Qualitative Research of Universidad de las Américas Puebla's Food Engineering Course Learning Outcomes

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Abstract

The Food Engineering (FE) program from *Universidad de las Américas Puebla* (UDLAP) is approved by the Institute of Food Technologists (IFT) and accredited by the *Consejo de Acreditación de la Enseñanza de la Ingeniería* (CACEI), which is the Mexican peer-accrediting agency of the US ABET. Graduates of UDLAP's FE program shall attain thirteen outcomes; eleven of them are similar to ABET Criterion 3 program outcomes[1]; as well as specific IFT core competencies regarding major areas: food chemistry and analysis; food safety and microbiology; food processing and engineering; applied food science; and success skills[2]. As part of assessment efforts, the Food Engineering Undergraduate Curriculum Committee (FEUCC) designed a strategy that uses both direct and indirect assessment measures that is reported elsewhere[3, 4].

During this past year the FEUCC has been delineating a new assessment plan for 2015-2020 in order to be ready to apply for the IFT re-approval of our program. Thus, thorough qualitative research (with data obtained from 2011 to 2014) for each of our food engineering program required food science and engineering courses was performed, in order to design a high-quality assessment plan. As part of this qualitative research, FE program faculty were asked to rate for each of the courses they teach the degree to which they are promoting FE thirteen outcomes and IFT core competencies. Responding whether they cover in great detail (as a course outcome), cover in detail, cover to some extent, or if they do not cover each outcome and/or competency in their classes; furthermore, faculty reported for every required course, the specific course learning outcomes, tools used to assess learning outcomes (indicating the level of assessment using the Revised Bloom's Taxonomy[5]), as well as related course learning activities. Protocol analysis of faculty responses was performed by means of an electronic qualitative data analysis software (Atlas.ti); identifying idea units within the responses, and classifying those units with coding schemes built from core competencies, learning outcomes with regards to two taxonomies (Revised Bloom's[5] and Coll's[6]), assessment tools and corresponding learning activities.

We were able to clearly identify the degree to which core competencies and outcomes are promoted and emphasized throughout the FE curriculum. Some areas of improvement were found regarding core competencies such as: "understand the basic principles and practices of cleaning and sanitation in food processing operations" and "understand the requirements for water utilization and waste management in food and food processing". Reported course learning outcomes were classified according to the Revised Bloom's (as remember, understand, apply, analyze, evaluate, or create) and Coll's taxonomies (as conceptual, *to know*; procedural, *to know-how*; or attitudinal, *to be*). Among common tools that faculty reported to assess student learning are: self- and peer-assessments, instructor assessment, exams, oral presentations, practical exercises, homework, in-class participation, projects, and lab reports. Learning activities that faculty reported include written reports, analysis of readings, in-class discussions, lectures, problem- and project-based learning, active and cooperative learning, exercises, and lab activities.

Introduction

Universidad de las Américas Puebla (UDLAP) is a Mexican private institution of higher learning committed to first-class teaching, public service, research and learning in a wide range of academic disciplines including business administration, the physical and social sciences, engineering, humanities, and the arts. Since 1959, the Commission on Colleges of the Southern Association of Colleges and Schools (SACS) has accredited UDLAP in the United States.

The Food Engineering program from UDLAP is approved by the Institute of Food Technologists (IFT) and accredited by the *Consejo de Acreditación de la Enseñanza de la Ingeniería* (CACEI), which is the Mexican peer-accrediting agency of the US ABET. Graduates of UDLAP's Food Engineering program (FE) shall attain thirteen outcomes; eleven of them are similar to ABET Criterion 3 (a-k) program outcomes[1] and the other two are as follows: "an ability to communicate effectively in English in written form" and "an ability to rationally use information and communication technologies as learning tools, and to find and manage important information"; as well as specific IFT core competencies regarding five major areas: food chemistry and analysis; food safety and microbiology; food processing and engineering; applied food science; and success skills[2].

UDLAP's Food Engineering program relies on many different mechanisms to measure the achievement of its goals: student course evaluations; exit interviews with graduates; student and alumni surveys; employer surveys; input from our food industry advisory board; UDLAP's Engineering School and University-wide assessments and review of programs; as well as national re-accreditation of the program by CACEI and international re-approval by IFT. These and other assessment measures are reviewed by the Food Engineering Undergraduate Curriculum Committee (FEUCC) and then presented with corresponding recommendations to the Food Engineering faculty on our annual faculty retreat. Every five years at UDLAP all programs are reviewed. This review includes among other things, a revision of several similar undergraduate programs both in Mexico and internationally. Further, opinions by alumni and experts from academy and industry are sought in order to assess our program. The FEUCC designed a strategy that uses both direct and indirect assessment measures that have been reported elsewhere[3, 4].

