



Writing to Learn and Journal Applications in the Introductory Astronomy Course

Tom English

Williams Observatory

Gardner-Webb University

The Introductory Astronomy Course is offered at Gardner-Webb University as an option for fulfilling the core physical science requirement. For several years the course was taught as a basic introduction to astronomy, with assignments limited to laboratory exercises and the option of a research paper or observing project. After several semesters of reading papers on the same old topics (Saturn and Venus seemed to be quite popular, as well as black holes, where many students found themselves over their heads), and chasing down potential plagiarism cases, a variation on the traditional research paper was sought. In particular, research and writing assignments were needed that would be more specifically suited to the semester at hand, and that would allow for individual expression.

The concept of Writing Across the Curriculum (WAC) presented itself as a vehicle through which such new assignments could be built. WAC, especially the “writing to learn” aspect of it, encourages students to learn about material by presenting situations in which the required writing is not so formal as the standard research paper. After attending two Gardner-Webb WAC workshops led by the Director of the Writing Center, several existing laboratory assignments were re-worked into a student observing journal. This log of observations was designed as an opportunity for students to write about their discoveries and frustrations as they attempt to understand the workings of the sky around them. Subsequent Gardner-Webb WAC Retreats (Price 47) allowed further development of similar writing-to-learn applications for the introductory astronomy course, including a number of simple writing assignments that help students express their frustrations and curiosities concerning the course material. More complicated research-based assignments were also developed at these WAC Retreats, including planet exploration pro-

posals, proposals to use major telescopes for observation of specific astronomical objects, and Internet surveys (English).

Of these varied non-traditional writing exercises, all of which are currently being used in the course, the logs and simple writing assignments have been especially beneficial to the course instructor as indicators of student progress. They also seem to have benefitted the students as well, by requiring them to write about what they are learning in class.

Observing Log

One of the easiest and most effective ways to incorporate writing into the astronomy course is the observing log. The course originally required two separate observing lab exercises in which the students attempted to note the effects of Earth's rotation and revolution through observation of diurnal and long-term shifts of the constellations. After the first Gardner-Webb WAC Workshop these exercises, along with others involving the phases and motion of the moon and telescopic observing were integrated into the observing log assignment. An open-ended general observing component was added to allow for more free writing on personal sky-watching experiences.

Thus constructed, the log is a natural application of journal writing. Good record keeping is important in astronomy, and application of the observing log to the introductory course helps develop student observing and communication skills. For many students this is the first time they have paid close attention to the sky, and the descriptions are often fascinating to read.

In the log, students are asked to record their general impressions of the sky at least twice a week (increased frequency during the condensed summer sessions). They are encouraged to include any sky related observations, including constellations, sunsets, weather, halo phenomena, and of course, the moon. These observations are set up so as not to require too much on-site time at the University's Williams Observatory, allowing students to do most of the work according to their own schedules. A lab session during the first week of the semester is used to clarify the specific and general goals of the assignment and to set a timetable. This session also provides an opportunity for the students to calibrate their hands for use in making angular measurements in the sky. It is often quoted in astronomical guides that the typical outstretched hand held at arm's length subtends an angle of about 20 degrees, but measurements made for this course tend to run in the 15-18 degree range. With knowledge of their angular calibration at hand, students can make rough measurements of positions of objects in the sky at any time, and from any location.

The logs are evaluated three times per semester, the first two serving as feedback, and the last scored for credit. Students are required to turn in the logs each time, as each evaluation covers only a certain window of time. For instance, the 24 March evaluation during the present semester (Spring 1997) covers observations made between that date and the 13 February evaluation. Log entries are noted on a special calendar-format evaluation sheet (Figure 1), with additional comments recorded for future reference. Brief comments are made throughout the student logs, and short summaries are included to guide students in future observations. The final evaluation is based on the accomplishment of the stated goals, with the three evaluation sheets used to compile the final grade. With this method of organization, a semester total of about an hour is spent reading, marking, and recording each log.

Early log entries tend to be sketchy accounts of the weather, and they often show students' frustrations with having to interpret a sky to which they have paid scant attention prior to enrolling in the astronomy course:

... the stars are clear and bright - there are so many and I'm having trouble finding the constellations on my star map. I think I see the Little Dipper, but I'm not sure.

Many students eventually develop enough confidence in their observing skills to fill pages with descriptive entries. An excerpt from a later entry by the same student shows this development.

