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Formative and Summative Assessment Techniques for Continuous Agricultural Technology Classroom Improvement

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Formative and Summative Assessment Techniques for Continuous Agricultural Technology Classroom Improvement

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Abstract

Four formative and summative learning assessment tools were used in two terms of an agricultural technology course. The formative assessment tools were a weekly e-mail feedback journal and a midterm electronic-survey. The summative assessment tools were a focus group and a student evaluation of instruction form administered at the end of each term. The weekly e-mail feedback journal and midterm e-survey assessments enabled several course adjustments during each course term, e.g., adjusting the content of the next class based on e-mail feedback, offering more real-world examples, and providing more example problems. The focus groups were used to explore more deeply students' perceptions of both the course and the formative assessments. The student evaluation of instruction form did not provide as much useful information about student learning and course improvement as the other assessments. Using multiple formative and summative classroom assessment techniques for a course had a synergistic effect on gaining insights into the teaching-learning process.

Introduction

Assessment in an educational context is defined differently by various authors. However, common to these definitions is gathering of feedback on the learning process, understanding the meaning of this feedback, and using the feedback to improve the teaching-learning process (Black and Wiliam, 1998; Wiggins, 1993; Huba and Freed, 2000; Palomba and Banta, 1999). Assessment takes place not only at institutional and curriculum levels, but also in the classroom. Classroom assessment involves teachers determining what students are learning and how and to what extent they are learning in the classroom (Angelo and Cross, 1993).

Historically, most classroom assessment has been summative with end-of-term assessments of the learning that takes place during each term of instruction (Boston, 2002). Summative assessment is often implemented by using final grades and some form of student evaluation of instruction (SEI). End-of-course SEI has been used in North American universities since the mid-1920s (Doyle, 1983). This summative approach allows for improvement only in subsequent teaching of courses.

SEI generally provides only limited insights on how to improve instruction. SEI tends to focus on instructors and their performance, rather than on teacher effectiveness in helping students learn (Huba and Freed, 2000). Weimer (1990) argues that SEI generally does not enable instructors to improve their teaching because it typically identifies instructional dimensions where student are satisfied or dissatisfied, rather than providing insights on how the teaching-learning process can be made more effective. As such, SEI does have value for evaluating instructors and instructional quality (Greenwald, 1997). With this in mind, it is valuable to think in term of assessments according to their purpose: either evaluating teaching or improving instruction (Weimer, 1990).

In contrast, formative assessment uses feedback to "adapt teaching to meet student needs" (Black and Wiliam, 1998, p. 140) over the period of instruction. Formative assessment's primary goal is to better understand interaction between instruction and student learning to improve learning. With such a goal, formative classroom assessment requires the gathering of the information needed to make instructional improvements. In an extensive review of research on the topic, Black and Wiliam (1998) found that use of formative assessment results in significant increases in learning as measured by test scores and that it helps low-achieving students to a greater degree than other students. Other studies by Fuchs and Fuchs (1986) and Crooks (1988) have also demonstrated how formative assessment successfully enhances student learning. In addition, the shift from a teacher-centered to a learner-centered educational paradigm creates a need for formative classroom assessment (Huba and Freed, 2000). If instructors are truly concerned with student learning, assessment of the quantity and quality of student learning is critical. Teachers must have continuous feedback on the progress of student learning to ascertain if their teaching methods are effective (Stiggins, 1997).

Informal formative assessments of student learning, such as looking for visual cues from students during the classroom activities and observing the types of questions asked by students, nearly always occur in the classroom (Angelo and Cross,

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1993). However, these informal assessments are generally not reliable or consistent enough to provide instructors with in-depth understanding of student perceptions of their learning, or with the opportunity to effectively improve instruction. To remedy this situation, a variety of formative and summative assessment methods can be used to obtain feedback on student learning in the classroom (Stiggins, 1997). For this study, two formative assessments a weekly e-mail journal and a midterm e-survey and two summative assessments an end-of-term focus group and an end-of-term SEI form were used. While such formative and summative assessments generally identify student perceptions about instruction and learning rather than directly measure if learning has taken place, there is a direct relationship between student perceptions of their learning and actual learning (Mentkowski, 2000).

