

A Worksheet for Planning the Assessment of Engineering Education Proposals

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The Problem:

In proposing curricular innovations, engineering educators typically focus on the details of the new subject matter or pedagogical strategy that they are proposing to undertake, without concrete discussion of why they want to do it or of the gains that they expect to realize. A proposed curricular change, however, is fundamentally a claim that the change will improve the situation in some way—students will be better equipped to succeed in follow-on courses, for instance, or will like the material better, or will be more effective as professionals. Such curriculum proposals also can fall short in two related areas: failure to ground the claim in the pedagogical literature and failure to express the claim in a way that supports assessment of its success or failure. Without an explicit statement of the claim being made, supported by a statement of the instructional theory being invoked and expressed in terms of concrete, observable, measurable outcomes, an effective assessment plan for the proposal cannot be designed (until you say clearly what you are trying to do, no one can judge whether or how well you did it). And given the current climate, without a well-designed assessment component a proposal is unlikely to be successful.

A Solution: An Assessment Worksheet

To support the efforts of participants in a curriculum design project both to coordinate their activities with other members of the team and to ensure that their efforts result in observable and measurable results, we have devised a simple assessment worksheet. (Olds and Miller, 1997, also propose a project evaluation matrix, but theirs attacks the problem of assessment from a somewhat different perspective.) The strength of our worksheet, we believe, lies in the fact that it encourages each member of the team (1) to articulate very specifically (and, perhaps as a consequence, to re-examine) the rationale motivating any proposed changes, (2) to formally subject those changes to the scrutiny of other team members, and (3) to place those changes in the broader contexts of an existing curriculum and of current instructional design theory. These activities, we believe, will both strengthen the coherence of the proposal and clarify the assessment strategies called for by the proposal's instructional goals and strategies.

The worksheet itself comprises seven fields. The first field, or column, labeled “Course(s) Proposed & Affected,” asks that the team put a label on a new course or pinpoint an existing course for which a change is proposed. But it does more, as well. By asking that other affected

courses be identified, it also invites an examination of the proposed change's impact on those courses and on the larger curriculum of which the course is to become a part.

**Course(s) Proposed
& Affected**

Proposed:

rev. Physics 101

Affected:

calculus sequence;
lower-division
engineering courses

Figure 1

The second field, labeled "Targeted Student Population," asks specifically for a characterization of the audience for whom the proposed change is targeted, which may be done on the basis of variety of classification schemes including class (i.e. freshman, sophomore), major, gender, or ethnic group, to name but a few. Simply, this field asks the designers to identify the students whom the proposed changes are intended to affect.

Course(s) Proposed & Affected	Targeted Student Population
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freshmen

Figure 2

The third field, "General Instructional Problem," constitutes a statement of the problem the proposed curricular changes are intended to address. The problem statement may also suggest the problem's cause. A team may believe, for example, that their freshmen-level physics courses are ineffective (the problem) because they unnecessarily present material at too high a level of abstraction (the underlying cause) and may, in addition, discourage many bright students from pursuing engineering and science degrees (a secondary or consequent problem).

Course(s) Proposed & Affected	Targeted Student Population	General Instructional Problem
		<p>freshmen-level physics courses are ineffective because:</p> <p>present material at too high a level of abstraction</p> <p>discourage many bright students from pursuing engineering and science degrees</p>

Figure 3

The fourth field in the assessment worksheet, "Proposed Instructional or Curricular Intervention," may well be the most important of the fields in that it proposes a detailed solution to the problem. A team that believes that freshmen-level physics courses are ineffective may, for example, propose a "get your hands dirty" alternative to the current course, or a course that encourages student collaboration, or that pairs students with differing levels of relevant background knowledge. What approach to teaching freshman-level physics, in other words, do the team members believe will be successful in addressing the problems the team has defined?

Let's say that the team has chosen to design a hands-on alternative to the current course. Their statement might (at least in its first version) identify the proposed instructional or curricular intervention as "present freshman-level physics content in a more concrete, contextualized way." To the extent possible, the intervention should also be quantified, or at least made concrete and specific. The statement might thus be revised as follows: "(1) provide at least one real-world example, experiment, or demonstration for each unit of freshman-level physics content and (2) provide at least two assignments in the term that ask students to go out of the classroom and solve a problem in a real-world community context."

Finally, the way in which the instructional problems are characterized and interventions proposed to ameliorate them may also significantly influence a potential funding agency's view as to whether the proposal addresses issues in their domain or consistent with their charter. The worksheet gives proposal writers a way to note the funding agency's current thematic focus (for instance, experiential learning) and to evaluate the extent to which their proposed activities address that focus.