As previously described[4], UDLAP's Food Engineering Program Assessment Plan consists of three major parts[3-13]:

Part I: Determining expectations. Along with stating expected outcomes, we try to identify if, in fact, we provide sufficient educational opportunities inside and outside of the classroom to develop the desired outcomes we assert we teach and/or develop. Courses may be one means, but several other options exist. To assure that students have sufficient and various kinds of educational opportunities to learn or develop desired outcomes, we engaged in curricular and co-curricular mapping.

Part II: Determining timing, identifying cohort(s), and assigning responsibilities. This part of the Assessment Plan focuses on how and when every Food Engineering Program faculty will be assessing desired outcomes, identifying appropriate times to assess students' level of

achievement of selected competencies. Assessing student learning over time known as formative assessment provides valuable information about how well students are progressing towards expectations. In addition, interpretations of student achievement could then be linked to the kinds of learning experiences that do or do not promote desired outcomes. Interpreting students' performance or achievement over time and sharing assessment results with students enables students to understand their strengths and weaknesses and to reflect on how they need to improve over the course of their remaining studies. Assessing student learning at the end of a program or course of study known as summative assessment provides information about patterns of student achievement, but without programmatic opportunity to improve achievement of assessed students, and without student opportunity to reflect on how to improve and demonstrate that improvement. Using both formative and summative assessment methods, the FEUCC is provided with a rich understanding of how and what students learn regarding intended outcomes.

Part III: Interpreting and sharing results to enhance general education effectiveness. This part is involved in making decisions based on interpretations of assessment results and then establishing communication channels to share those interpretations so that the FEUCC acts on and supports interpretations to improve student learning of intended competencies. The question underlying assessment results is what has faculty and FEUCC learned about its students' learning? Interpretations of student performance might lead to innovations in teaching in courses or in redesigning the Food Engineering curriculum. These kinds of changes will need to be recognized and addressed at UDLAP's highest decision-making levels to assure that our institution commits the appropriate finances and/or resources to enact the kinds of changes or innovations that interpretations identified. Interpretations are being shared with several institutional committees. Once the Food Engineering Program makes changes to improve the quality of its education, the assessment cycle will begin anew to discover if proposed changes or innovations do improve student achievement. The assessment cycle once again will explore how well students' are learning based on innovations or changes proposed by the FEUCC.

UDLAP's FEUCC has been utilizing assessment results to enhance student learning through curricular modifications. Several improvements and modifications (such as performing embedded assessments in several FE courses) have already been reported[3, 4].

Methodology

During this past year the FEUCC has been delineating a new assessment plan for 2015-2020 in order to be ready to apply for the IFT re-approval of our program. Thus, thorough qualitative research (with data obtained from 2011 to 2014) for each of our food engineering program required food science and engineering courses was performed, in order to design a high-quality assessment plan. As part of this qualitative research, FE program faculty were asked to rate for each of the courses they teach the degree to which they are promoting FE thirteen outcomes. The scale used in the FE outcomes matrix was: 0 = not promoted, 1 = initiate, 2 = develop, or 3 = emphasize the learning outcome. With the responses the FE curricular map regarding program outcomes was developed. Similarly, faculty filled an array in which for each of their courses had to indicate if the IFT Core Competencies were covered. The scale used in the IFT matrix was: 3 = covered as a course outcome (in great detail), 2 = covered in detail, 1 = covered to some

extent, or 0 = if not covered. With these responses the FE curricular map regarding IFT core competencies was developed.

Furthermore, faculty reported for every required course, the specific course learning outcomes, tools used to assess learning outcomes (indicating the level of assessment using the Revised Bloom's Taxonomy[5]), as well as related course learning activities. Protocol analysis of faculty responses was performed by means of an electronic qualitative data analysis software (Atlas.ti); identifying idea units within the responses, and classifying those units with coding schemes built from core competencies, learning outcomes with regards to two taxonomies (Revised Bloom's[5] and Coll's[6]), assessment tools and corresponding learning activities. Since these assessment tools are part of UDLAP's Food Engineering Program Assessment Plan participation of teachers was mandated and therefore 100% participation was achieved.