E-mail journals have been shown to promote communication between students and instructor, with benefits to both. These benefits include providing students with motivation to reflect on course material and opportunities to seek help in a non-threatening forum to improve their understanding of course material. Instructors receive benefit from e-mail journals by having access to an expanded sample of students' perceptions about course instruction and information about student learning including misconceptions (Meel, 1999; Wolffe and McMullen, 1995-96). Deal (1995) found that e-mail journaling also helps students develop improved self-assessment skills and to better synthesize what they are learning. She found commensurate benefits to instructors through the deeper understanding of student concerns and perceptions provided through the journals. The use of e-mail helps to encourage timely communication concerning course material (Angelo and Cross, 1993; Spence and Sandmeyer, 1995). The key component of this type of feedback is the closing of the loop between student questions and instructor responses. It is important for students to perceive that their questions and feedback are considered valuable to the instructor (Spence and Sandmeyer, 1995).

Teacher-designed surveys are also a way to receive formative feedback. Using this type of feedback, adjustments can be made during the term. Instructors can solicit feedback on the course in general, or regarding a specific project, testing procedures, or presentation of course concepts. This type of feedback can be used several times throughout the term, but perhaps the most reasonable time to use a survey is around midterm. Midterm feedback surveys are usually short, simple, and course specific (Angelo and Cross, 1993). When interpreting the feedback, the instructor must determine what changes can be made yet this term, those that will have to wait till next term, and those that cannot be implemented based on pedagogical reasons (Davis, 1993). Implementing a web-based midterm feedback survey provides the instructor additional flexibility in survey design and enables rapid collection and analysis of results (Lieberman et al., 2001).

Focus groups can be effective in obtaining specific summative data from event participants. A focus group is "a carefully planned series of discussions designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment" (Krueger and Casey, 2000, p. 5). Christopher (2000) reported on the use of student focus groups as one evaluation component of a university-level course. She found the open and interactive setting of the focus group to facilitate deep thinking about the course and to uncover specific suggestions of how it might be changed. Hendershott and Wright (1993) used student focus groups to explore student attitudes about and behavior arising from general education curriculum requirements at a university. They found focus groups uncover "rich data" (p. 158) going beyond information gleaned through surveys. Hamilton et al. (2002) found that the use of student focus groups resulted in specific suggestions for course improvements as well as significant increases in SEI ratings.

Current literature supports the potential for using formative and summative assessment to improve instruction. However, little has been written showing how several assessment methods can be synergistically employed in the same course to promote course improvement. The goal of this research was to investigate the interaction and usefulness of several formative and summative classroom assessments in making course improvements the first two terms that an instructor taught a specific agricultural technology course. Specific objectives of the research were to:

1. Investigate and compare the use of two formative and two summative assessments to identify and understand student perceptions of their learning and the teaching methods in the course.

2. Determine how the formative assessments could be used to make course adjustments during the duration of the course.

Methods

The Course

The course that formed the basis for this study was entitled Fluid Power Systems for Agriculture, an elective offered in the Agricultural Systems Technology curriculum within the Department of Agricultural and Biosystems Engineering at Iowa State University. The course provided an introduction to fluid power technology as applied to the agricultural equipment industry. Students were expected to come into the class with basic problem solving skills and competency in college algebra and trigonometry. Each week, the two-credit class met for a one-hour "lecture" period in which the instructor discussed course content and the students participated in team exercises centered around course topics. Class time was structured around a multimedia presentation consisting of drawings, images,

animations, and text which was available on-line to students. Active learning exercises in which the students interpreted hydraulic schematic diagrams through discussions with their neighbors were intermixed with the presentation. The instructor also worked problems and reviewed problems from past quizzes in the class. In addition to the classroom session, there was a weekly two-hour lab session. WebCT Campus Edition (WebCT, Inc., Lynnfield, MA), an online course management and content delivery system (Rehberg et al., 2001), was used to provide course content to the students and for weekly quizzing and practice exams.

The Assessments

Four classroom assessments were implemented when the first author was teaching the course for the first time during the spring of 2001. They were repeated in the spring of 2002 for the same course. There were 29 and 27 students in the 2001 and 2002 classes, respectively. The assessments were (1) a weekly e-mail journal, (2) a midterm feedback e-survey, (3) an end-of-term focus group, and (4) an end-of-term SEI form.

