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Assessing Student Work to Support Curriculum Development: An Engineering Case Study

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Abstract

Knowledge and abilities associated with interdisciplinary education include integrating knowledge across disciplines, applying knowledge to real-world situations, and demonstrating skills in creativity, teamwork, communication, and collaboration. This case study discusses how a departmental curriculum committee in Agricultural and Biosystems Engineering at Iowa State University adapted the collaborative assessment protocol used in Washington Center's national project on Assessing Learning in Learning Communities to meet curriculum committee goals. These goals included developing a strategy for examining engineering students' interdisciplinary understanding across the curriculum and for ensuring that assessment efforts would support program improvements designed to give engineering graduates the specialized knowledge and abilities named by the National Academy of Engineering. As a means to help students achieve critical learning outcomes by aligning curriculum, instruction, and assessment, the curriculum committee undertook a comprehensive review of student work at different levels by posing the question, "what suggestions might we offer to this student to deepen or develop the work?"

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Today's engineering graduates need specialized knowledge and abilities associated with interdisciplinary education. This article discusses how a departmental curriculum committee in Agricultural and Biosystems Engineering used a collaborative assessment protocol to both examine the development of engineering students' integrative thinking and to guide a continuous curricular improvement process.

Preparing students to address future challenges and to engage with contemporary issues requires helping them to develop the ability to think in multiple ways and to find new ways of integrating knowledge (Boix-Mansilla, Miller, & Gardner, 2000; Lattuca, Voigt, & Fath, 2004). The Association of American Colleges and Universities' report *College Learning for the New Global Century* (2007) affirms this call, stating that every student "will need wide-ranging and cross-disciplinary knowledge, higher-level skills, an active sense of personal and social responsibility, and a demonstrated ability to apply knowledge to complex problems" (p. 11). In the case of engineering, the *Educating the Engineer of 2020* report (National Academy of Engineering, 2005) calls for a different type of engineering graduate who can integrate knowledge across disciplines, apply knowledge to real-world situations, and demonstrate skills in creativity, teamwork, communication, and collaboration.

Even though associations, institutions, and individual disciplines are espousing the goal of promoting a different type of learning, several critical questions remain largely unanswered: How do we clearly articulate,

observe, and measure interdisciplinary learning outcomes? How do institutions encourage interdisciplinary outcomes for students, design intentional learning experiences to promote the outcomes, and ultimately assess student achievement of the outcomes? In this article, we use an engineering case study to explore the implications of using a protocol to assess integrative student learning. We describe the use of a systematic review process to facilitate faculty discussion of interdisciplinary student learning outcomes demonstrated in actual student work. Pellegrino (2006) suggests that three educational components—curriculum, instruction, and assessment—need to be developed to support new learning goals and need to be aligned to support each other. Building on that insight, we offer insights about how this assessment process can facilitate understanding of learning across the curriculum and provide insights into ways of structuring learning experiences.

Why Interdisciplinary Learning for Engineers

Recent studies echo this call to engage students in disciplines beyond engineering to make them better engineers and, ultimately, lifelong learners (e.g., Adams & Felder, 2008; Bok, 2005; Pellegrino, 2006). The literature offers examples of student learning outcomes associated with interdisciplinary education, including integration of knowledge, innovation, synthetic thinking, critical thinking, sensitivity to bias, and ethical reasoning (Kavaloski, 1979; Newell, 2002; Newell & Green, 1998). Similarly, Lattuca et al. (2004) refer to the capacity to recognize, use, and evaluate multiple perspectives. ABET (formerly the Accreditation Board for Engineering and Technology) changed its accrediting process in 2000 to include crosscutting interdisciplinary learning outcomes (see Table 1). These outcomes require students in degree programs to use critical thinking and problem solving to see connections and differences among disciplines, integrating abilities such as communication and teamwork, as well as a knowledge of contemporary issues, ethics, and an understanding of the impact of engineering solutions in multiple, broad contexts. Assisting students in achieving these outcomes involves faculty efforts to design learning experiences that offer opportunities to develop meaningful connections.