The instrument (electronic version) was assigned to each teacher that imparted a food engineering program required food science and engineering course (n = 40). Teachers answered the instrument at the end of the corresponding semester, which then was sent to the FEUCC. Information gathered contains qualitative and quantitative data. The quantitative data contains punctuations of the program outcomes or core competences for each course. The qualitative data provides information related with the specific course learning outcomes, tools used to assess learning outcomes, as well as related course learning activities

After protocol analysis of faculty responses five main categories were obtained:

- *Competencies*. Related to Core Competencies established by IFT.
- *Course Learning Outcomes*. Established by the teacher in correspondence to the FE program outcomes and UDLAP's graduate profile.
- *Bloom's Taxonomy*. Referred to the relationship of tools used to assess learning outcomes and the dimensions established in the Revised Bloom's taxonomy[5].
- *Assessment Tools*. The methods and strategies that teachers utilized to assess student learning (formatively and summatively).
- *Learning Activities*. The activities realized by students during the course, as planned by the teachers.

Since the information obtained for the category "Course Learning Outcomes" was different for every course, the learning outcomes were classified using Cesar Coll's taxonomy[6]. This classification divided in three categories these outcomes:

- *Conceptual*. Referred to outcomes related with facts, concepts and principles, i.e., "to know".
- *Procedural*. Outcomes related with the process, i.e., "to know-how".
- *Attitudinal/Values*. Related with values, attitudes, and norms, i.e., "to be".

Information was analyzed with Atlas.ti software, which ordered and categorized the obtained qualitative data. This software allowed to organize teachers' responses contained in the instruments and facilitated categorization of responses. Every responded instrument by teachers became a PDF file, because software can analyze information from a PDF or Word™ file. Once

PDF files were obtained, a Hermeneutic Unit was created, which is a folder situated in the hard drive of the computer and is composed of primary documents, in this case, the PDF files.

The analysis is started codifying the primary documents, selecting text fragments and identifying categories assigning a code and dividing them in families. Making use of a tool in the software, the created families were transported to a database in Excel™, which allowed us to convert the qualitative information into quantitative data, making graphs with data and facilitating the analysis.

Results and discussion

Coll's taxonomy[6]

The IFT core competencies, course learning outcomes, and Bloom's taxonomy categories have similar frequencies (Figure 1) regarding Coll's taxonomy[6] category 1 which is related with conceptual outcomes ("to know"), which allowed FEUCC to consider that in the food engineering program required food science and engineering course, teachers are assessing students' acquisition of facts, concepts and principles (which they will be applying later in their course or in the FE program) in correspondence with IFT and FE program expectations.

With regards to Coll's taxonomy[6] category 2, which is related with "to know-how" or procedural outcomes, the frequencies have different scores (Figure 1). Teachers are not assessing students' procedural outcomes as expected by IFT and FE program. Coll's taxonomy[6] category 3 results, which are related with attitudinal outcomes ("to be") are a major area of opportunity since teachers are almost not assessing students' values or attitudinal outcomes, which by the way are not even expected by IFT or the FE program, even though they are essential 21st century skills[14].

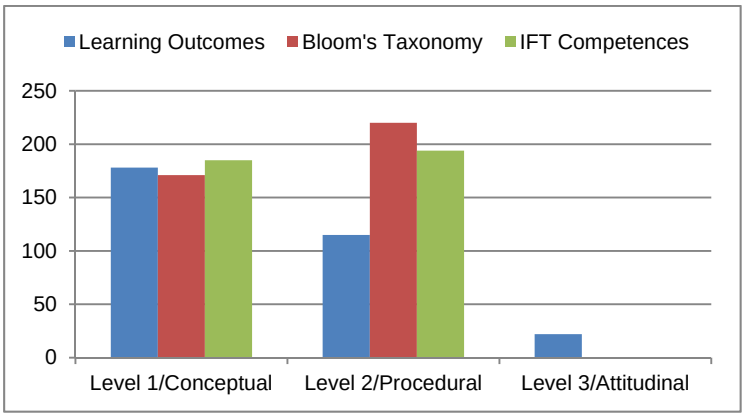

Figure 1. IFT Core Competencies[2], Course Learning Outcomes, and Bloom's Taxonomy[5] frequencies regarding Coll's taxonomy[6]