Weekly E-mail Journal. Students were required to complete a focused e-mail journal by submitting weekly responses to the following statement and questions that were developed by the course instructor:

1. Summarize three main points discussed in today's class.
2. What was most clear to you in today's class?
3. What topics are you having difficulty understanding and why?
4. What questions remain in your mind about the content of today's class that I could answer?
5. What helped you learn in today's class?

This set was developed to address the objectives of the study and provide a good learning experience for the students. The number of questions was limited in number so that the students were not unnecessarily burdened by the weekly assignment. The e-mail answers to these questions were to be submitted by midnight of the day following each lecture period. This time frame was chosen so that the classroom experience was still fresh in the students' minds. Later during the week, the instructor read the student submissions in one block of time. The instructor communicated his responses through (1) e-mail replies to the individual students posing questions, (2) e-mail replies to the entire class, and/or (3) replies incorporated into the following lecture. Five percent of each student's course grade was based on the proportion of possible journal entries that he/she submitted and completion of the mid-term survey. Justification for basing a portion of the course grade on completion of these two assessments came from the expectation that communicating about course content and perceptions of their learning would facilitate further learning.

Midterm Feedback E-survey. At mid-term, students were asked to complete a course survey administered through WebCT. While responses to the survey were anonymous, WebCT indicated which students responded to the survey. The survey consisted of the following questions that were developed by the course instructor to achieve the objectives of the study:

1. On average, how much time outside of class do you spend on AST 337 per week (please be honest)?
2. What do you have the most difficulty understanding in AST 337?
3. What can I do to help you learn about hydraulics?
4. What suggestions do you have for improving the class?
5. Please rate the instructor's performance in helping you learn (5 = excellent to 1 = poor).
6. Do you find WebCT helpful to your learning in AST 337? Why or why not? (asked in 2002, only).

The instructor examined the responses to identify reoccurring themes. Ambiguities and questions arising from the data were used in the development of guiding questions for the subsequent focus groups.

End-of-Term Focus Group. Near the end of each term, a pool of students was selected from each class to represent a cross section of past academic performance. These students were asked to participate in the focus group and were offered a light lunch as an incentive. Their participation was voluntary, and some students were unable to participate because of time conflicts. Guiding questions for the focus group discussion were developed based on e-mail responses and the midterm feedback e-survey. A focus group moderator and recorder, neither of which was the course instructor, guided and recorded focus group discussions which lasted approximately one hour. Discussions were recorded on audio tape, and the recorder made annotations to indicate which student was speaking. The audio tape was transcribed by a departmental secretary. In the focus group transcript, the anonymity of the participant was protected by changing the names of the students before it was released to the instructor. The instructor read and analyzed the transcript only after the course was finished. The transcripts were analyzed using the long table method (Krueger and Casey, 2000), to find potential answers to questions that were raised by data from the other assessments. The students were told that the instructor would not know their identity and the instructor would not be involved in conducting the focus group, so that results would not be influenced by students thinking that their comments would affect their course grade. In 2001, seven out of 29 students participated (24%); while in 2002, three out of 27 students participated (11%).

End-of-Term SEI. At the end of each term, a departmental SEI form was completed by the students. The SEI form, developed by the departmental curriculum committee, presented a series of

statements about the instructor (n=14), the course (n=8), and the room (n = 2). For each statement, the student was asked to provide a ranking from 1 to 5 indicating a "poor," "marginally satisfactory," "satisfactory," "good," and "excellent," respectively. Additional written comments were invited "to aid the instructor in making personal and course improvement." Anonymity was maintained. The instructor was not given the SEI results until after course grades had been submitted.

provided the instructor with current information on the students' perceived understanding which was used to plan the next class.

The questions that the students raised also provided much insight into the learning process. The instructor was particularly attentive to student questions during the rapid weekly review of e-mail journals because they provided opportunities for direct responses to student concerns or misunder-