Table 1. *ABET Student Learning Outcomes for Engineering Programs (ABET, 2008)*

Engineering programs must demonstrate that their students attain the following outcomes:

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to design and conduct experiments as well as to analyze and interpret data
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. An ability to function on multidisciplinary teams
5. An ability to identify, formulate, and solve engineering problems
6. An understanding of professional and ethical responsibilities
7. An ability to communicate effectively
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. A recognition of the need for, and an ability to engage in lifelong learning
10. A knowledge of contemporary issues
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Source: Criteria for Accrediting Engineering Programs, 2008–2009. (2008). Retrieved September 17, 2008, from http://www.abet.org/ Linked%20Documents-UPDATE/Criteria% 20and%20PP/E001%20 08-09%20EAC%20Criteria%2012-04-07.pdf

Challenges in Assessing Interdisciplinary Learning

If institutions and disciplines agree that student learning outcomes associated with interdisciplinary thinking are essential, then it is clear that in addition to developing intentional strategies to promote interdisciplinary learning, institutions must find ways to assess whether students acquire interdisciplinary skills as a result of these experiences. Using national data from a faculty survey, Lindholm, Astin, Sax, and Korn (2002) reported that nearly 40% of faculty report having taught an interdisciplinary course. However, there is little evidence of the impact of this strategy on student learning outcomes (Lattuca et al., 2004). Some argue that the inability to assess the impact of interdisciplinary education on student learning is one of the biggest challenges at the undergraduate level (Latucca, 2001; Rhoten, Boix-Mansilla, Chun, & Klein, 2006).

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Part of the difficulty in assessing interdisciplinary learning is because the concept itself remains vague. Stated definitions vary and characterize a broad range of learning practices. Considering the variety of definitions of interdisciplinary learning, Boix-Mansilla and Duraising (2007, p. 218) note "the lack of clarity in the literature about how to define substantive indicators of quality interdisciplinary work is not surprising." The multiple possibilities and fluid nature of interdisciplinary work can result in "moving targets" that become difficult to assess (Lattuca et al., 2004). In this article, we adopt Veronica Boix-Mansilla's (2005) definition of interdisciplinary understanding as "the capacity to integrate knowledge and modes of thinking drawn from two or more disciplines to produce a cognitive advancement . . . in ways that would have been unlikely through single disciplinary meaning"   (p. 16). Judging the merit of interdisciplinary student work, however, remains difficult and requires a dynamic framework (Boix-Mansilla & Duraising, 2007).

Previous assessment strategies are not well suited to measure the complexity, ambiguity, and multiplicity of skills involved in the creation of new meaning and solutions through integrative learning (Rhoten et al., 2006). Boix-Mansilla and Gardner (2003) suggest that, at best, traditional assessment approaches (e.g., grades, surveys, standardized tests) serve only as proxy criteria that fail to align with interdisciplinary learning measures. Similarly, the engineering curriculum committee for the Agricultural and Biosystems Engineering department at Iowa State University found that assessing the multiplicity of student learning outcomes in the agricultural engineering degree program presented a new challenge for which traditional approaches were insufficient.

Framework/Protocol

Boix-Mansilla (2005) suggests using these three dimensions as the foundation for assessing interdisciplinary work:

1. *Disciplinary grounding*: Has the student demonstrated mastery of the disciplinary content base? Does the student understand the methods used in the discipline? Does the student understand the mechanisms used to communicate understanding in the discipline?
2. *Integrative leverage*: Can the student integrate disciplinary perspectives to generate new understanding? Does the student offer a more comprehensive explanation by integrating knowledge? Is there new understanding generated that would not be possible using a single discipline? Does the piece use

integrative devices such as graphic representations, models, or complex explanations?

3.   *Critical stance:* Does the student use integration to strengthen the piece and support the purpose of the work? Does the student understand the limitations of the work? Does the integration withstand critique?

Boix-Mansilla also argues that in order to assess students' ability to integrate material, their thinking must be "made visible" through "performances"—students must be asked to use what they know before assessment can take place. Within this context, the Agricultural and Biosystems Engineering department curriculum committee decided to use the collaborative protocol developed by Boix-Mansilla to assess students' integration of knowledge through a close analysis of student work in departmental courses. The collaborative assessment protocol (see Table 2) identifies the steps the curriculum committee followed to examine the three dimensions of interdisciplinarity. The version of the protocol used by the curriculum committee is an adaptation of the protocol used in the Washington Center's National Project on Assessing Learning in Learning Communities. Our adaptations reflect an effort to align the assessment protocol with the curriculum committee goals, which from the beginning included developing a strategy for examining students' interdisciplinary understanding across a curriculum and also finding ways to ensure that assessment efforts support program improvements.