Assessment tools

The methods and strategies that teachers utilized to assess student learning included 75 different types, which were codified and 9 categories related with assessment tools were obtained (Figure 2):

1. Self- and peer-assessments
2. Instructor observations
3. Tests
4. Oral presentations
5. Practical exercises
6. Homework assignments
7. Participations
8. Team projects
9. Laboratory practices
10. Others

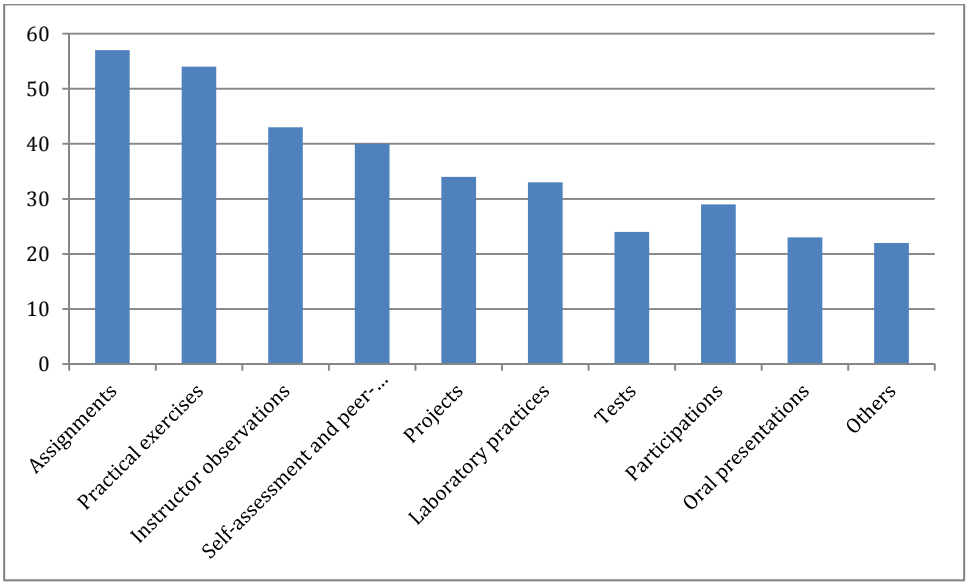

Figure 2. Frequencies of methods and strategies that teachers utilized to assess student learning

Homework assignments were the most utilized by teachers as tools to assess students' learning. Practical (in-class) exercises, instructor observations, self- and peer-assessments, team projects, and laboratory practices (and reports) were also commonly utilized by teachers to assess student learning (Figure 2). However, very few teachers used these tools formatively; most of them still embrace the traditional concept of testing. Since formative assessments (ongoing assessments designed to make students' thinking visible to both teachers and students) are essential to help both teachers and students monitor learning progresses[15]; it would be interesting to understand why few teachers are using assessment tools in a formative manner; a follow-up research is nowadays underway.

Learning activities

Activities realized by students during the course, as planned by the teachers, were codified according to the type of activity, i.e., “group reading”, “previous reading”, “and class reading”, were categorized as “reading analysis”. Thus, 9 categories were obtained (Figure 3):

1. Reports
2. Reading analysis
3. Discussions
4. Lectures
5. Challenge-based learning
6. Active and collaborative learning
7. Exercises
8. Research
9. Others