...I identified many constellations, and noticed even more stars than usual. I attributed this to the especially dark sky and clear conditions tonight. Most surprising to me was what I saw in the constellation Orion. The "sword" appeared to be linked by a faint line of stars to the "belt." I have never noticed this before.

Poor weather is often as an excuse for not having any meaningful entries. Students are asked to observe approximately twice a week, and during the present semester only about 55% of the nights have been clear enough for extensive observations.

I am observing the sky from outside my dorm. The sky is cloudy and it has been raining - just like the night before. I can't see any star nor can I see the moon.

This was the second in a series of five increasingly desperate entries submitted late one semester by a student who still had several observing tasks to accomplish. The weather occasionally gives unexpected opportunities for the students, such as the times when the local television personalities are forced to report on topics in astronomy about which they know little or nothing,

...I caught an error on the evening news tonight. The meteorologist clearly doesn't know the phases of the moon... she was about to give the weather report when she showed a picture of the skyline and the moon. She made a comment about how beautiful the moon was a few hours ago - that it was big and orange and (here it is...) not quite full, but getting there. Sorry, but you're wrong! It is now a waning gibbous moon. It was full on Sunday.

What a proud moment for the student and the instructor. A goal of every teacher is to produce students who are competent enough to hold their own in the subject after the class is completed. This student is well on her way, as is this one

On my way to the post office at 10:00 a.m., I was thinking about the moon phases I had seen this week, and decided that the moon should be out this morning. It was! The sky was very clear and blue, and the moon was a faint waning gibbous moon, setting in the west.

Many log entries involve the sharing of newfound (even if limited) knowledge with friends and family. The following entry, like the last, describes the moon as seen in the daytime -- an occurrence many thought impossible before taking the class

Walking out of church I saw the moon in the west and showed it to about seven of my friends. They were impressed. I told them about next week's meteor shower and some of them might try to watch it with me...

These writings show a general enthusiasm for the sky that would not necessarily be developed in the traditional classroom treatment (no matter how many pretty pictures the students are shown). Students who gain an appreciation of the sky developed through the process of keeping an observing journal will be able to share that appreciation with their children and grandchildren -- long after they have forgotten how

many moons orbit Jupiter, the difference between a white dwarf and a neutron star, and the intricacies of astronomical spectroscopy. Though this is a simple exercise, it is truly writing to learn.

The first few times this assignment was made there were several instances of students submitting falsified entries. Perhaps they hadn't thought that an astronomy instructor who stressed observing the sky might keep his own log. Constellation observations on rainy nights and bright early evening moon apparitions during third quarter phase are easily spotted as fraudulent, especially when the instructor's log is plotted on the evaluation calendar form and used for comparison.

Questions/Response: Sky and Stars

During the past few years occasional in-class writing exercises have been used to gauge student interest in, or understanding of, course material. Typically, the first class meeting of a semester includes two such assignments. First, the students are asked to write about "something related to space or the sky" about which they are curious. This exercise helps identify areas of student interest for the instructor, and gives students an indication that they have some influence over the choice of topics for the course. Since astronomy is such a wide-ranging science with a range of new topics in the news each year, there is the possibility of tailoring course topics to suit student interests or events in the news (Caton 29). Such specially constructed courses lend themselves naturally to writing-to-learn activities, and some of the exercises discussed herein were used in such a course at Gardner-Webb.

Students come to the class armed with curiosity about the sky and space, and when prompted to inquire in writing about something they have seen in the sky, they respond with a wide range of topics. Basic observational questions are covered, such as,

People often discuss observing the Milky Way. I have tried several times to see it, or to understand what they are talking about, but I still don't know or can't see it. Is there such a thing and if so, where in the sky and at what time should I look?

This student has a valid concern. References to the Milky Way are common, and the proliferation of astronomical images might give one the impression that they should look for a majestic spiraling galaxy somewhere in the sky, not the faint luminous band that is visible only from dark locations away from light pollution. When prompted by such questions, the instructor can point out and discuss the Milky Way during

class observing sessions. Other submissions touch much deeper concerns than observing,

Could it be possible that everything, well maybe not everything, but could a bunch of rocks come crashing down to Earth and kill everyone? (At least in my lifetime?)

In these days of increased awareness of asteroids that cross Earth's orbit, such questions have become common, and this topic produces some of the most animated discussions of the whole semester.

