2.10 AN ASSESSMENT OF THE ADDED VALUE OF A WRITTEN COURSE PROJECT IN A GENERAL METEOROLOGY COURSE

Kenneth Parsons*
Department of Meteorology

Angela Beck, Patric McElwain
Department of Humanities and Communications
Embry-Riddle Aeronautical University, Prescott, Arizona

1. BACKGROUND

As dedicated educators, we are deeply concerned about the success of our students. Our goal is to ensure that true learning occurs; that is, that students grasp concepts and master the ability to think clearly and logically and not merely memorize facts in preparation for the next test. Consequently, a nearly constant challenge in education is to present material in such a manner that the different learning styles of all students are addressed, thus giving all students the opportunity to succeed.

In addition to ensuring that students master basic subject material, good educators attempt to develop the students' ability to communicate clearly and effectively both verbally and in writing. The underlying premise here is that when students graduate and enter the workplace, they will have to communicate information and ideas well in order to be effective and productive employees. Embry-Riddle Aeronautical University (ERAU) emphasizes that verbal and written communication skills should be developed and enhanced across the curriculum and not just left to the English or communication courses.

In lower division science courses, especially survey courses, the goal is to develop meaningful assignments that contribute to both deeper understanding of the subject matter and improved communication skills in support of the ERAU ideal. A related challenge is the ability to demonstrate that the assignment has indeed achieved the desired goal.

Numerous studies have shown the value of employing writing assignments in science courses. In one case, Kokkala and Gessell (2002) designed a collaborative-learning community linking biology courses and English courses and had their students engage in extensive writing about biology. Using pre/post tests of both writing and science skills, Kokkala and Gessell found that students not only became better writers, they also discovered the nature of acceptable evidence in the field of biology.

In another excellent example, Gutierrez (1995) examined multiple classes of elementary-school children, at different schools in Southern California. In this three-year study, half the classes used writing to teach the content, i.e., were "courses where knowledge is socially constructed" and the other half were classes dominated by traditional activities. Gutierrez gave pre- and post-tests for writing skills (essays) and content skills (exams) and found significant differences in the writing skills of these two groups. The students in the traditional courses could not demonstrate competence in the subject matter, nor could they produce extended, fluent texts. This study provides additional evidence that writing allows students to more fully engage content matter and, thus, learn it more thoroughly.

In this paper, two nearly identical general meteorology courses are evaluated. One course is taught in the traditional fashion with lectures and multiple-choice progress exams and final exams. The second course is taught in somewhat the same fashion with the exception that a course project including a written report is added to the mix of teaching/learning approaches. The value of that project is assessed in this paper.

2. PROJECT DESCRIPTION

The course project requires the students to collect weather data, and then in a written document, the students must summarize, present, analyze, and evaluate the coherency,

* Corresponding author address: Kenneth E. Parsons, Embry-Riddle Aeronautical Univ., Dept. of Meteorology, 3700 Willow Creek Road, Prescott, AZ 86301; e-mail: kenneth.parsons@erau.edu.

interrelationship, and accuracy of the data and data sources.

The first types of data that must be collected are five days worth of synoptic surface analyses (high and low pressure systems and fronts) for the U.S. with the same valid time for each day's data. The students then plot the five analyses in a monochromatic color on one U.S. map with a different color for each day. The underlying objective is to have the students see the movement, development, dissipation, and/or change in structure of the surface systems over the five-day period. Hopefully, the students' interest and enthusiasm for the project will be heightened because the data being collected are current and not merely an aged case study.

The second types of data that must be collected are three 24-h surface prognoses with the verifying analyses. The students plot these sets of data on three different maps using a monochromatic color scheme with the prognosis plotted in red and the verifying analysis in black. In this case, the objective is to develop on a very limited scale a judgment of the accuracy of the forecast product.

The third types of data that must be collected are seven days worth of surface data for three cities in the U.S. One of the cities is always Prescott, Arizona where one of ERAU's residential campuses is located. The other two cities vary from semester to semester, oftentimes to coincide with the hometown of many of the students in the class. The specific data requirements are maximum and minimum temperatures and, since most of the students are in flight training, flying weather at 6:00am local time in the three cities. The temperature data must be presented in a graphical format that will allow easy comparison of the data for the three cities. The flying weather must be presented in a table that would also allow easy comparison.

Here, there is at least a two-fold objective. One objective is for the students to see the correlation between the surface data and the synoptic analyses, assuming that the timing and structure of the synoptic situation cooperates. In the project instructions, the students are specifically instructed to look for such correlations and to comment on them in the written report if appropriate. The second objective is to demonstrate the value of having a flying program in Prescott, Arizona versus Chicago, Illinois or Portland, Oregon for example.

3. LEARNING CONTRIBUTION

Multiple-choice exams were administered to all students before (pre-test) and after (post-test) the written project to evaluate the contribution of the course project to student learning. The exam scores for the classes with and without the written project were then compared using a *t*-test statistical analysis. The descriptive statistics for these tests are summarized in Table 1.