Table 2. *Collaborative Assessment Protocol for Student Work*

The purpose of this protocol (which was developed by Veronica Boix-Mansilla, March 2006, and adapted for National Project on Assessing Learning in Learning Communities) is to provide opportunities for teachers to discuss pieces of students' work and notice integration and opportunities for growth. The protocol can be used to assess and support students, to advance professional development, and to reflect about assignment design.

I. Getting Acquainted—General Assessment
   1.   Introducing the work: Presenting teacher shares minimal information about the work, avoiding value description. Teacher should:
     • State the course and the level, whether it is initial or advanced
     • Provide copy of syllabus
     • Describe the assignment, sharing relevant and intended learning outcomes
     • Provide copy of assignment instructions and explain how assignment fits into the overall curriculum

   2. Looking at the work: In silence, individuals read or observe the work brought in.

II. Zooming In—Targeting Assessment of Understanding

   1. Revealing disciplinary grounding (learning outcomes): Group members describe what they view as the disciplinary insights or modes of thinking or the ability areas that seem to be informing this work, pointing to the evidence in the work that makes them say so.
- What evidence suggests achievement of intended learning outcomes?
- What suggestions might we offer to this student to deepen learning?

   2. Revealing integrations: Group members describe what they view as overarching integrations of perspectives attempted by the student, pointing to the evidence in the work that makes them say so. How is the student bringing things from different classes together—for instance, is the student offering a complex explanation, an aesthetic synthesis, a contextualization, a pragmatic solution, or some other product based on integration?
- What evidence suggests learning achieved in previous courses?
- What would happen to students' understanding if key information from another course was not included?
- What suggestions might we offer to this student to deepen or develop the work?

III. Stepping Back

   1. Hearing from the presenting teacher: After listening without intervening, the presenting faculty adds her or his perspective on the general and targeted assessment comments.
- What might you do differently in terms of this assignment?
- What was effective?
- What changes (assignment, course, curriculum) would you recommend?

   2. Implications for teaching: By examining students' work in this way, what have you learned about designing assignments that support student learning outcomes? What are the curricular implications?
- What items represent best practices for other assignments?
- What are the implications (e.g., curriculum, advising)?

In order for its degree program to be accredited, the Agricultural and Biosystems Engineering department must demonstrate that its graduates have achieved the ABET learning outcomes. The overall program assessment plan calls for each department to identify key assignments, which students include in a portfolio. The department uses the portfolio as one of several direct measures of student performance. With the parallel difficulties of assessing a multiplicity of student learning outcomes and using that assessment process to improve curriculum and instruction in mind, the department curriculum committee—which included several faculty, an undergraduate, and a staff member in the department—decided

to use the collaborative assessment protocol to review key assignments. Instructors were invited to bring student work from key assignments, but their selection of work to share was not necessarily made with reference to the overall ABET learning outcomes.

In the following section, we will discuss the process and the results of reviewing student work from four departmental courses in the agricultural engineering curriculum, our initial efforts in using the protocol. These courses included: Engineering Problems with Computer Applications, Computer Applications and Systems Modeling, Agri-Industrial Applications of Electric Power and Electronics, and Engineering Graphics and Introductory Design.

Disciplinary Grounding

The curriculum committee first reviewed a sample of student work from a shared comprehensive exam for a 100-level course Engineering Problems with Computer Applications Laboratory. This three-credit course, focused on solving engineering problems and presenting solutions through technical reports, requires students to create computer programs to solve problems.

The team quickly discovered that interesting things happen when conversations about student learning shift away from a focus on assigning grades or looking for correct responses toward a focus on the evidence of learning present in student work. In particular, the curriculum committee used the collaborative assessment protocol to consider the degree to which selected student work demonstrated an understanding of content and methods within the discipline. For example, on one problem students are asked to provide a free body diagram (a graphic representation of a structural element subjected to various forces) to demonstrate their understanding of the problem. This step requires the students to demonstrate how different disciplines inform their understanding of the problem. The faculty could look at the diagram and determine the degree to which the student had demonstrated understanding of how several disciplines (e.g., geometry, statics, and physics) applied to the example. The inclusion of the schematic not only allowed students to demonstrate their ability to present a solution to a problem, but it also made the students' thinking visible in a way that allowed faculty to explore students' understanding of multiple facets presented in the problem. In this case, the curriculum committee could see evidence that the students demonstrated learning from multiple disciplines rather than simply seeing if the final calculation matched an answer key.

