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ABSTRACT

The introductory materials science course at Worcester Polytechnic Institute (Massachusetts), while still being regarded as in a state of evolution, has remained nearly constant for the past two years. Since the course is given each term, except summer, to 40-90 students of various disciplines, there has been ample opportunity for continual experimentation and evaluation. The course material is divided into ten units of work, each with its own objective containing several measurable behavioral statements. Each student is allowed to proceed at that individual's own pace and, when ready, to be evaluated on each unit in sequence. Self-learning resources are listed with the unit objectives and include references to the "recommended" and "alternate" texts, suggested problems in each text, and designated numbers of specially made television tapes germane to the unit. Three regular class-meetings per week are scheduled. Evaluation and grading are based upon the results of a half-hour written assessment which is often called a "hurdle," followed by a ten to fifteen minute oral interview. A determination of "no pass" (0), "pass" (1), or "pass with distinction" (2) is made at that time from a combination of the written and oral evaluation. If students fail to pass, they repeat the unit. (LS)

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"A NOVEL TEACHING APPROACH TO MATERIALS SCIENCE"

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INTRODUCTION

Much has been said and done in the past fifteen years concerning the teaching of the first course in materials science. Many of us have seen the transition from a physical metallurgy course with integrated laboratory to a more general course in the science of materials which frequently makes no provision for any practical supplementary instruction in the laboratory.

Worcester Polytechnic Institute recently has undergone a rather dramatic change in its overall educational experience to a broad program involving a significant amount of project work. The college calendar has been changed to five terms of seven weeks each, including a summer term, plus an "intersession" of two weeks of short courses in January.

Our introductory materials science course, while still being regarded as in a state of evolution, has remained nearly constant for the past two years. Since the course is given each term, but the summer, to forty to ninety students of various disciplines, there has been ample opportunity for continual experimentation and evaluation. The parallel developments of individually paced instruction (IPI), the WPI emphasis on self-learning, the movement to larger class size, and the rapidly paced seven week term have each had an influence on the methods of presentation. In addition,

a change from a limited mechanical engineering course to an all-campus engineering science course with the addition of a chemical engineer to the original metallurgy group has resulted in a broader representation of disciplines among students electing to take the course. Opening up the availability of the course has also attracted more second year, and even some first year students into the course.

COURSE FORMAT

Responding to these campus innovations, while simultaneously striving to increase learning effectiveness in this subject area, has led to the present format:

The course material is divided into ten reasonably logical units of work, each with its own objective containing a number of "you should be able to" measurable behavioral statements. These statements cover the minimum number of topics deemed essential within that unit. Each student is allowed and encouraged to proceed at that individual's own pace and, when ready, to be evaluated on each unit in sequence.

Self-learning resources are cited in the list of unit objectives and include references to the "recommended" and "alternate" texts (Van Vlack's orange text for engineers and the light mustard introductory science text,

respectively, this past term), suggested problems in each text, and designated numbers of specially made television tapes germane to the unit. Other resources provided on request are supplementary hand-out sheets and problem solutions. Three regular class-meetings per week are scheduled; attendance is optional with the student. All lectures for the course are contained in more than twenty television tapes varying in length from twenty to forty minutes. Two copies of each tape are available - one in the college library and one in an auxiliary viewing station in the materials engineering area. Class meetings consist of two somewhat informal lectures where questions are allowed and one designated question-and-answer period per week. The class lectures proceed through the course material at a predetermined pace, but the question-and-answer period allows for questions on any topic in the course.

PERFORMANCE EVALUATION

Evaluation and grading are based upon the results of a half-hour written assessment which is often called a "hurdle", followed by a ten to fifteen minute oral interview. A determination of "no pass" (0), "pass" (1), or "pass with distinction" (2) is made at that time from a combination of the written and oral evaluation. Students are strongly urged and expected to come fully prepared to the assessment and to use the hurdle to demonstrate that preparedness. The logistics of this arrangement require that

one professor be available for a total of about sixty oral interviews per week in handling a class of forty students -- essentially two full days per week. To reduce waiting time in student lines outside the professor's office, appointment forms are posted on a convenient class bulletin board in the materials engineering area. Students are required to sign-up only in available appointment slots prior to the day of the appointment.

This oral interview has received nearly unanimous favorable evaluation from students who have completed the course. In general, the conduct of the interview is informal and unstructured. However, the questions asked by the professor during that one-to-one meeting are usually "think" questions intended to determine whether the quality of the written work accurately reflects the level of knowledge of that unit. A specific example of content in an interview when a student does not pass the assessment would include coaching on the weak points discovered and recommendations for further study. The student and the professor usually agree when the verdict is "repeat this unit".

When the student, on the first try at the assessment, has answered the written questions correctly and the oral interview confirms a mastery of the required objectives, the professor will assign a grade of "pass with distinction". Often, he then will go beyond the assessment content and discuss some advanced material related to that unit.

The most difficult judgments are those on the border-line between "pass" and "pass with distinction". It has been observed that, in spite of WPI's reduced emphasis on grades, students still strive for the higher evaluation. While there are occasional protests, there is usually mutual agreement on the level of performance achieved. Most students, in fact, say "thank you" as they leave the grading interview. The gratitude may be for the coaching, for the interest and time of the professor, for the "benefit of the doubt" on the grade assigned, or for a deserved and needed pat-on-the-back just received.

OBSERVATIONS

To attempt to claim that there have been no negative student reactions to this approach would, of course, be false. During a term when more than one professor has been involved in the grading, there have always been comparisons made by the students. Some students prefer one professor, others prefer a different one; the preference is stated quite strongly at times. The instructional staff has conferred a number of times in attempts to be as consistent as possible in the grading criteria. However, as might be expected with subjective judgment being partly involved, it appears that this problem is inherent.

Personality conflicts also can develop in these brief meetings. Yet, to reiterate, students seem to appreciate this close contact and have, in

the main, been highly favorable in their evaluations of the program.

In further consideration of the negative side of this approach, it is pertinent to say a few words about the instructional effort involved. Administrators who have the task of assigning and scheduling faculty teaching loads do not always appreciate the number of hours that must be spent in this grading-learning interview.

As implied earlier, a course population of forty requires about sixty interviews per week. This figure, which varies from term to term, is based upon approximately six weeks of interviews for an average of 7 units with an average repeat rate of 25% for those who do not negotiate a given hurdle on the first attempt. When three class meetings per week are added to this number, the result is fifteen contact hours per week for a class of forty -- a recognized full load for one professor.

Another problem posed by this format is that it does not allow the students opportunities for laboratory experience. While it would appear feasible to add this feature as a learning resource, the level of staff personnel involvement, already high, would increase significantly. Therefore, the reluctance to assign further staff time is understandable from manpower and budgetary considerations. However, since it is believed that the knowledge gained from the practical laboratory is highly desirable,

a two-week laboratory course will be offered in the January, 1976 "Intersession". If successful, it will undoubtedly be repeated. Also being considered is a separate seven-week all laboratory course which would follow the introductory materials science course.

Meanwhile we shall continue to use and improve our "novel" approach because it has appeared to be a successful learning experience within our new educational framework.