The second initial writing exercise, one that produces especially interesting results, is the "What is a star?" assignment. Also at the beginning of the semester, before any information is presented, students are asked to describe their understanding of what stars are. Responses range from the roughly correct representations,

A star is basically like our Sun, since the Sun itself is a star. Stars are made of gas and are burning in some way. They are formed in a cloud of gas. They eventually die and blow up leaving another cloud of gas. They rotate like Earth.

to misconceptions and the predictable discussions of meteors (so-called "shooting stars" or "falling stars")

I think a star is a bright light in the sky. We use the stars for guides because if you look in the sky, the brightest star points to the north. I also feel that a star is a piece of something that has fallen off of something in the sky. If you see a star fall from the sky you are supposed to make a wish and it will come true.

The papers are collected and redistributed in anonymous format two months later (after we have discussed stars in detail) for evaluation. In the evaluation stage, students are asked to critique, correct, and add to, the papers they have been given. They are often surprised at the naive and sometimes bizarre descriptions they are asked to critique. Cases like the second example cited above require several obvious corrections, but the first example contains a few subtle points in need of correction or clarification (the "burning," "rotate like the Earth," and "blow up" points in particular). The responses show the confidence that comes with knowledge of the subject, and are useful indicators of student understanding of the material. The environment in which the evaluation is undertaken is not so tense as a regular examination, as students are given half credit

for submitting an initial star description, and are asked to earn the remaining 50% with their discussion of the writing sample.

General Questions/Response: Dealing with Problem Material

Short in-class writing assignments can also be used to probe student knowledge and to identify problem topics. For several semesters, in-class writing was assigned on occasion to address problems students were having with material that had been covered to date. The assignment required that students write about a topic with which they had struggled unsuccessfully to understand. Simple questions alone were not accepted. Each response was to include a discussion of what aspects of the topic were understood as well as notes on where trouble arose. Comments and follow-up questions were noted by the instructor on the collected papers. Upon return of the papers, the students were asked to answer their questions and clarify their earlier statements. Again, 50% credit was granted for acceptable initial responses, and the remaining credit was earned through the student follow-up. Such exercises were typically assigned 2-3 times per semester. They allowed students an opportunity to overcome problems with the material, and helped the instructor identify problems the class was having.

For the present semester's large class (28 students), this idea has been carried to an extreme, in interest of determining 1) the usefulness of such an approach on a regular basis, and 2) the best way for an instructor to handle a large flux of student response writing. Students are asked to bring questions/discussions and general reading responses for each reading assignment (typically two per week). The same restrictions apply as in the occasional assignments of previous semesters, and some instructor response is noted on each paper, but there is no required follow-up. In this format the assignments function as an information exchange between student and instructor. Students are encouraged to cover specific topics in the assigned reading, or to branch out to related topic of interest, always taking care to discuss the nature of their understanding and the context of their questions. Responses range in length from a couple of sentences to a page, and they might contain one question or several. Grading is handled on a five-step scale, with scoring indicated as +, ✓, -, x, and 0. The highest grades are rare, and are reserved for students who really engage the material, communicating effectively their level of understanding and developing well-thought-out questions. Students are advised that the point of the exercise is not to get things "right," it is to communicate what they are understanding/struggling with about the material, i.e., it is okay to be wrong. Any reasonable attempt to indicate a problem with the material at hand will

score at least a -, and the last two grades are reserved for inappropriate or no response. Several grades are dropped when calculating the final assignment average, so that absences and occasional lack of response is allowed.

Typical response rates are about 75%, and it takes approximately an hour for the instructor to work through the papers. Instructor comments range from brief notes of clarification or suggested reading to half-page discussion of the topic. The papers are read the morning before the upcoming class, thus preparing the instructor to cover any points that need further clarification, or to expand the discussion in a new direction indicated by student interest.

It is common that certain topics will confuse large numbers of students. Consider the case of synodic and sidereal periods of a planet. In the grand scheme of the course this topic is not particularly important, but as students make their way through the text they often come to a grinding halt when confronted with it. Reading responses from this chapter sometimes focus on synodic and sidereal periods, with a wide range of results. For instance, after reading the material, one student guessed the definition of the synodic period as follows:

...Is the synodic period the time it takes to go around twice?
Or am I not even close?

While another student asked,

Is the difference between the synodic and sidereal periods
just that sidereal is the time for one orbit and synodic the
time for half an orbit?

These students read the same material, but reached very different, and both wrong, conclusions about the nature of the synodic period, which in reality is just the time it takes for successive orientations of Earth, Sun, and Planet to occur (The sidereal period is essentially the time for one complete orbit .). Other responses range from the whimsical

...if the Sun were cubical would it produce square orbits,
assuming that the planets were cubical as well?

to the reflective (note the recurring impact theme)

After reading this section I have come to realize that collisions
between objects in space are fundamental in shaping the

planets and satellites. If this is so, should we be worried about getting hit?