Course(s) Proposed & Affected	Targeted Student Population	General Instructional Problem	Proposed Instructional or Curricular Intervention
		freshmen-level physics courses are ineffective because:	(1) provide at least one real-world example, experiment, or demonstration for each unit of freshman-level physics content
		present material at too high a level of abstraction	(2) provide at least two assignments in the term that ask students to go out of the classroom and solve a problem in a real-world community context
		discourage many bright students from pursuing engineering and science degrees	(In the RFP, the funding agency uses term "experiential learning" for one of its emphases)

Figure 4

The fifth field, entitled "Rationale," asks team members to tie the problem they are addressing and the solution they are proposing to the relevant literature. This column addresses the second major failing of many curriculum proposals written by engineering educators: an apparent unfamiliarity with the literature of instructional theory, as evidenced by a paucity of citations to that literature. For instance, assuming that it indeed is the case that traditional approaches to teaching physics are "too abstract," that they are "ineffective," and that they adversely affect student recruitment to the sciences and engineering, what evidence exists that would suggest that "hands-on" or collaborative versions of freshman physics would ameliorate the problem? Or, in the absence of such evidence, what can at least be inferred from the similar work of others? If there is no research directly related to the teaching of physics, perhaps hands-on or team-based classes in other subjects have had positive effects that could be invoked in support of the proposed curricular changes. Importantly, this field asks the team to relate their efforts to similar efforts by colleagues whose experiences may inform their own efforts. Moreover, it asks the team to ground their proposal in relevant instructional theory.

Course(s) Proposed & Affected	Targeted Student Population	General Instructional Problem	Proposed Instructional or Curricular Intervention	Rationale

Figure 5

The sixth field asks for "Specific Predicted Quantifiable Outcomes." This field addresses the third major failure of curriculum proposals: failure to plan an assessment scheme tied directly to the claims made by the proposal. In the preceding example, the hands-on physics course has

been characterized as a problem on two fronts: it has been ineffective in teaching physics, and it has been an impediment to recruitment. One would expect a solution, then, to address ways to improve student knowledge and skills as well as student attitudes and the impact of the attitudes on choice of a major. One would also expect that the nature of the hoped-for improvements would be articulated as specifically as possible.

For example, the course's intended effect on the student's acquisition of knowledge and skills should be specified concretely. What outcome is sought? Is the goal for the student to simply acquire more knowledge, or is he or she expected to be able to use that knowledge to reason and solve problems in physics? Or is the student expected to have acquired and be able to demonstrate certain skills? Or, is he or she expected to be able to use their knowledge and skills to create actual products or to solve actual problems? If the team members choose to aim for the outcome that after taking the class students will be able to solve actual problems, they need to classify the specific types of problems they mean.

Also, how do the proposal writers expect the desired changes in attitude to be expressed? Is it enough that the course positively affect student's attitudes as expressed on a questionnaire, or should the course be considered a success only if it results in a greater proportion of actual declarations of science and engineering majors among those students who have taken it? If the latter, the team might specify that the new course is expected, as an outcome, to "increase the percentage of students who, upon completion of freshman-level physics, take the rest of the lower-division sequence of courses required of applicants to engineering or science departments and actually apply to one of them."

The proposal writers must weigh the stringency of the tests of success to which they will subject their proposed work, but the first step is to brainstorm a list of specific predicted quantifiable outcomes that they will look for and measure, tied to the specific problem definition and proposed instructional interventions.

Course(s) Proposed & Affected	Targeted Student Population	General Instructional Problem	Proposed Instructional or Curricular Intervention	Rationale	Specific Predicted Quantifiable Outcomes
					<p>(1) equip students to solve the following types of physics problems in a real-world context: (list of problem types)</p> <p>(2) increase the percentage of students who, upon completion of freshman-level physics, take the rest of the lower-division sequence of courses required of applicants to engineering or science departments and actually apply to one of them</p>

Figure 6

Finally, the seventh field asks for the “Assessment Strategies” that will be used to determine whether the intervention was effective. That is, field six specifies the outcome to be assessed, and field seven specifies the assessment tool and protocol to be used. If care has been taken in formulating responses in the first six fields, this field is relatively easy to complete—which, essentially, is the point of this entire exercise. An enormous number of common assessment methodologies exist (See, for example, Stiggins, 1994) in the form of tools such as selected response, essay, performance assessment, and personal communication assessment options. Regardless of which tool is chosen, this field needs (1) to identify the data that are available or will be for analysis, (2) to suggest which of the assessment tools will be used, and at what point, and (3) to explain briefly the rationale behind the choice of that tool and timing.

Course(s) Proposed & Affected	Targeted Student Population	General Instructional Problem	Proposed Instructional or Curricular Intervention	Rationale	Specific, Predicted, Quantifiable Outcomes	Assessment Strategies
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Figure 7

Conclusion:

This proposed worksheet is intended to be just that—a working tool to help engineering educators systematically formulate proposals for curricular innovation. The protocol of filling out the worksheet is intended to increase the likelihood that the resulting proposal will be clear, scholarly, and amenable to meaningful assessment.

References:

Olds, Barbara, and Ronald L. Miller, "A measure of success: Here's how to design an evaluation plan for your next educational research project," *ASEE Prism*, December 1997, pp. 24-29.

Stiggins, Richard J., *Student-Centered Classroom Assessment*, New York: Macmillan College Publishing Company, 1994.

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