# Curriculum Assessment Using Professional Certification Criteria

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## Introduction

This paper describes a curriculum assessment approach developed for a graduate-level program in environmental health and safety (EHS). The program was created in the mid-1970s to serve a growing need for trained safety professionals and its graduates are considered by many EHS professionals to be qualified and prepared for practice, as evidenced in part by informal employer surveys and placement rates annually approaching 100% within six months of graduation. But employer surveys and placement rates do not provide much information useful for curriculum assessment. Recognizing that the curriculum itself had not undergone any recent assessments, program faculty decided in 2008 to address the following question: does the current curriculum provide sufficient opportunity for students to obtain the knowledge and skills required for professional practice in EHS? Further, how could faculty answer this question internally without bias?

To answer these questions, the program faculty quickly realized they needed an objective, externally-based curriculum assessment scheme. The point cannot be emphasized strongly enough: this was not an outcome assessment effort. Although an important piece of the overall assessment puzzle, the faculty was not interested at this time in assessing how well its students were learning the subject matter being presented in the curriculum. Rather, the faculty was more interested in the fundamental questions of curriculum assessment mentioned above. After all, outcomes assessment inherently assumes that a good outcome measure indicates effective learning which, in turn, positively correlates with the professional quality and competence of a program's graduates. However, what if a student learns a topic well, but the topic is irrelevant to practice? Or, what if a topic relevant to practice is only mentioned in the curriculum – or worse, not presented at all? Without proper curriculum assessment, outcomes assessment may reliably measure a graduate's learning, but runs the risk of being an invalid tool for assessing their professional quality and competency.

### *Current practice*

In this context, learning outcomes are most commonly described as the foundation for driving programmatic changes, but at least for STEM-based programs, most outcomes are adapted directly from ABET criteria for accreditation and are accordingly vague (e.g., "an ability to communicate effectively"). Worth noting as well, ABET clearly defines program outcomes:

> "Program **outcomes** are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program." [1]

However, the "skills, knowledge, and behaviors" are not defined in any way. In fact, most accreditation and certification boards leave it to program faculty to decide what skills, knowledge and behaviors should be included in their program in order to meet their stated outcomes. For example, the Educational Standards Committee of the American Society of Safety Engineers (ASSE) had worked with ABET in the mid-2000s to specify specific program criteria required to be in place if a program wanted ABET accreditation. Subsequently, this committee published guidelines for the broad topics to be included in a safety curriculum, but with a caveat:

> "The committee did not want to provide a long list of required courses or topics areas that were common in previous safety curriculum criteria by the [Board of Certified Safety Professionals] and ABET. The committee believes strongly that programs should be provided flexibility…"[2]

Yet, anecdotally, most programs typically exercise the flexibility to *not* assess their curriculum at this level. Of the academic programs that do, *curriculum mapping* appears to be the most common tool used to make this decision.[3,4,5] This method requires identifying what students do in their courses and what the faculty expects them to learn (the skills, knowledge and behaviors) and then clarifying the relationship between the two, or "mapping the curriculum." This process reveals if a student's learning opportunities are linked or consistent with faculty expectations. Inconsistencies suggest places for curriculum improvement that bridge the gap between the two and, in turn, increase the likelihood of meeting program objectives. In order to identify the skills, knowledge and behaviors needed by a student, common practice is to glean information from a program's stakeholders (e.g., faculty, administration, alumni, employers, funding agencies, peer programs, and professional societies). However, each stakeholder has its own agenda and another problem arises: each party has a different and biased opinion about what students need to know when they graduate.

### *External job analysis*

Notably, accredited certification and licensure agencies utilize recognized methodologies based on a voluntary consensus standard for Conformity Assessment (ISO/IEC 17024) in order to ensure that their examinations test people on the activities, knowledge and skills required in their profession. The key step in this process involves a job analysis of current practitioners. Within the EHS profession, the Board of Certified Safety Professionals (BCSP) has a primary mission to assess the professional competency of safety professionals via the Associate Safety Professional (ASP) and Certified Safety Professional (CSP) exams. Surprisingly, the BCSP was very transparent in its exam development process, publishing highly-detailed "blueprints" describing the skills and knowledge expected of a safety professional and from which the ASP and CSP exams were developed.

