary information. However, the villanelle structure has both a limited length and inherent repetition. He tried to get around these constraints by using very extensive footnotes to explain the meaning and significance of each verse. However, the student ultimately did not provide enough information on each technique and demonstrated only minimal synthesis, the main weakness of this project. He also did not satisfy the requirement that the information be understood by a non-specialist.

Likewise, Student 4's project was a prime example of a performance that captured the spirit of the assignment with respect to effective communication but did not meet the goal of synthesis. Utilizing the tune of the 1967 song "Alice's Restaurant," the student altered the lyrics to transmit the desired information. Overall the project was clear, entertaining, and accurate. The song he chose lent itself well to communicating lots of information while not losing the style of the original piece. He provided a transcript so that I was able to verify his references. The only weak point of the assignment was that he entirely failed to address one of the rubric components and only partially addressed another. He presented no extrapolation of each technique's advantages beyond the strict limitations of what was given in the article, and he only determined how the techniques complemented each other for a subset of the methods. Conversely, some projects that were not particularly creative received relatively high scores because they were very effective at using their chosen medium.

In evaluating the projects, I found that a common thread with many was that the students were not able to properly reference their sources. Due to the chosen medium, Students 5a and 5b

encountered the difficulty of citing sources and only provided a bibliography. One of the few team efforts that I received, the students created a short movie, with an academic conference setting, to present the necessary material and compare and contrast the different techniques. The movie was well-organized, touched on all of the assignment's main elements, and ultimately was an "A" project. They could have solved the citation problem by putting the references into their script but did not do so. I realized that I had assumed students would have a firm prior knowledge of how to cite sources and, therefore, I had not covered this step. For this reason, I did not penalize incorrect citation too heavily but did require some citation as part of their grade.

Many students also did not understand how to best use their chosen media to provide the necessary information and to do so in an understandable manner. For instance, Student 6 used a pamphlet format to provide information; she used the pamphlet's natural form to organize her work (by leaf) with the last leaf explicitly addressing the synthesis portion of the rubric. In spite of this, the quality of communication was the project's major weakness. The written segments were brief - almost by necessity given the medium - and it was therefore hard to explain the material adequately, especially in terms understandable by a layperson. Although graphics that expanded upon the text could have been well used here, they were not, and the only graphics were purely for visual appeal. Also, while the techniques were compared with one another, the brevity of the text left necessary details lacking.

Several students produced more traditional PowerPoint presentations using loosely connected bullet points with low contrast text; while this style might work when accompanying an oral presentation that ties it together, it was not the best choice in which to convey written material. Student 7, for example, used the PowerPoint format to present a classical term paper. While she did include appropriate and helpful graphics, she did not move beyond the source articles to draw new conclusions and did not explain the material well, especially for the imagined audience layperson. Therefore, what mainly kept her from scoring higher was that she did not move beyond the minimum assignment requirements.

During evaluation, I found that the main difference between how students performed was the degree to which they completed the required assignment elements, rather than the degree of synthesis and communication effectiveness. While many projects were quite creative, there was not strong evidence that most students had moved beyond information regurgitation to critical evaluation of information.

Reflections

Although the project assignment counted for a small percentage (10%) of the overall course grade, I was struck by the relatively large amount of effort some students put into their projects. This indicated that the assignment succeeded in engaging students more than did normal coursework. It also engaged a broad spectrum of the class: while there was a general correlation of project grade with overall course grade, it was not true that the top performers on the project were exclusively the best students in the class. Rather, there were students who did well on the project, but whose performance in other course areas was lackluster. These were exactly the students that I wanted to reach with the assignment, and it pleased me to see them effectively putting forth so much effort. Finally, as hoped, students had the chance to practice their critical thinking skills, and there were those who did indeed combine and interpret the material in ways not encapsulated in the individual articles.

The largest obstacle in implementing this assignment was the grading burden. Due to the number of projects received and lack of a teaching assistant to share the load, I did not have time to give individualized feedback. This lessened the effectiveness of part one of the project. However, there are solutions to this obstacle that I can implement in the future. One would be to require group, rather than individual, work. This would mean ensuring that each group member is pulling his or her weight, but I suspect that this is not an insurmountable problem. I also hope in future to have a teaching assistant to help with the grading and feedback process.

The other main shortcoming encountered during evaluation involved my rubric. There were a number of elements that were not independent of each other, consequently making it harder to effectively discriminate between elements. I also found that I could have further modified and customized my versions of the AACU metarubrics. In the future, I would like to further tweak the rubric, including more orthogonal elements to allow greater ease in assessing individual project aspects.

Within the course of a semester we cover the whole of the universe, and there are elements one must cover before really getting into the astrophysics aspect. Therefore, during the Fall 2009 course I attempted to choose a subject for the students to work on that required only a minimal amount of knowledge so that they could start the assignment early in the term. While I will keep this aspect of the project, if possible in future I would like to start the assignment even earlier in the semester.

I am also interested in looking at the question: how will the students' final projects improve if I build a scaffold of assignments? Therefore, I would like to implement shorter assignments early in the semester to teach them how to synthesize and analyze information from multiple sources. I would also like to provide more concrete examples to demonstrate what I would like to see at various stages of the assignment.

In their evaluation of the course, I asked students specifically about the project and, generally, received positive feedback. One student highlighted some of the strengths and weaknesses of a creative project such as this.

“Well, I loved the project because of how creative it is. The only thing I would change is making the project more creative by not allowing people to write papers. I understand that idea may go against your idea of everyone communicates differently; however, college students write papers all the time, so, I say, bring on the creative juices. I mean, how awesome is it to be required to mix math and sciences with the arts? In my opinion, that project was one of the best requirements that has ever been asked of me in a class.”