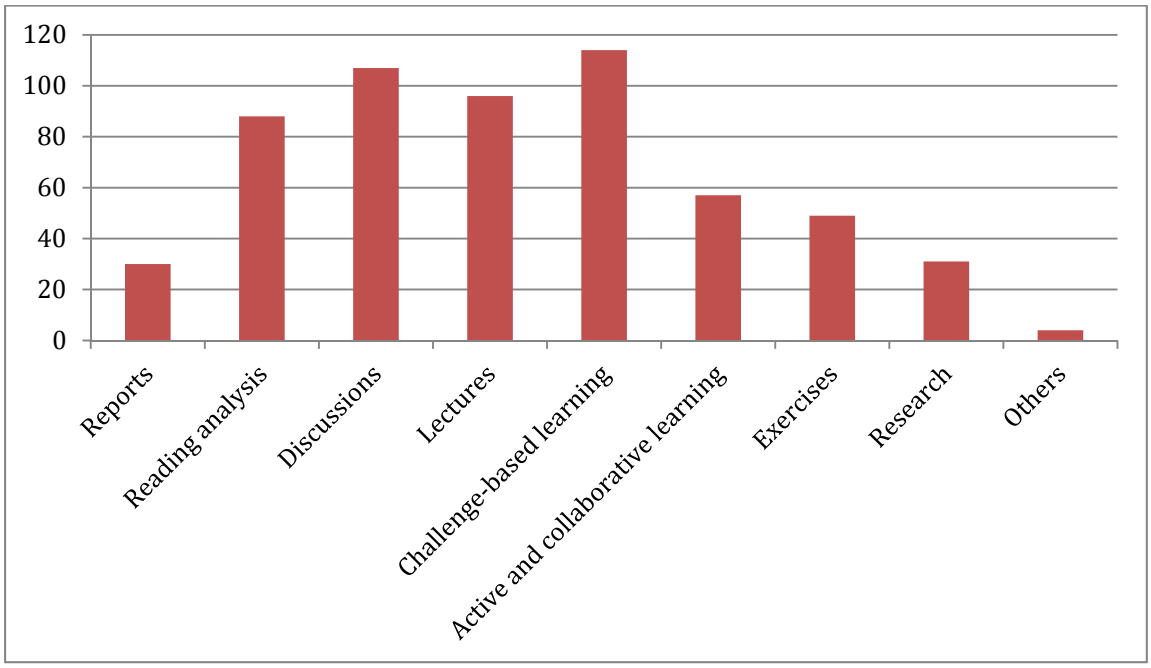

Figure 3. Frequencies of learning activities realized by students during the course, as planned by the teachers

Challenge-based learning, (in-class) discussions, lectures, and reading analysis were the most utilized activities designed by teachers to enhance students’ learning. It is important to note that several FE courses have been redesigned from a lecture-based format to a challenge-base format[15]. We use the term "challenge-based" as a general term for a variety of approaches to instruction that many have studied, which include case-based instruction, problem-based learning, learning by design, inquiry learning, anchored instruction, and so forth. There are important differences among these approaches, but important commonalities as well[15-17].

Final remarks

We were able to clearly identify the degree to which core competencies and outcomes are promoted and emphasized throughout the FE curriculum. Some areas of improvement were found regarding core competencies such as: "understand the basic principles and practices of cleaning and sanitation in food processing operations" and "understand the requirements for water utilization and waste management in food and food processing". Reported course learning outcomes were classified according to the Revised Bloom's (as remember, understand, apply, analyze, evaluate, or create)[5] and Coll's taxonomies (as conceptual, *to know*; procedural, *to know-how*; or attitudinal, *to be*) [6].

Among common tools that faculty reported to assess student learning are: self- and peer-assessments, instructor assessment, exams, oral presentations, practical exercises, homework, in-class participation, projects, and lab reports. The roles for assessment must be expanded beyond the traditional concept of testing. The use of frequent formative assessment helps make students' thinking visible to themselves, their peers, and their teacher. This provides feedback that when utilized appropriately can guide modification and refinement in thinking[15]. Furthermore, given the goal of learning with understanding, assessments must tap understanding rather than merely the ability to repeat facts or perform isolated skills[15-17].

Learning activities that faculty reported include written reports, analysis of readings, in-class discussions, lectures, challenge-based learning, active and cooperative learning, in-class exercises, and lab activities. Having faculty describe the degree to which their course promotes the studied outcomes is only a first step. An external look at each course (e.g., reviewing course learning outcomes, assessment tools, learning activities, and student work from the course by an *ad-hoc* committee) would validate faculty's perceptions. This external look is part of our new assessment plan for 2015-2020.

The goal of the Food Engineering Undergraduate Curriculum Committee is that after implementation of its plans, assessment will become a collective means whereby colleagues discover the fit between IFT and Food Engineering Program expectations for student achievement and patterns of actual student achievement. Assessment of FE Program and Course Learning Outcomes as well as IFT Core Competencies, then, will become a lens through which our Food Engineering Program assesses itself through its students' work. Then after several semesters of implementation and motivated by institutional curiosity, assessment of competencies will become, over time, an organic process of discovering how and what and which students learn. An institutional commitment to assessment (a curiosity about learning) will eventually transform our Food Engineering Program into a true learning community that raises questions about student learning and development[3-13]. We think we are in the right track.

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