The exam blueprints were derived from a three-stage job analysis study of current safety professionals, including 1500 survey responses with respect to the skills and knowledge needed to perform the safety job in a professional, competent manner.[6,7] BCSP then categorized the resulting 249 knowledge items as either "foundation" (relevant to the ASP exam) or "advanced" (relevant to the CSP exam) and listed the knowledge items along with an additional 298 skill items under a hierarchy of domains (e.g., risk management) and tasks (e.g., "design effective methods to reduce or eliminate risk"). Relevant to this initiative, the BCSP also undertook a generalized curriculum mapping effort, linking the skills and knowledge items with 15 "subject matter" domains typically taught in a safety program[8] (see example for Measurement and Monitoring in Figure 1) – but provided no guidance on how to adapt this generalized curriculum map to a specific program. However, in a separate publication, one of the individuals involved in the original job analysis study did provide some guidance by not only describing the job analysis survey but also suggesting several ideas for using its results to assess a safety curriculum.[9] With these two sources of information in hand, the program faculty now had an objectively derived set of skills, knowledge, and behaviors and also some ideas as to how to assess the curriculum.

**Measurement and Monitoring**

**Subject Areas**

Exposure Monitoring Protocols
Monitoring Methods
Monitoring Equipment

**Knowledge (Foundation Level)**

- Methods and techniques for measurement, sampling, and analysis (D2-T1)
- Uses and limitations of monitoring equipment (D2-T1)

**Knowledge (Advanced Level)**

- Electronic data logging and monitoring equipment (D1-T2)
- Electronic data transfer methods and data storage options (D1-T2)
- Methods and techniques for measurement, sampling, and analysis (D1-T1, D2-T1)

**Skills (Advanced Level)**

- Calculating statistics from data sources (D1-T2, D1-T3, D1-T4, D2-T3)
- Calibrating and using data logging and monitoring equipment (D1-T2)
- Conducting job safety analyses and task analyses (D1-T1)
- Consulting with equipment manufacturers and commodity suppliers (D1-T1, D1-T4, D2-T1, D2-T2, D3-T1, D3-T3)
- Creating data collection forms (D1-T2)
- Determining occupational exposures (D2-T1)
- Determining statistical significance (D1-T3, D1-T4, D2-T2, D2-T3)
- Interviewing people (D1-T3, D2-T1, D2-T2, D2-T3, D3-T1, D3-T3)
- Maintaining data integrity (D1-T2)
- Using data management software (D1-T2)
- Using monitoring and sampling equipment (D1-T1, D2-T2)
- Using sampling and measurement devices (D3-T1)

Figure 1: Example of BCSP's mapping of knowledge and skill items to subject matter areas. The D (domain) and T (task) numbers cross-reference the underlying exam blueprints.[8]

## Methodology

Because of the sheer number of skill items and the difficulties in teaching skills in a traditional academic setting (most skill development occurs during actual practice, such as in an internship or after graduation, although lab experiences mitigate this to some degree), the faculty decided to exclude the 298 skill items identified by the BCSP from the assessment and focus exclusively on the 249 knowledge items. Although the paper describing the job survey suggests several ideas for how the blueprints might be used to assess curriculum, it provided only cursory details with respect to implementing any of the approaches. Nor had any academic EHS programs published any work utilizing these suggestions. So, without any precedents on which to rely, the program faculty decided to proceed with developing its own methodology for assessing its curriculum.

