Convincing Students That Writing Is Important

Audeen W. Fentiman
The Ohio State University

Introduction

Students are accustomed to writing essays and reports for only one audience: teachers whose job it is to read and grade the papers. When the paper is assigned, the uppermost question in most students' minds is, "How long does it have to be?" Students generally don't think about how to entice someone to read the paper or what information they want to convey to the audience. The intended audience (i.e. the teacher) *must* read the paper, and there is no penalty for producing an unremarkable, even useless, paper that is technically, structurally, and grammatically correct.

On the job, a person's writing will be evaluated using a much different standard. Laboratory reports may be used to replicate experiments essential to a company's success. Millions of dollars in contract funding could be awarded or denied based on the quality of a written proposal or a "Phase I" report. Professionals must understand the needs of their audiences, put themselves in the audience's place, and provide the required information in a useful format.

Teachers tell students how important it is to provide what the reader needs. But students typically fail to grasp this concept. Most of them have no experience writing with the purpose of communicating essential information. An assignment that helps students focus on the needs of the readers has been designed for a high school Introduction to Engineering class. In this assignment, teams of 4 students spend ten weeks designing, building, testing, and documenting a product that meets specifications provided by course instructors. One team's (Team B's) final report is given to another team (Team A) that has not seen the finished product. Using the report, Team A must build Team B's product and then critique the report, indicating how it could be revised to make it more useful to the reader.

This paper will supply some background on the Introduction to Engineering course and the project for which the report was written. Details will be provided on the assignment, how it was graded, and how it was received by the students.

High School Introduction to Engineering Course

Introduction to Engineering is a 2-course sequence recently developed for beginning engineering students at The Ohio State University. The ultimate goal of the college level course sequence was to increase the number of engineering students who were retained in the discipline through graduation. The course was quite successful in that regard, and faculty members were curious about whether Introduction to Engineering might be effective in encouraging women and minority students to study engineering if it were offered to a more diverse group of students. An urban high school would have such a population.

Ohio State's College of Engineering sought to team with an urban high school where substantial numbers of students would have the mathematics background necessary to be successful in Introduction to Engineering and an industry partner that could help to mentor the students and provide the materials to equip an engineering laboratory. Walnut Hills High School in Cincinnati, Ohio, and General Electric, which operates an Aircraft Engines plant in the Cincinnati area, joined with Ohio State to prepare and pilot the high school Introduction to Engineering course.

In 2001, faculty and staff from The Ohio State University College of Engineering, with input from teachers at Walnut Hills High School, reorganized the 2-course college-level Introduction to Engineering sequence (designed to be taught over two 10-week quarters) for presentation over two 18-week semesters in high school. The course content was not changed thus making high school students taking the course eligible for possible college credit.

The course had two main components, basic skills and hands-on laboratory activities. In the "basics" portion of the course, students learned skills that would be valuable in engineering courses, in an engineering career, and in a wide variety of other courses and careers. Those skills included, teamwork, written, oral, and graphical communications, visualization and sketching, use of computers and a number of standard software packages, and problem solving. In the hands-on laboratory portion of the course, students spent half of the year doing and reporting on activities that helped them to understand how and why engineers made particular decisions when designing common objects such as a single-use camera or a bicycle. In the second half of the course, teams of students were asked to design, build, test, and document a product of their own to meet specifications provided by the course instructors. The written report for the team design project served as the vehicle for convincing students that writing is important. More details on the Introduction to Engineering course at Walnut Hills High School can be found in References 1 and 2. [1,2]

Design/Build/Test/Document Project

In the second half of the Introduction to Engineering course, student teams learned and practiced the design process. Their goal was to design and build a working conveyor/sorter system that would sort three different kinds of recyclable objects into bins. In the final test of the system, ten copies of each object were to be placed in random order and at random locations, within a specified area, on the conveyor belt. Objects would move down the belt and be directed into the proper bins. In addition, the teams learned to build circuits and then designed a counter that would allow them to count the number of objects sorted into one of the three bins. Students were given materials and instructions for construction of the conveyor belt. Instructors also provided specifications for the performance of the sorter system and a selection of materials from which the sorters could be built. Students began the design process by brainstorming and making sketches of their sorter concepts. They refined their ideas, determined what materials would be needed, requested those materials, and then built a prototype. Prototypes were tested, refined and retested. On the day the projects were scheduled to be completed, the teams' systems were graded on the basis of the number of objects (out of 30) sorted correctly within 3 minutes and the accuracy of their counter. A competition was held, in addition to the grading, to determine which

team could sort the objects fastest and most accurately. A team's score in the competition was the number of objects (again out of 30) sorted into the correct bin minus the number of seconds required to sort them.