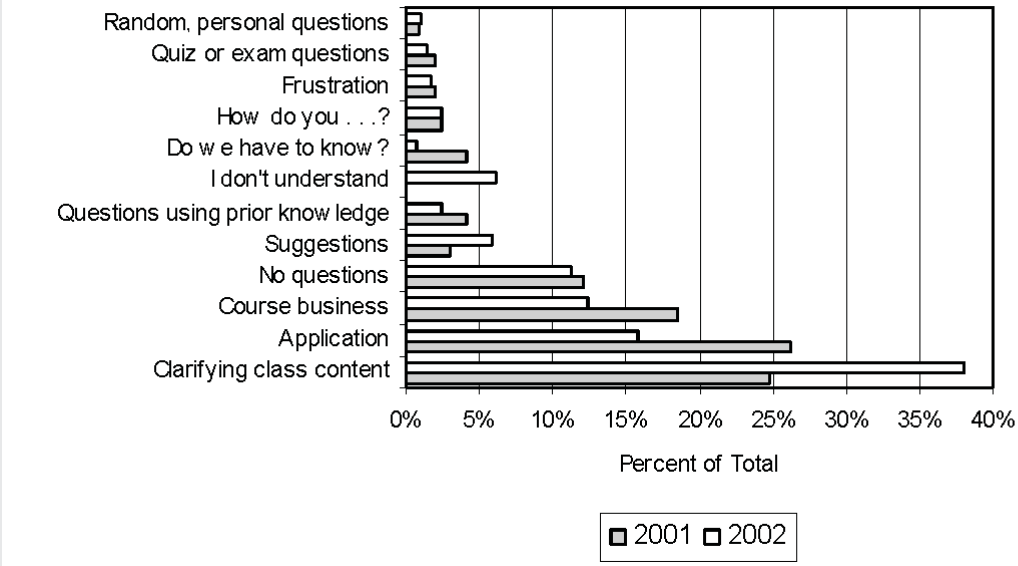

Figure 1. Percentages of student question type by category from the weekly e-mail journals (2001, N= 340; 2002, N-292).

Results and Discussion

Weekly E-mail Journals

The weekly e-mail journals provided timely updates on how students perceived their learning to be progressing after each class period. The instructor used this feedback in preparation for the next class period. He presented responses to student questions, reviewed confusing course content from the previous class, and used student questions to bridge the content from the previous class to new topics in the current class.

In addition, the e-mail journals provided regular and voluminous feedback enabling the instructor to understand how the class generally comprehended the material and to make appropriate adjustments in the following class period. For example, the students provided responses identifying what topics were clear such as, "It was most clear to me that pumps produce fluid flow, not pressure." Another student wrote, "The most clear thing in my mind was the understanding of viscosity, and what makes one fluid more viscous than another." Students also indicated topics were causing them difficulty in understanding such as, "I didn't really understand Viscosity Index." Another student wrote, "I had difficulty understanding the hydraulic schematic." These statements

standings in the next class. In 2001, 340 student questions were collected. The largest category of questions (26%) was those asking how specific course content could be applied in the real world (Figure 1). The second and third largest categories consisted of those clarifying content discussed in the previous class (25%) and inquiries about course business (19%). About 12% of responses indicated students did not have a question. In 2002, out of 292 questions, the largest number of questions (38%) were clarifying course content. The second and third largest categories consisted of application (16%) and course business (12%) questions. Overall, the majority of the questions dealt with course content and provided the instructor with a wealth of information on student learning and how the students were processing the content from the previous class.

Feedback about the email journals was obtained from the focus group discussions. Students indicated that the instructor's responding to student questions at the beginning of the next class made them feel their feedback was shaping the direction of the course. Students also indicated that answering a question of one student helps other students as well since other students often have the same question but are not able to articulate it. One student com-

mented that answering questions "makes you a little more attentive in class too . . . because you are covering stuff that you have asked, or there's a pretty good chance that your peers have asked, and there's a pretty good chance that you are interested in it too." Another student said, ". . . there's a lot of questions that I've had which I really haven't been able to put into words on the journal . . . he has them in next week's notes. . . that part is real good." Requiring students to write about course topics in the journal is making them interact with and think more deeply about course content. The weekly e-mail feedback journal also allowed the instructor to gauge student perceptions about their learning and his teaching methods in a timely manner. The instructor was thus enabled to make well-informed judgments about how to guide the course to optimize student learning.

While the e-mail journal was effective, it was limited by two constraints. First, the quality of feedback depended on students providing feedback that truly represented their experience. Enthusiasm for responding to the e-mail journal tended to wane in the last half of the course as indicated by the decrease in the number of responses as the semester progressed (Figure 2). Second, reading through all of the student responses each week required a substantial amount of instructor time, and would require even more if all responses were categorized and reflected upon throughout the course. Typically, the instructor read through the responses when preparing for the next class, looking for questions to address to provide new opportunities for learning. The instructor also tried to gain an understanding of difficulties students were encountering to provide a review of content in the next class to help learning. In incorporating this feedback into the subsequent class, he made modifications to the presentation and lecture notes. While a general understanding of student perceptions of learning came through the quick during-course analysis, more insight came after working with the data in the post-course analysis which had value for subsequent classes.