To accomplish the review, the program instructors and three recent graduates from each course were recruited by the faculty to provide feedback voluntarily. The first task for the participants was to review the curriculum course-by-course. For each of the fourteen courses in the program, the instructor and students were asked individually to go through the complete knowledge item list and mark all items they believed to have been covered included in the course. This step helped narrow the focus of each subsequent course review as any items left unmarked by all four individuals in this phase were not included in later phases of the project. In addition, a primary, secondary or tertiary priority ranking was assigned to each remaining item based on the number of respondents marking the item (e.g., 3 or 4 marks indicated a "primary" topic for the course).

Next, for each course, the individuals rated the extent of coverage for the remaining knowledge items using the criteria in Table 1. To improve consistency between respondents, one person conducted personal interviews with each respondent to allow discussion and clarification of the knowledge items and assist respondents in determining the appropriate coverage rating. This person also gathered anecdotal evidence on each criterion to support the ratings given and explain any discrepancies with the priority assignments. The resulting ratings and rankings for each of the knowledge items across the 14 courses were then entered into a Microsoft Excel spreadsheet. Analysis of this master dataset consisted of exploring coverage at three levels: individual knowledge items, knowledge items within subject matter areas (as defined by the BCSP) across the program and knowledge items within a course.

Table 1: Rating scale for knowledge item coverage

| **Evidence of Item Coverage Within a Course<br>Rating Scale: (0-5)** | |
|---|---|
| 5 | Thoroughly covered in lecture. Projects, presentations, quizzes, tests or other tangible products were utilized to assess mastery of the knowledge item. |
| 4 | Discussed extensively in lecture. Material related to the item was included in homework assignments or quizzes to assess the level of knowledge acquired. |
| 3 | Item was covered in the course and included in notes, slides, handouts, activities, etc. However, students were neither tested nor asked to demonstrate their understanding of the item. |
| 2 | The knowledge item may not have been covered or discussed in lecture, but was included in assigned reading material. |
| 1 | Although possibly relevant, the item was not covered in any way in the course. |
| 0 | The knowledge item is not relevant to this course. |

## Results

Of the 249 knowledge items, only three items (business management software, Poisson distributions, and agricultural/food supply safety) were left unmarked across all 14 courses. On the other hand, 11 items were marked in at least 10 of the 14 classes (including education and training methods, several types of administrative hazard controls, facility safety principles and hazard identification); there were no items that appeared in all 14 courses.

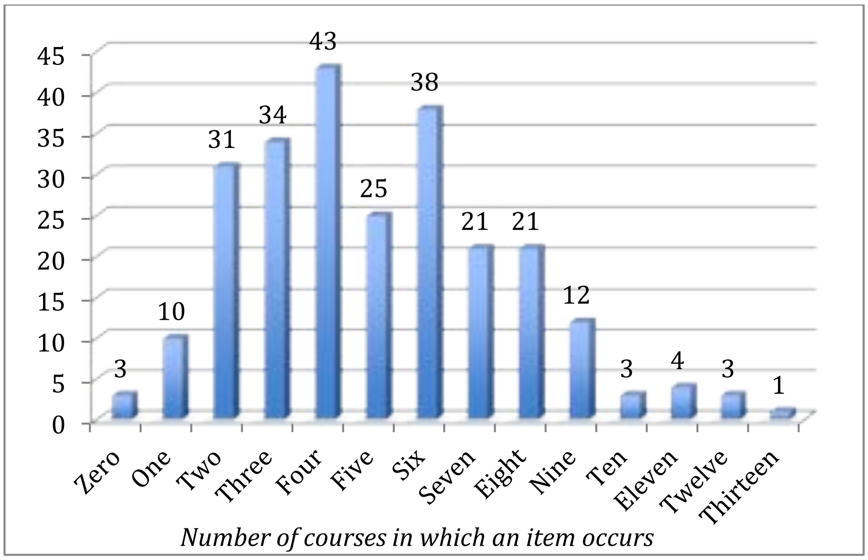


Figure 2. Frequency of knowledge item occurrences within the curriculum (14 courses total)

Coupling this with the coverage ratings, further analysis (Table 2) revealed that the program delivered 88% of the BCSP knowledge items with a quality of coverage rating of 3 or better (76% of the items received coverage ratings of 4 or better while almost 65% were rated as a 5). In addition, aggregating the items into the respective subject matter areas showed that anywhere from 58% to 100% of the knowledge items covered within each of the 15 subject matter area had a quality of coverage rating equal to 3 or better (Table 2). For example, the curriculum covered all the knowledge items in four subject areas with a coverage rating of 3 or better (ergonomics, measurement/monitoring, organizational/behavioral sciences, and risk assessment/management) while failing to adequately cover between 20 and 42% of the items in another four subject areas (business management principles, general sciences, EHS management and auditing systems, and security sciences).