Teams were required to document the design process and to prepare a written report, including detailed, dimensioned drawings of the final sorter system. The report was a significant portion of the total grade for the team project. Performance of the system and an oral report on the project were the other components of the grade. Teams were told from the beginning of the project that their reports would be given to another group of students who would be asked to reconstruct their sorter (without the counter) based on the information in the report. Furthermore, they knew that the other team's success in reconstructing their sorter system would be a component of the grade on the written report. Teams were told repeatedly that clear communication of the design is the responsibility of the team writing the report. They were encouraged to think through exactly what information the students building their system would require – including what materials they would need to build the system – and include that information in the report.

Students began working on their reports early in the design process. They received comments and guidance on their report throughout the semester. In addition, they continued to learn basic skills such as dimensioning and the use of a computer aided design (CAD) package that would help them prepare a high quality report. The draft of the first half of the report was reviewed by the instructors and returned to the students in time for them to apply lessons learned from that experience as they prepared the second half of the report. Instructors then reviewed and returned the second half of the report. A week after the final test of the system performance, teams submitted the final drafts of their reports.

Two sections of Introduction to Engineering were taught at Walnut Hills. While students undoubtedly talked to each other about their projects, the students in one class did not have an opportunity to see the sorter systems constructed by teams in the other class. After collecting the final drafts of reports from all teams in both sections, the instructors made copies of the reports and gave a copy of each team's report to a team in the other section. Teams receiving the report had one day to read it and plan their approach to reconstructing the sorter system described in that report. The next day, they presented to the instructors a list of the materials they would need to build the sorter. They had the remainder of that day and one more to build the sorter and test it. Students were to make notes on what was not clear in the report. They were given one day following construction and testing of the sorter system to critique the report and make written comments that the authors could incorporate to make the report easier to use.

Grading the Report Exchange Exercise

Grading the report exchange exercise was not simple. It was important to create an incentive both for the authors to write the very best report they could and for the team reconstructing the system to make every effort to build a system that worked. The reconstructing team needed an incentive to offer thorough and constructive criticisms, and the authors had to be motivated to incorporate the recommended changes into their work. The instructors needed to look at the

reports several times, keeping copies of the various drafts and comments on them so that they could determine whether students had made an effort to correct their errors. Table 1 is a list of the tasks teams were required to do during the report exchange exercise. Included with each task is a description of how the task was to be graded. Figure 1 is a sample scoring sheet.

Table 1. Tasks Required to Reconstruct the Sorter and How Grades Will Be Assigned

Team A is the team reconstructing the sorter system, and Team B is the team that wrote the original report.

Task 1. Gather all materials needed to make the sorter. A detailed list should be in the report. At the end of the exercise, Team A will give Team B a score from 10 to 0 for this task. A score of 10 means that the list was complete and 0 means that no list was provided in the report. During the final grading of the report, instructors will verify that the score is reasonable.

Task 2. Build the parts of the sorter system as they were described in the report. Team A will assign a score from 10 to 0 for this task. A score of 10 means that all parts could be built without having to make assumptions. A score of 0 means that there were no drawings and no descriptions of the parts in the report. Team A and Team B will both receive this score. Instructors will verify that the score is reasonable.

Task 3. Assemble the parts of the sorter system on the conveyor belt in accordance with descriptions and drawings in the report. Team A will assign a score of from 10 to 0 for this task. A score of 10 means parts could be assembled without having to make assumptions. A score of 0 means that there were no drawings or descriptions of the assembly. Team A and Team B will both receive this score. Instructors will verify that the score is reasonable. Instructors will take the photo of the assembled system. (Note: This photo is to be compared with a photo taken of the system that Team B originally built.)

Task 4. Test the system. Thirty items, 10 each of 3 types of recyclable objects, will be used in the test. The rules that governed the final competition will apply. One point is awarded for each of the first 5 items of each kind that are deposited in the correct bin. A maximum of 15 points will be awarded. Both Team A and Team B will receive the points.