During each course term, for example, the instructor read student responses to the questions dealing with learning methods that the students felt helpful. But often, it was difficult to gain much understanding from these individual responses. Part of the reason was that the responses were class session dependent, and the mix of teaching methods in different classes varied. In post-course analysis, however, more understanding was derived from these responses by examining aggregated data.

The responses to the learning methods question were categorized according to the type of teaching method that students felt best helped learning in particular classes. Across the two years, the percentages of responses were highest for multimedia, active learning exercises, and working problems, respectively. In 2001, 337 responses were collected. The category active learning exercises received the most responses (18%), while multimedia, physical components, working problems, and particular figures were the next highest capturing 12%, 12%, and 11% of the total number of responses, respectively. In 2002, 279 responses were collected and the multimedia category received the most responses (21 %), with working problems (14%) and explanations (11%) receiving the next highest numbers of responses (Figure 3).

Two possible reasons may explain why particular methods received high numbers of responses. First, particular methods were perceived as being useful in students' learning. Certain visuals were often cited as helping learning as the students found that these multimedia visualizations crystallized particular concepts. One student wrote that a diagram "helped my [me] recall a lot about what I already know," or another wrote that a pump diagram "was helpful in understanding how hydraulic systems work." Second, some methods were used more frequently than others, and we

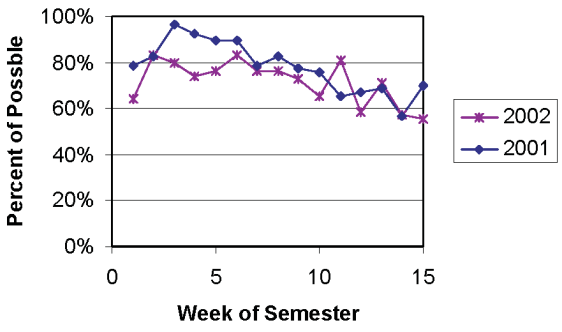

Figure 2. Percentages of possible number of email feedback responses per week in the semester (2001, N= 29; 2002, N-27).

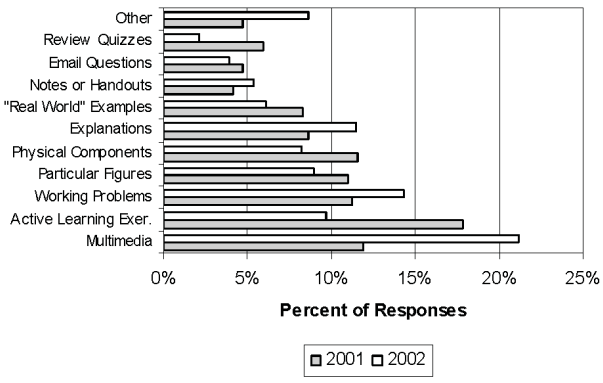

Figure 3. Percentages of responses to the weekly e-mail journal question, "What helped you learn in today's class?" categorized by type of instructional method (2001, N=337; 2002, N-279).

would expect a positive correlation between response rate and the frequency of use. Multimedia presentations, for example, were used in every class period and received a high response rate.

Perhaps the most salient cases are those methods that were not used with such a high frequency, but still received a high number of responses. For example, for only about 10 minutes of about one third of classes were students able to see and touch physical hydraulic components. Even though a small amount of class time was devoted to the physical components, across the two years, they received 10% of the responses. This indicated that students perceived the use of physical hardware in the classroom to be very helpful to learning, thereby revealing their preference to learn visually. Another interesting case is the real world example category that only received 7% of the responses in two years, even though the instructor made efforts to try to include "real world" examples in most classes. There may be a difference between what the instructor and the students perceive as being real-world. Evidence for this difference was found in both the mid-term feedback survey and the focus groups.