In reviewing another problem from the course final exam, the curriculum committee determined that students struggle with understanding units of measurement. The discussion moved beyond a simple notation of whether students have the correct answer to a review of curricular areas where they might gain exposure to these key understandings. The faculty began to ask questions like, "If students learn about units in chemistry, are they able to apply that understanding to different contexts?" or "If students are asked to solve a problem in its entirety instead of in smaller parts, do they learn key concepts such as units of measurement more effectively?" By reviewing examples of student work, the curriculum committee was able to focus on a specific disciplinary skill (understanding units of measurement), but then expand the conversation to consider ways to support student learning. Notice that the conversation did not focus on the quality of the exam question or the preparation of the student. Instead, the group acknowledged that they saw evidence of a lack of understanding in the student work; they confirmed that they had also noticed this lack of understanding in their classes, and they began to ask important questions about ways to enhance understanding.

The conversations helped to clearly define the important disciplinary content, methods, and types of communication we expected students to demonstrate. One faculty member who used the protocol process outside of this curriculum committee noted, "Until this process, I didn't stop to think about what things I wanted students to be able to do and demonstrate in my assignment." The refined protocol process we used asks the presenting faculty member to clearly articulate the expected learning outcomes from the course syllabus and to briefly explain how the assignment aligns with the core curriculum in the department. Our experience suggests that when we develop an intentional focus on discovering evidence of these key student learning outcomes, we come to a better understanding of the core disciplinary skills we hope students achieve.

During the review of student work, faculty began to wonder about ways to design assessment activities that would clarify for them whether students achieved the key learning outcomes in the course. For example, instead of simply determining whether the programming language developed by the students demonstrated proficiency in writing computer code, could the faculty develop components of an assignment that would make the students' thought processes more clear? One strategy the curriculum committee discussed was the incorporation of flow charts that would help students illustrate their thought processes and problem-solving strategies as they developed their programming. Through this conversation, faculty began to wonder whether the key disciplinary content focus should

be on students' ability to write programming codes that solve a problem or whether the key focus should be on the overarching logic that provides a framework for how to solve the problem. While students ultimately need to combine these two skills, the inability of the faculty to see students' understanding of the overarching logic presents two problems. First, it is not clear to the faculty if the students have an underlying understanding about how to address the problem. Second, if the task does not ask about the underlying logic, it may provide an implicit message that the key learning outcome is simply developing the right code or series of programming commands rather than developing critical thinking skills in addition to developing the appropriate code or command sequence.

The curriculum committee also reviewed a 200-level course Computer Applications and Systems Modeling. One of the important learning outcomes for this course is students' ability to apply their knowledge of mathematics, including their understanding of differential equations. After the committee reviewed the assignment, the group noted that the assignment did not include opportunities for students to make their understanding of differential equations visible. The group then talked about the importance of this skill in order for students to fully understand solutions, while noting that the differential equation course is not a prerequisite for the course. Noticing that students' understanding of a key concept (differential equations) was not visible in the assignment eventually turned into a discussion about course sequencing; faculty began wondering whether it was important for students to have this key understanding before taking the course. By reviewing the sample of student work and recognizing the ways in which the assignment limited students' ability to demonstrate their understanding of numerical techniques and mathematical models, the team understood that not only is this key learning outcome missing from the assignment, but also that the outcome might not be fully integrated into the course. Faculty noted that students could arrive at the correct answer by supplying the necessary programming code without necessarily understanding the mathematical concepts. An important outcome of using the collaborative assessment was a curricular change: The course was moved to the junior (300) level so that students had the necessary prerequisites to help them achieve the course learning outcomes.

Integrative Leverage

The curriculum committee considered the second dimension, integrative leveraging, by using the protocol process to explore ways that

student work demonstrated students' ability to integrate knowledge across disciplines. This review considers questions such as:

- What evidence suggests learning was achieved in previous courses?
- What would happen to students' understanding if key information from another course was not included?
- What suggestions might we offer to this student to deepen or develop the work?

Clearly it is difficult to consider the first foundation of interdisciplinary work (disciplinary grounding) without also noticing the ways that students integrate disciplinary perspectives. For example, in the first example the committee considered how the student work integrated chemistry, physics, and statics to answer problems. Here, we offer another example of student work from a key assignment to consider student integration in more detail.