Task 5. If the system did not perform well enough to generate 15 points, Team A may modify the system. Modifications must be minimal and maintain the general concept described by the report's authors. The system may then be tested again. Using the rules outlined in Task 4, Team A may earn up to 15 points. No points from this task will be awarded to Team B.

Task 6. Write detailed comments on the copy of the report you used to build the system. The comments should be sufficiently detailed so that if Team B made the changes Team A suggested and gave the report to a third team, that team would be able to build the system with no delays. Focus on the part of the report that describes the sorter system, but Team A should read and

comment on the rest of the report also. Instructors will award up to 25 points to Team A for the quality of the comments they provided.

Task 7. Return reports and photos of sorter systems to teams that wrote the original reports.

Task 8. Team B modifies its report in accordance with changes suggested by Team A and makes any other changes it thinks will improve the report. Instructors will award up to 25 points to Team B for making modifications based on Team A's suggestions. If Team B does not think some suggested changes should be made, they may submit a letter with the final report explaining why the suggestions should not be followed.

Task 9. All teams will turn in their final reports, along with the draft containing comments from the team that reconstructed their sorter.

Figure 1. EXAMPLE SCORING SHEET

Team A (Building Team)   Team B (Report Authors)

Team Name _____   Team Name _____

Task 1   0   0 1 2 3 4 5 6 7 8 9 10
                                                        (circle one)

Task 2   0 1 2 3 4 5 6 7 8 9 10   _____
                        (circle one)   (same as Team A)

Task 3   0 1 2 3 4 5 6 7 8 9 10   _____
                        (circle one)   (same as Team A)

Task 4   _____   _____
                      (enter 0 – 15)   (same as Team A)

Task 5   _____   0
                      (enter 0 – 15)*

Task 6   _____   0
                      (enter 0 – 25)

Task 8   0   _____
                                                      (enter 0 – 25)

TOTAL   _____   _____

* Team A gets the higher score of Task 4 or Task 5. Team B gets the score on Task 4 only.

Team's complete grade for the switch/build exercise:

Each team will be Team A for one sorter and Team B for another. Thus each team will get an A score and a B score. The total number of points possible from A is 60, and the total possible points from B is 70.

Student Reaction to the Report Exchange Exercise

Even though students knew that another team would be required to build a sorter from the information in their report, some of them did not appreciate the implications of that requirement until the reports had been exchanged. Within minutes of having received another team's report, a team in the first class to meet asked the instructors to return their report so they could make some modifications before it was given to a team in the next class. The request was, of course, denied. However, it was clear that as soon as the students were transformed from report writers to report users, they began to understand the importance of clear documentation of their designs.

The quality of comments made by the teams reconstructing the sorters was uneven. Some teams made an effort to provide detailed suggestions while others simply noted that information was missing. Likewise, when the author teams received the comments, some made more effort than others to incorporate the suggestions. The completed final reports were due at the end of the school year. By that time, students had been working on the report, off and on, for several weeks and were tiring of it. In addition, almost all students taking the course were seniors, and there was a serious decline in attendance and interest near the end of the school year. Some students were taking AP exams, others were involved in extracurricular activities, and some just decided that, for them, the school year was over. In future years, this report exchange exercise will be done a little earlier in the year to ensure students give the final report more attention.

Concluding Remarks

Having students exchange reports on design projects and build another team's product relying solely on information in the project report helps the students understand the perspective of the reader. Certainly the comments students write on a report as they are using that document to reconstruct another team's sorter system are valuable to the original authors. Feedback from the instructors is useful as well. However, perhaps the single greatest contributor to improving a student's ability to write a report that is useful to the reader is actually being a reader and trying to understand what the author has presented. The next time the students are required to write a report that conveys information someone must use as a basis for action, those students will remember their experience and make an extra effort to present the information clearly and completely.

Bibliographic Information

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Biographical Information

AUDEEN W. FENTIMAN is Chair of the Nuclear Engineering Graduate Program and Interim Director of the Nuclear Reactor Laboratory at The Ohio State University. She previously served as an Associate Dean in the College of Engineering. Her research interests include radioactive waste management, environmental risk assessment, and engineering education.