Responding to Administrative Priorities

A Case for the Evidence Based Assessment Of Learning Outcomes

***Capsule*:** A case for the purposeful evidence based assessment of learning outcomes on both course and institutional levels is presented. The evidence needs to be aligned to learning goals in order to provide useful evaluation data. Examples of goal/evidence alignment are provided.

***Summary*:** Singer (2008) summarizes the outcomes of the National Academies' National Research Council Board of Science Education *Workshop on Linking Evidence and Promising Practices in STEM Undergraduate Education*, held on June 30, 2008, with respect to evidence and learning goals. The summary is presented at the follow-up workshop held October 13 – 14, 2008. In the summary, Singer makes a case for the systematic evidence-based assessment of learning outcomes. The assessment process's goal is to obtain useful and pertinent data on the degree of success of a given "promising practice." Goal attainment requires that evidence is aligned with learning goals and therefore that assessment instruments are designed with the goals in mind. Multiple types of evidence should be collected to insure process completeness; reliance on evidence from a single instrument may result in incomplete or incorrect conclusions. She notes that current assessment practices tend to be more fact- and procedure-checking than an investigation of the degree of students' conceptual understanding and long-term retention of knowledge, likely because factual and procedural knowledge is easier to evaluate. A related recommendation is that people developing curricula identify evidence that would prove that a certain learning goal is met, and create appropriate instruments for its capture.

Singer also notes that engineering educators seem reluctant to use social science methodologies which have contributed to educational research efforts on evaluation and evidence, and which may prove useful in assessment processes. This reluctance may be due, in part, to unfamiliarity with the methodologies. Finally, she notes that evidence acceptable for instructor or student/class evaluation may be too narrowly defined to support research in STEM undergraduate education. Evidence supporting the latter, along with related learning goals, should be broadly enough defined to allow for research to progress. Therefore, learning goals, evidence, and outcomes need to be considered, developed, and assessed at both course and institutional levels.

Mestre (2008) provides an example of aligning learning goals and evidence. He proposes three learning goals based on observations of the accelerating rate at which the engineering knowledge base grows; the increasing complexity of engineering problems, necessitating a multidisciplinary approach to solutions; and the practice of students discarding or otherwise forgetting knowledge once it has been assessed (p. 2). The goals and associated evidence are:

- "Goal 1: Structure instruction to help students learn a few major principles/concepts well and in-depth" (and then to apply them across disciplines; the "target" is "content coverage"). The recommended evidence is documentation of the "1) (a)bility to display understanding of the conceptual underpinnings behind problem solutions, and 2) (a)bility to apply big ideas in relevant contexts both within a domain and across domains" (pp. 2 – 3 and 5)
- "Goal 2: Structure instruction to help students retain what they learn over the long term" (the "target" is "promoting learning that lasts"). Noting that little attention has been seemingly paid to the amount and type of knowledge retained in both the short and long term, and processes by which retained knowledge is learned, Mestre suggests that concept-based instruction may be a suitable method for achieving this goal. A reasonable conclusion regarding evidence, then, is that documentation of the correct application of relevant concepts in problem analysis and solution would be acceptable; in this case, concept inventories would be good assessment instruments (pp. 2, 3, 8, and 12 - 13).
- "Goal 3: Assist students in building a mental framework that serves as a foundation for future learning" (the "target" is "helping students organize their knowledge for optimal efficiency in future learning and application"). Obtaining evidence in support of this goal's attainment may be more difficult than obtaining evidence in support of goal 2, and will likely need to be gathered using inductive methods. One suggestion is to use an expert-novice format in structuring assessments under the assumption that students exhibiting expert behaviors are more likely to have a framework in place and know how to access it than would novices (pp. 2, 3 – 4, and 8 – 9).

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Mestre also suggests that we will need to develop and use non-traditional methods of assessment to secure desired evidence, especially when evaluating progress under goals 2 and 3. The fact- and procedure-checking assessment instruments prevalent in STEM education do not address the degree and completeness of concept learning and are thus both inadequate and limiting in scope.

There is a vast, rich literature on assessment and evaluation; the following are representative. Those interested in a scaffold for structuring assessments may find Anderson and Krathwohl (2001), a revision of Bloom's cognitive processes taxonomy, useful. The taxonomy can serve as a foundation for assessment instruments evaluating the degree to which a student has mastered various levels of cognitive skills. An example of this process is presented in Thompson, *et al*. (2008). Chappuis and Chappuis (2008) discuss the differences between and uses of formative and summative assessments; both types are important in keeping learning processes on track and vital. Related CASEE reports are Donohue (2008 and 2009a).

***Implications for Engineering Education*:** To ensure consistency in collecting and evaluating evidence, administrators are encouraged to work with faculty to develop policies concerning evaluation of course and institutional learning goals. Consistent course data may facilitate institutional level assessments and therefore subsequent report development. Administrators are also encouraged to foster alliances between interested faculty and researchers from other disciplines, such as education and sociology, who are working on similar issues. Engineering faculty are likely to have learned the majority of their pedagogic knowledge from sources close to them during graduate studies, such as their thesis advisor, and exposure to other considerations and methods may be helpful. Additionally, offering faculty professional development initiatives addressing the design and use of appropriate formative and summative assessment instruments may be warranted. Donohue (2009b) discusses related implications.

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