The committee reviewed student work examples from a 300-level course Agri-Industrial Applications of Electric Power and Electronics. In this course, students are given a ground fault interrupter (GFI) laboratory assignment. The committee reviewed responses to the assignment, looking for evidence of students' ability to apply knowledge of mathematics, science, and engineering; analyze and interpret data; communicate effectively; and solve problems.

During the review, the committee discussed the importance of finding ways to make integrative thinking observable in student learning assignments. In this laboratory assignment, students analyzed the functioning of a ground fault interrupter, a lifesaving device many of us rely on when plugging in an electrical appliance in wet conditions like a bathroom or kitchen. The student response to the laboratory problem included the creation of multiple ways of communicating technical information, such as visual representations of the laboratory circuit that the student constructed, and numerical data. The review committee noted how the visual diagrams and graphs helped students demonstrate their ability to analyze data and effectively communicate information.

The committee found the focusing question regarding "what suggestions might we offer to this student to deepen or develop the work" to be extremely valuable. For example, in one case the group recommended that the student review how the individual pieces of communication might be better integrated to address the problem. The group noted that the student reported data using a measurement of time; however, a diagram of the laboratory circuit did not include any equipment that could measure

time. In this case, it was not clear if the student understood the purpose of the task, was uncertain about the necessary equipment to solve the problem, or simply forgot to include the equipment in the experiment design sketch. However, the committee noted a lack of clarity in the student's communication about the purpose of the experiment and use of equipment. The invited representation of the student's thinking created an opportunity for faculty to challenge the student to think more deeply about how all the pieces of his or her response could be integrated to clearly present a solution to the problem.

The committee also noted the importance of open-ended questions in the lab assignment. For example, the last question of the assignment asked students two items: "Did the GFI exhibit adequate performance for personal protection?" and "Draw a conclusion and then explain how you were able to come to that conclusion." We noted that this type of open-ended question is critical to a laboratory assignment where students may stop short of the key learning outcomes. Rather than focusing on the experimental design and the reporting of data, the key task for the assignment rests on students' ability to analyze and apply the information in a meaningful and accurate manner. The group noticed the need to encourage students to provide detailed responses to this question—to explain their solution, communicate knowledge, and demonstrate integration.

As we discussed ways of encouraging more thoughtful responses to open-ended questions, the committee thought about strategies for sequencing assignments that would help students understand the expectations for integrative learning. For example, our review team recommended that after an assignment, the class could have a discussion of a key question (like one of the questions noted above), including a review of samples of previous student work to engage students in discovering what was done well and what could be improved in the work. We highlight here that a student served as a member of the department curriculum committee. The student noted several times that similar discussions of student learning and the quality of student work would be extremely helpful in giving students information about expected learning outcomes and ways to demonstrate understanding in assignments. Another possible strategy we discussed would be the development of a common rubric that students could use to self-reflect and to critique drafts of peer projects. The committee wondered if a rubric on the design process would help students develop deeper thinking in areas such as the analysis of alternative designs. In short, the committee realized that if we expect students to demonstrate integration then we need to find ways to make it clear to students what we mean by integration and what constitutes high quality student work.

Critical Stance

The curriculum committee considered the last dimension, critical stance, by exploring ways that integrating disciplines strengthened student work and also by critiquing the integration in students' work. Although the protocol process does not specifically highlight this step, we found that the "Stepping Back" section of the protocol allowed the committee to examine critical stance in detail.

The curriculum committee reviewed a key assignment from a 100-level engineering course, *Engineering Graphics and Introductory Design*. The course includes graphics, computer modeling, design, and geometry. In the course, students learn to apply the engineering design process while developing communication skills. The sample of student work reviewed by the curriculum committee was a team design project that presented multiple designs for a machine built to perform specific tasks. The paper also included an analysis of the design and alternative solutions to the design problem.