Midterm Feedback E-survey

During both years of the study, 100% of the students in the class responded to the e-survey. The responses for specific questions requiring short answers ranged in length with no answer provided in only one case, to one or two word answers like "conversions" or "viscosity," to responses that consisted of many sentences with as many as 85 words. These responses provided formative assessment of student perceptions of the first-half of the course. They provided a more global perspective of the course, as compared to the weekly e-mail journals which provided perspective on individual classes. The midterm feedback e-survey helped the instructor better understand student learning difficulties by providing feedback that could be easily summarized and interpreted.

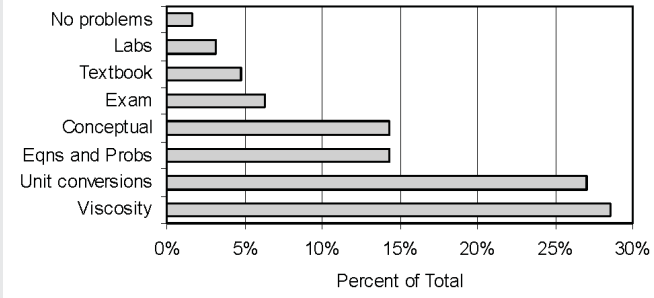

Figure 4. Percentages of responses to the most difficult to understand course areas from the midterm e-survey (2001 and 2002 classes combined N=63; some responses fit into multiple categories).

Students indicated difficulty in topics or skillsthat were computational in nature. Over the two years, 29% of the e-survey responses were related to the fluid property of viscosity (Figure 4). Problems with viscosity may have been primarily a unit conversions problem, because students in the course are required to convert from one set of viscosity units to another and to apply the concept of viscosity to fluid power system problems. However, students may also have had difficulty connecting the concept of viscosity with prior knowledge and experience. Thus after the first year, the instructor related viscosity to common fluids (e.g. water, honey, alcohol) with which the students would be familiar.

The second highest number of responses (27%) indicated difficulties with unit conversions. Competency as a fluid power technologist requires skill in converting between units in both English and S.I. measurement systems. The large number of students encountering unit conversion difficulties indicated a potential deficiency in this pre-requisite problem solving skill. These findings resulted in additional emphasis on the unit factor method in two pre-requisite basic problem solving classes starting in the fall of 2001.

Similarly, responses to the question about how the instructor could help student learning also provided greater insight into student learning preferences than the responses in the weekly e-mail journal about learning methods used in individual classes. Two themes emerged from the student responses. One theme as indicated by 46% of the responses across both years was that "real world examples," "more hands on stuff," and "more practical stuff" would enhance their learning. The second theme that emerged—21% of the responses—was that the students thought more examples, as indicated by responses such as: ". . . more examples . . .," and ". . . do more problems/examples," would help learning (Figure 5).

When asked a more general question about what students would consider as an improvement for the class, two themes emerged that were similar to those identified above. Many responses indicated that

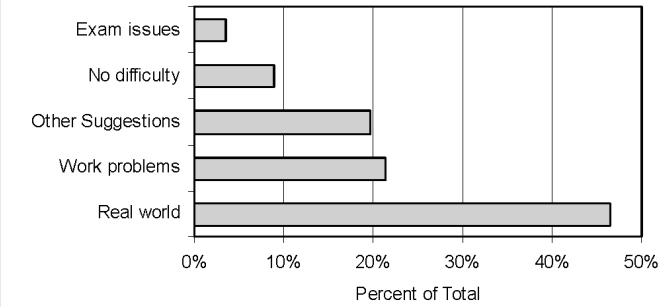

Figure 5. Percentages of responses to what helped students learn best from midterm e-survey (2001 ans 2002 classes combined, N=56).

giving the course a more practical orientation and working more problems could improve the course. Nevertheless, from the short answer responses of the students, it was sometimes difficult to know how to interpret students' responses. Additional data were collected through the focus groups to better understand these responses. In addition, there were also many suggestions in the responses that were difficult to categorize because they tended to be specific in nature. These included suggestions such as, "involve us as a class more in lecture so we are less prone to fall asleep" and ". . . have the pump and motor equations and efficiencies on a single sheet." These suggestions were generally understandable and often provided information on how the course could be improved.

Timing of the administration of formative assessment relative to major assignments in the course is important. In 2002, for example, the e-survey was completed right after the graded midterm exam was returned to the students. This led a few students to provide responses that directly related to the exam. In one case, the student clearly indicated in his survey response, that he/she received a low grade on the exam and responded to every short answer question with statements of frustration about his poor exam performance. Other students provided responses about the exam which seemed to be statements of frustration but could also have been opinions on how to improve the exam relative to the rest of the course. Care should be taken when a survey is administered relative to other course events so that interaction between the event and the survey responses is minimized.

