ChE curriculum

LEARNING THROUGH READING SCIENTIFIC PAPERS

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For several years I have assigned to students in my undergraduate classes the reading of an international publication. This research and discussion work is done as part of a formal course which also contains homework, quizzes, labs, and exams.

This activity may be commonplace in American or European departments, especially at the graduate level. However, it is unusual in some developing countries because of restricted access to many journals published nowadays, because language problems arise (since most publications of interest are not written in the students' native language), and because professors sometimes do not understand the importance of publications.

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I am convinced that analysis of and conferences about an international publication give students a broader vision of the subject being studied, encourage constructive criticism, promote discussion, and stimulate efforts toward better oral and written communication (in the native language of the students). At the level I usually assign this kind of work, most students have already had to write laboratory reports in chemistry, physics, physical chemistry, and so on. However, it seems that instructors give no emphasis to the quality of the written material, but rather stress the quality of the experiments. Grammar, spelling, and style are in general mediocre, but no measures are taken to remedy these defects. Usually, students and professors become aware of the problem when the students submit their senior projects for approval . . . too late to be corrected.

The idea of assigning articles for reading, as a partial assignment within a course, is often resisted by some in the class, a situation that sometimes results in a poor and deficient report. Therefore, I have had to develop a convincing argument and use part of my teaching time to talk about the importance of going beyond what is given in my lectures and about the importance of clearly transmitting ideas, either in oral or written form. Together with the assignment, I hand out a two-page note in which I present some ideas on why I bother them about reading the articles, and give them some general rules about the work. The note reads, in part

To be able to read a publication critically, to understand and to interpret equations, methods, theories, and general ideas proposed in a publication, is an activity that an engineer cannot disregard. The only way of keeping up-to-date nowadays, when scientific publications have tremendously increased in number, is to read at least some of the large volume of articles. To learn how to read a publication is a task which takes time. Why should we wait longer? We will have to do it eventually. We should leave this university with not only a solid basis in chemical engineering, but also with a broad background to solve any kind of problem which may face us in our professional work. To be able to transmit to other people, orally or in written form, exactly what we want them to hear and understand is a task as difficult as, or more so, than the preceding one. There exists more than one case of a student from the last

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semester who cannot meet face-to-face with another person to discuss clearly his or her point of view on any problem. There also exists more than one case of a student who is about to graduate but who does not feel comfortable speaking in front of his own classmates because of the dread of making a fool of himself. We have to learn how to overcome that drawback . . . it is not too late.

The assignment consists of the same five main parts for any course I lecture in, namely

1. **To read and understand the paper thoroughly. This involves knowing what theories, methods, equations, approximations, and applications are contained in the publication, and, of course consulting the literature when it is necessary.**
2. **To present an original contribution related to the subject of the article and to the topics studied in the course. Modifications, applications, and extensions of the subjects of the publication are appropriate for this part.**
3. **To present two numerical problems related to the topics of the article. The problems must be presented with detailed solutions. Originality and ingenuity are the main factors considered in the evaluation of this part.**
4. **To submit a written report about the article. The report must be original and should contain what the student understood about the subject. It should also contain the original contribution and the problems.**
5. **To prepare and give a talk in front of the class and the professor in which the main ideas, results, and conclusions on the subject are presented. There is a time limit of fifteen minutes for each student.**

Of these steps, the first one has always been the most difficult for my students, although they recognize that it is the most important part for developing a good contribution (step 2), inventing original problems (step 3), writing a good report (step 4), and giving a clear talk on the subject (step 5).

With points (2) and (3) my idea is to promote originality and develop creativity. With a new contribution, students create new situations, prove some of the proposed concepts, compare their ideas with others found in the literature, and speculate about the scope of the subjects. Inventing problems and then solving them is an exceptional exercise in which students test themselves on their comprehension of the publication. To invent a good problem, the ideas about the subject must be absolutely clear. Otherwise, the problems may result in unclear, ambiguous, and contradictory situations . . . in summary, a poor problem.

For the written report, I give my students several rules concerning the form and style of the report, but allow them maximum freedom on the subject itself in order not to limit their creativity or working capacity. Clarity, depth, and continuity in the presentation of the subject, originality of the written material, presentation and organization of the report, and quality of writing are the main factors considered in the evaluation of the report.

The importance of clearly transmitting ideas is self-evident. With a time limit of fifteen minutes for a talk, the students are forced to present the essence of the article, select the main equations, show the most relevant figures and tables, and discuss the most important conclusions and scope of the paper. Emphasis must be given by students to their own findings, their original contributions, and their application problems. Participation by the rest of the class is encouraged as a form of promoting discussion, enriching the presentation of the subject, and obtaining the maximum benefit from the talk. Clarity and continuity of the presentation, adjustment to the time limit, answers to questions from the class, and participation in other students' presentations are the main factors considered in the evaluation of this part.

The most important factor for making the idea work is to get students interested in what they are doing. To that end the professor has to adequately reward good work and punish poor work. Giving written reports and oral presentation an appreciable importance, say between 20% and 30% of the final grade of the course works well. The professor should also use strong and weak works as examples of what should and should not be done by the students. The results I have obtained with this kind of work have encouraged me to improve upon the system each semester. □

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mendations stated concisely at the end of each section. Overall, the Committee recommends a variety of specific changes largely oriented toward the educational process. Representatives of industry, academe, government, and engineering professional societies are urged to work together to develop the necessary initiatives.

In summary, the report presents carefully documented findings and useful recommendations intended to guide and inform the reader. It should be read by those concerned about engineering education and practice in the United States including engineering educators and administrators, government policymakers, and industrial leaders. □