The review team noted that the student work provided evidence of students' ability to integrate multiple disciplines. Initially the group recognized aspects of quality in the students' responses that enhanced the effectiveness of the student work. For example, the presence of figures with captions demonstrated strong communication skills. Students' use of language, citations, and transition sentences demonstrated high-quality writing. With time, the group considered more substantive questions about the quality of integration as evidence of student learning. For example, the committee noted that the students' use of the same baseline body for their machine while exploring alternative designs was an efficient use of time and resources and demonstrated a clear understanding of engineering design. Similarly, the students presented information about the costs and benefits of alternative designs in both the written text and through the display of data in graphs. In this way, students demonstrated an understanding of engineering trade-offs and the various constraints that impact the engineering design process. The review team also noted that the design matrix students included, ranking each design alternative on specific criteria, demonstrated their ability to integrate math and technical content with their design decisions.

Faculty commented that these integration and analysis skills are not always evident in the student work they see in subsequent design projects in the senior capstone course. Some faculty noted that senior students sometimes "short cut" the design process because they enter

the problem "knowing" a solution and then they simply plow ahead with an assumed best solution. Faculty commented that when students try to find the one best solution at the start, they are less likely to fully analyze their solutions. When the capstone projects fail to demonstrate analysis of alternative design solutions, faculty wonder if students still understand the multiple factors that influence design; they also wonder about the learning experiences students have between this first-year design course and the senior capstone which might contribute to an apparent decrease in the ability to effectively use the engineering design process.

Implications for Designing Learning Experiences

1. Align assignments with key learning outcomes. Clearly articulate the expected learning outcomes for the course and examine how key learning assignments align with expected course outcomes. Because the key assignments were selected by instructors, the curriculum committee could offer suggestions for strategies to increase alignment and to ensure focus on key departmental learning outcomes.

2. Invite students to make their integrative thinking visible in assignments. Find ways to make student thinking observable in student learning assignments. Specifically, find ways to make students' integrative thinking visible. Design specific questions that support students' ability to demonstrate key learning outcomes.

3. Clarify expectations. Design strategies that help students understand expectations for integrative learning.

4. Support deep learning by using collaborative conversations about students' work to identify important pedagogical questions. Identify ways to scaffold student learning to encourage deeper understanding. The review group considered questions like: "How do we encourage students to offer detailed responses when asked to 'explain your answer'?" "Should we actively encourage students to incorporate other disciplines or skills (e.g., drawing a sketch of a design) or should this be left to the students' judgment?" "How do we best support student learning without being prescriptive?" "Should early assignments contain cues or an outline that helps students address complex and open-ended problems?" "How do we support creativity and limit the temptation to find the 'one right answer'?"

5. Consider student learning across the curriculum and over time. A review of student learning from courses across the curriculum allows faculty to engage in conversations about developing comprehensive learning experiences that cross the curriculum. Our faculty team came up

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with questions about course sequencing, noticed gaps in key integrative learning outcomes, and considered new ways of designing learning experiences across courses. For example, the team wondered about the possibility of "spiraling" the curriculum so that students would learn key skills in early courses (like analysis of design solutions) and then be asked to apply those skills in more advanced levels in similar assignments in subsequent courses. Another strategy we considered was working on being more intentional about sequencing assignments across courses to build on previous projects. For example, if the key learning outcome of a course is analysis and critical reflection, rather than invest additional time in the development of a new design, could students use a design from a previous course and work with it on a deeper level?

6. Redesign learning experiences based on engaging in the protocol process. We found that our thinking about assessment took a different direction when we were not focused on assigning a grade to an individual. Our use of the protocol—of looking at student work for evidence of learning—enabled a faculty team to ask questions such as: "What evidence do you see that reflects achievement of intended learning outcomes?" and "What suggestions would you offer this student to deepen or develop his or her understanding?" The shift in focus here is clear. Instead of determining whether an answer was correct, we engaged in a discussion of student learning and of ways to better support that learning. Often the answers to the question regarding suggestions we might make to the student to deepen his or her understanding pointed to ways that we as faculty could redesign learning opportunities to be more helpful.

Although our title focuses on assessment and curriculum development, this should not obscure the fact that our use of the collaborative assessment protocol ultimately focused on finding ways to improve student learning. Through this project, we experienced a version of an effective approach to assessment that can guide a continuous curricular improvement process with improved student learning at its heart. Helping students achieve critical learning outcomes requires that curriculum, instruction, and assessment align. This case study provides examples of how the use of the collaborative assessment protocol can assist with this alignment process. The Agricultural and Biosystems Engineering curriculum committee's use of this process is radically changing—for the better—its conversations about instruction, curriculum development, and assessment. We encourage others to consider using this protocol as a way to intentionally concentrate on examples of integrative student work.

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