End-of-Term Focus Groups

In general, focus group discussions consisted of honest, open and frank opinions of what the students thought about the class. They seemed to be uninhibited in speaking their mind and free in providing negative comments.

Because of the small percentage (18%) of students involved in the focus group, results may not be representative of the entire class; however, the results were not in conflict with the other assessments which collected data from the entire class. The focus group assessment of the course had value because of the in-depth insights into student thoughts about the course, students' perceptions of their learning, and students' observations on how the instruction and the other assessments were helpful to their learning. The focus group was summative and as such did not lead to instructional improvements during the same term. Nevertheless, the deeper understanding into (1) student learning preferences and (2) perceptions of teaching methods derived from the focus group discussion was beneficial and applicable to subsequent terms.

Student Learning Preferences. Focus group discussions clarified feedback from other assessments leading to a greater understanding of how student learning was taking place and insight into how students prefer to learn. The focus group discussions clarified what it meant for the class to be more "real-world" or "practical" themes that arose from the midterm e-survey. The discussions revealed that when students referred to something being "real-world," they meant they can see the connection between the course content and their past practical experience with hydraulics either from growing up on a farm or from work experiences. In addition, a visual over a verbal learning preference was identified from the discussions. For example, one student said, "I need to see what is there and see how it works," or another replied, "I just think it's good to see how things work visually instead of just reading [about] it." They also found value in animations of fluid power systems. On the other hand, students indicated, for example, that they had difficulties reading the textbook to gain an understanding of how things work. A student said, "I just can't read about it and learn about it very well." Or another, "I know myself I just can't stick my nose in a textbook and learn everything I need to know."

Perceptions of Teaching Methods.The focus group discussions also provided summative reflections on the methods that helped learning across the entire course, in contrast to the weekly e-mail journal, which provided class dependent feedback or the midterm feedback e-survey in which the students were asked formatively what could be done in to help their learning throughout the rest of the course. In these discussions, the students indicated that WebCT quizzes, starting off each class period with answers to journal questions, and making connections with real-world experiences were teaching methods that helped their learning.

The focus group discussions provided clarification as to whether students prefer a teaching method because it facilitates learning or simply because it makes getting by in the course easier. Some students seemed to indicate preferences for teaching methods that made the course easier. For example one student said, "We don't really have to learn them [sample problems], because he will teach them." Regarding the e-mail journal, on the other hand, a few students discussed the difficulty that they had developing answers for it each week; however, most of the participants indicated that the e-mail journal was helpful for their learning. Another student indicated that he didn't prefer another method, even though it may have been important in his learning: "I get a little perturbed when he goes over stuff [in the quizzes] we haven't covered. . . . I'd just rather have him tell me it and then just be able to repeat it back on the quiz rather than look it up myself." These examples illustrate how the focus group discussions filled in gaps present in other assessments.

End-of-Term SEI

A critical analysis of the SEI form revealed that it reflected a teacher-centered paradigm of education. The SEI form starts with a sentence, "Your frank and

honest answers to each question in this evaluation will help your instructor improve this course and teaching procedures used in it." This statement sets the tone for the entire SEI form, that is, the quality of a course is primarily a matter of the instructor's performance. The questions related to the instructor and course solicited ratings based on how well the instructor had performed or met the expectations of the students. The instructor, for example, was rated on how well he "knew the subject matter," "presented legible board work," or "was well-prepared for class." The third group of questions addressed the adequacy of the physical classroom environment. Students were asked directly about their learning in only two questions: (1) "The course assignments helped students learn subject material," and (2) "The course increased student knowledge of the subject."