Table 1. Descriptive statistics of exam scores from classes with and without a written course project.

	With writing	Without writing
n	127	137
$\bar{x}$ pre-test	0.6734	0.6806
s^2 pre-test	0.0229	0.0182
s pre-test	0.1461	0.1558
$\bar{x}$ post-test	0.6861	0.7730
s^2 post-test	0.0170	0.0170
s post-test	0.1224	0.1373

In Table 1, *n* represents the number of students, $\bar{x}$ represents the mean score, s^2 represents the variance, and *s* represents the standard deviation. A *t*-test statistical analysis was conducted using the values reported in Table 1. The results of this analysis are shown in Table 2.

Table 2. *t*-test statistics (*t* score and degrees of freedom, df) of exam scores from classes with and without a written course project.

t-test	First test	vs. Second test	Results
A	Pre-test w/ writing	Pre-test w/o writing	t = -0.3865 df = 262
B	Pre-test w/ writing	Post-test w/ writing	t = -0.7497 df = 251
C	Pre-test w/ writing	Post-test w/o writing	t = -5.3999* df = 261
D	Pre-test w/o writing	Post-test w/o writing	t = -5.2062* df = 272

*Significant with p<0.01 compared to $t_{0.01}$ = -2.326.

As shown in Table 2, *t*-test A is a baseline that compares the mean pre-test scores from both classes. Because there is no significant difference between the two scores (t = -0.3865), it can be assumed that the two groups of students had similar understanding of the course content before the writing project was assigned.

t-test B compares the pre-test and post-test of the class with the writing project. Unfortunately, this class demonstrated no significant gains from the pre- to the post-test (t = -0.7497). That is, the "with writing" class did not seem to improve their understanding of the course content. *t*-test D likewise compares the pre- and post-test of the class without the writing project. Unlike the "with writing" class, the "without writing" class did demonstrate significant gains (t = -5.2062, $p<0.01$), suggesting that the "without writing" class gained significant mastery of the course content.

Moreover, as shown by the results of *t*-test C, the "without writing" class significantly outperformed the "with writing" class on the post-test (t = -5.3999, $p<0.01$). Thus, contrary to other similar studies, the written assignment apparently did not aid student learning.

4. CONCLUSIONS

Contrary to expectations, students engaged in a written project did not demonstrate significant gains in learning as measured by pre- and post-test multiple-choice exams. The statistics presented in this paper suggest the hypothesis that learning was occurring that was not documented in the test scores and proposes areas where that learning may have occurred.

A review of the communications courses taken reveals that the students have not taken a technical report-writing class, which is an optional general-education requirement for aeronautical science students who comprise this particular meteorology course. Thus, the writing assignment in this course exposes the student for the first time to methods of formatting, presenting, and documenting technical material in the form of tables, graphs, and figures, and then how to assemble that material into a formal written report. It is possible that the students in the "with writing" course did not make significant gains in their content skills because they were simultaneously learning those content skills in addition to new technical writing skills. By struggling to master two skill sets at once, these "with writing" students were unable to fully master either in the short time provided. If students were required to take a technical writing course before this meteorology course, then they might be in a stronger position to use their writing skills to acquire content knowledge.

In addition, it is likely that the multiple-choice exams do not adequately measure the learning that occurs in areas covered by the written report. Certainly, those exams have difficulty in assessing improvement in the student's ability to perform higher order tasks such as analysis, synthesis, and evaluation that are required by the report.

Another area where it is likely that learning has occurred is in the mechanics of collecting the data and writing the report. The students' research skills in finding the data, normally found on the internet, and then in some cases decoding the data certainly have been improved. Many students used computer software to graph the maximum and minimum temperatures. Even if they have prior experience with the software, this process improves their ability to use the software for a specific purpose.

Anecdotal evidence of learning can be gleaned from the written reports. Many students have written that the report forced them to observe the weather on a consistent basis, and as a result, they observed the motion and development of weather systems. With respect to the verification of the 24-h prognoses, many students have expressed surprise at the accuracy of the forecasts.

Further research focusing on improving the course project as well as formally quantifying its contribution to student learning will serve to validate or invalidate these hypotheses. This suggests a longitudinal study consisting of an on-going comparison of classes with a written course project to those without the written project. However, the assignment may need to be simplified or made more manageable by breaking

it into smaller sections. Another option may be to recommend a curriculum change to require a technical writing course or at least inserting a technical writing component into an existing communications course.

In addition, a survey instrument will be developed that will gauge the students' perception of the value and applicability of the project to the learning objectives specified in the course and espoused by ERAU as a university. Also, the instrument will attempt to quantify the learning that has up to now only been expressed in anecdotal form.

5. REFERENCES

Gutierrez, K., 1995: Unpackaging academic discourse. *Discourse Processes*, **19**, 21-37.

Kokkala, I., and D. A. Gessell, 2002: Writing science effectively. *J. College Science Teaching*, **32(4)**, 252-257.