Finally, each of subject areas was investigated further by identifying which courses had adequate coverage ratings for each knowledge item within a subject area (3 or higher) and which courses had inadequate coverage ratings (0-2). At this point, the analysis could have explored knowledge items with excessive coverage (in order to identify items within a course that could be de-emphasized in favor of spending more time on other items), but the faculty chose to focus on exploring which knowledge items were not being covered adequately.

As an example, consider the EHS management and auditing systems area (Figure 3), which had the lowest percentage of items rated as adequately covered (58%). The course level analysis revealed that course 6011 presents all the knowledge items pertinent to this area, covering half of the topics adequately and the other half inadequately. Courses 6002, 6012, 6111, and 6211 each present some of the knowledge items pertinent to this subject area and each does so adequately for at least 20% of the items. Other courses (e.g., 6051, 6101, 6401 and 6821) touch on these items, but only a few and, in many cases, inadequately. A subsequent review revealed that a set of EHS standards comprised the majority of items inadequately covered in the curriculum: the ANSI/AIHA Z10, ISO 19011, the ISO 14000 series and the OHSAS 18000 series.

Table 2. Knowledge item coverage by subject matter area

| Subject Matter Area | Number of knowledge items | % of items rated 3 or higher for coverage | % of items rated 5 for coverage |
|---|---|---|---|
| Business Mgmt Principles | 28 | 71.4% | 39.3% |
| Ergonomics, Human Factors Sciences | 11 | 100% | 81.8% |
| Emergency Mgmt | 8 | 87.5% | 75.0% |
| Environmental Sciences | 18 | 94.4% | 66.7% |
| Education, Training, Communication | 23 | 95.7% | 78.3% |
| Fire Sciences | 11 | 90.9% | 90.9% |
| General Sciences | 8 | 62.5% | 62.5% |
| Hazard Recognition and Control | 44 | 100% | 93.2% |
| Health Sciences | 18 | 94.4% | 61.1% |
| Industry-specific Safety Principles | 12 | 91.7% | 66.7% |
| Measurement/Monitoring | 5 | 100% | 100% |
| Organizational/Behavioral Sciences | 10 | 100% | 50.0% |
| Risk Assessment and Risk Mgmt | 18 | 100% | 55.6% |
| EHS Mgmt and Auditing Systems | 12 | 58.3% | 25.0% |
| Security Sciences | 23 | 78.3% | 26.1% |
| Average | | 88.3% | 64.8% |