In 2001, 25 out of 29 students (86%) completed SEI forms; while in 2002, 25 out of 27 students (93%) completed the forms. In 2001, the mean scores ranged from 4.40 to 3.64 across all items, with the exception of a mean score of 2.83 for the statement, "The text material was well-written and easily understood." In 2002, the mean scores ranged from 4.65 to 3.64 across all items. When asked if the course assignments helped them learn subject material, in 2001, the students responded in a manner that yielded a mean score of 3.72 and a standard deviation of 0.94. For the same question in 2002, the mean score was 4.08 and the standard deviation was 0.70. When asked if the course increased student knowledge of the subject, in 2001, students responded in a manner that resulted in a mean score of 3.67 and a standard deviation of 1.05. On the same questions, in 2002, the mean score was 4.36 and the standard deviation was 0.57. Using the ratings, the students indicated that their learning was between "satisfactory" and "good" in 2001 and between "good" and "excellent" in 2002.

Of the 50 forms, 17 had written comments on them (34%). Students often composed their written comments with multiple phrases that were often distinct suggestions, criticisms, or praise. From the written comments, 33 distinct phrases were found. Seven of these phrases (21%) were positive statements like, "Instructor did an excellent job trying to improve the class," or "very good course." Seventeen of the phrases (52%) were neutral statements or suggestions such as: "more useful lab practices" or "make this class 3 credits." The remaining nine phrases (27%) were negative statements like "I hate WebCT" or "hated the grading system." It was difficult to categorize the phrases because so many different topics were addressed. Of the categories drawing the largest number responses, WebCT received five responses that were both positive and negative. There were also four suggestions about making the course more practical.

While the SEI form provided a means of instructor evaluation, it tended to provide less feedback to the instructor on how to improve learning. In particular, the quantitative measures reveal some measure of student satisfaction, and some basic guidance on course improvement could be derived from them. Generally, however, the scores did not depart from the range corresponding to satisfactory to excellent ratings. Thus not much meaning could be derived from these measures. The written comments, if provided, have potential to provide suggestions for course improvement though they usually are so brief that they lack the context for useful interpretation.

Synergism of Assessments

Through this research, we found a synergistic effect when using multiple formative and summative classroom assessments techniques for a course. For example, the preference that the students had for connecting the course to more "real world" examples and practical applications was detected in the e-mail journals and the mid-term survey. The repeated occurrence of these themes prompted the related guiding questions for the focus groups. These questions were successful in stimulating discussion that lead to deeper understanding of what these concepts mean to these students. Therefore, the understanding of student learning and preferences builds from one assessment to another. Part of the reason for the synergistic effect of the multiple assessments was that each of the assessments differed from the others in several ways. They differed in repetition with the e-mail journal repeated weekly and the others only once. They differed in focus with the e-mail journal on each class, midterm e-surveys on first halves of the courses, and focus group and SEI on entire courses. They also differed in the type of questioning with the e-mail journal and midterm e-survey using open-ended but focused questions, focus groups with open-end questions and group interaction, and SEI with closed rating questions.

Through careful analysis of the data from each of the assessments and by using the questions arising from one assessment to design or guide the analysis in another assessment, the interaction between student learning and instruction was more fully understood. Clearly, adequate assessment of student learning is both formative and summative and will require more than a traditional SEI. Formative assessment promotes student reflection on learning, provides the instructor with information that can be used to change the course during the term, and thus provides students with evidence that their feedback is critical in the learning process and is taken seriously by the instructor. As shown in other studies, while SEI may be a valid indicator of instructional quality (Greenwald, 1997), SEI tends to provide less information useful for improving instruction. Having the other forms of assessment available for the same course emphasized this fact.

Summary

Multiple assessments were helpful for a new instructor to gain understanding of how students

learned and what methods were perceived as helpful for learning. Formative assessment helped the instructor also quickly understand where students had difficulties learning and enabled improvements during the courses. The following conclusions can be drawn from this study:

1. The combination of assessments was helpful in understanding which instructional methods students preferred and how instruction could be improved.

2. The weekly e-mail feedback journal helped the instructor immediately understand where students were experiencing difficulty in learning particular concepts. This feedback allowed the instructor to make timely course adjustments to help students overcome these difficulties. Furthermore, students felt encouraged that their feedback was affecting how the course was taught.

3. The mid-term e-survey provided a more global perspective of student learning. While some specific suggestions were easily understood, other responses were somewhat difficult to interpret.

4. The focus group discussions provided deep insight into perceptions of student learning and instructional methods, particularly as they clarified feedback generated from other methods. Because they were summative, the results could only be used to improve future classes.

5. The SEI provided a low effort evaluation of student perceptions of the course, particularly their preferences and overall satisfaction with the instructor. It provided less useful information for course improvement than the other assessments.

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