At first, there is quite a bit of resistance to writing about what one does not know. Students believe that if they write something that is wrong, that they cannot receive full credit. There is also the fear of asking the ever-dreaded “stupid question.” Thus, early responses tend to be straightforward questions and pleas for help with difficult material, along the lines of

I do not understand Kepler’s Laws. Can you please explain them to me?

Though this response serves the purpose of informing the instructor about a problem topic, it does not shed much light about the level of understanding the student has reached. Such responses are scored low, with feedback added to encourage students to tell more about what parts of the material they do understand, and where it is that they become unsure. They are also encouraged to attempt to explain the topics as best they can. In doing this, they are forced to confront the material. It is this engagement that helps the learning process, and stimulates class discussion. An amazing transformation happened to the class only two weeks into the present semester. During the lecture of moon phases and eclipses a sudden flurry of questions erupted from a class that had been mostly silent to that point, elevating the discussion to levels rarely reached. Having an audience that has done its background reading and wrestled with the material has its advantages.

The questions generated by this method are quite useful for the instructor and the student. The instructor sees something of the student thought processes, while the student gets personal feedback on topics of interest or difficult points. It is interesting that some of the students who are least likely to talk in class are contributing some of the most involved responses. Thus far, discussions with students in and out of class have revealed a level of general competency and familiarity with course material that has been lacking in the past. This is a direct result of the daily interaction with the information presented in the textbook through a simple writing-to-learn exercise.

For a large class (for the case at hand, large might be defined as more than 20) daily assigned reading responses impose a severe burden on the instructor. A scaled-down version of this approach would be better suited for the course, perhaps weekly responses, or full-chapter responses would still accomplish the goal of producing students who are

prepared for the lecture, and who communicate their understanding of, and problems with, the material to the instructor.

Inclusion of writing to learn exercises in the form of observing logs and various in-class writing assignments and required reading responses has favorably enhanced the introductory astronomy course at Gardner-Webb University. The student writing allows the instructor a means of assessing student progress, in addition to allowing the students an opportunity to receive feedback on the material at hand. It has been an experiment worth undertaking, provided that class sizes are small enough to keep from overburdening the instructor, and will continue to be applied by this instructor, both in the formats presented here, and in other applications.

Works Cited

Caton, Daniel. "A Blindman's Buff Through Astronomy." *Mercury* 25.6 (1996): 29.

English, Tom. "Non-traditional Writing Assignments in the Introductory Astronomy Course." *Bulletin of the American Astronomical Society*, 29.2 (1997): 788. (Also available at: <http://www.aas.org/meetings/aas190/program/abs/abs/S008003.html>.)

Price, Gayle Bolt. "Creating Scholarly Community Through a WAC Faculty Retreat." *Proceedings of the Third National Conference on Writing Across the Curriculum, Coll. of Charleston, 6-8 February 1997*. Ed. Allison Cleveland, et al. Charleston: Coll. of Charleston, 1997. 47.

6-12 JAN			8 CLD			11 CLR)	12 CLR)
13-19 JAN	13 CLR)	14 CLR)	15 CLR DAY)	16 PC DAY)			
20-26 JAN			22 ?	23 CLD 8)		25 CLR)	
27 JAN - 2 FEB		28 CLD AM CLR PM				1)	
3-9 FEB		4 CLD					
10-16 FEB		11 CLR TEL)	12 CLD				

Name _____

General: GOOD WORK SO FAR
15 1 FEB, 22 JAN UNCFAR, SOME OTHERS WEAK
CONSTELLATION NOTES
LUNAR HALO III.

Telescopic: M79, γ CMa, β MON, SATURN, MOON
NEEDS MAGNIFICATION + DESCRIPTIONS ALL WHITE

Moon: MANY PHASE OBS. - 10
1 FEB = WRONG
NOTICING MOON SHIFT VS. BACKGROUND - QUALITATIVE ONLY

Sky Motions: TRIED TO MEASURE ORION'S POSITION 28 JAN

Other: LAB SPECTRA OK, NO ANGULAR MEAS. 1000

Figure 1. Sample evaluation sheet for observing logs. Each student observation is noted in the calendar section, while specific comments regarding individual requirements of the log are noted in the allotted areas. Calendar abbreviation key: CLR = clear, CLD = cloudy, PC = partly cloudy, TEL = telescopic observations made on this date,) = moon observation.