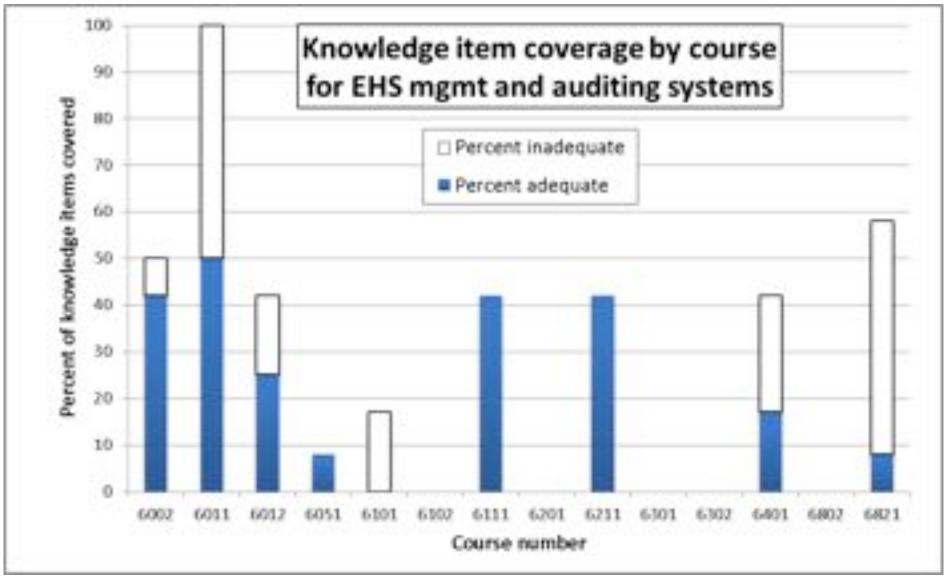


Figure 3: Knowledge item coverage across courses in the *EHS management and auditing systems* subject area. "Adequate" is defined as items covered with a rating of 3 or better.

**Discussion**

As the results suggest, the curriculum was covering the requisite knowledge items, but had room for improvement. The analysis clearly revealed missing knowledge items and inadequately covered material, but more importantly, the results could be easily shared with and utilized by program instructors. For example, by adding a lecture and an in-depth assignment on EHS standards in the 6011 course, a reasonable expectation is that subsequent evaluation would yield higher coverage ratings for many of the individual knowledge items and improvement in percentage of adequately covered items within the EHS management and auditing systems subject matter area. Any additional coverage of EHS standards in other courses likely would further boost these ratings.

The biggest disadvantage in using this approach was the time and effort required. On average, the surveys and interviews took about two hours per course, and each participant had to take their task seriously to provide accurate information. For each course, the instructor had to commit to the time required and provide data not only on the subject matter covered but also information on how material was presented and tested. In turn, a subset of students needed to commit time and effort to do the same, and recruitment was challenging given that some class sizes were quite small. The graduate student on the project spent an average of four additional hours per course: setting up the assessment spreadsheets, coordinating and conducting the surveys and interviews and then entering and interpreting the data.

Although program faculty felt the approach needed some additional fine-tuning in terms of the time commitment, they all agreed that the approach is promising. One main reason is that the BCSP foundation provides a significant degree of objectivity to curriculum assessment. Rather than rely on feedback from numerous stakeholders in the program, each with different agendas and conflicting opinions, recall that the knowledge items used in this approach are derived from a profession-wide job analysis study conducted in compliance with an accepted international standard (ISO/IEC 17024) and utilizing data collected in three stages, including 1500 survey responses from practicing EHS professionals.[6,7] Regardless of academic institution, the vast majority of faculty would not be unable to perform a study of this depth for their program.

More importantly, the results from this approach answered the questions raised earlier in terms of whether or not program graduates are exposed to the material they should know in order to practice as EHS professionals. This curriculum assessment methodology provided answers at several levels by providing baseline measurements of knowledge item coverage both within individual courses and in the overall program. Even more encouraging is that the BSCP made recent changes to its blueprints that should simplify this assessment methodology: the exam blueprints now have fewer domains while more clearly detailing the knowledge and skills areas within those domains.[10] Because BCSP has been open with publishing the skills and knowledge items sets derived from their job analysis studies, this approach can be readily adapted to any EHS program. Degree programs in other disciplines may be able to apply this method, but only if the certification or licensing body for that discipline is willing to share its job analysis results.

## Conclusion

Reflection on this curriculum assessment process identified opportunities for beneficial improvements within both the program curriculum and the methodology itself. But ultimately, by using the certification agency's job analysis data to indicate the knowledge needed by graduates of a safety program and developing a combined rankings and ratings methodology to assess coverage of this knowledge, the faculty was able to satisfactorily and objectively answer the initial question posed: indeed, the program's students were graduating with the "requisite skills and knowledge to practice effectively…in a competent, professional, and ethical manner."

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