

Assessment Techniques for Industry Desired Competencies in Construction Education

**Scott J. Amos, Ph.D., PE, AIC
Weber State University**

Abstract

As the popularity and use of project oriented classes emphasizing hands-on education continues to grow, construction educators are faced with the challenge of evaluating student performance in this non-traditional setting. This article discusses and provides examples of proven authentic assessment techniques, including rubrics, and portfolios that could prove useful for construction educators attempting to validate the satisfaction of industry desired competencies.

Introduction

The past decade has been an extremely productive period of thinking about engineering education. The National Science Foundation has reported that among other factors, half of all U.S. students who start out in engineering disciplines switch to other majors in search of better teaching, more challenge and opportunities to work in teams on real-world problems. In response to this, there has been a quite revolution in education characterized by the tremendous growth in project or process oriented classes with an increased emphasis in hands-on education. One of the most important challenges with this approach to education has to do with how established performances and goals will be assessed. The new tools that have been developed are distinctly different from the factual testing-orientation of the past.

Current Trends In Education

Traditional education is based on the principal that students must have certain knowledge which is transmitted to the student through teaching, in a certain sequence, the content of an educational plan devised by educators. The mastery of content being more important than the development of skills. Traditional teaching methods cater to those who like converging quickly to a correct answer by recipe or cook-book solutions. This conventional content oriented educational environment has now become information-rich. Most education taking place in schools today is focussed on knowledge that is expanding and changing at such a rate that conventional approaches to transmitting it to students are destined to failure. There is too much information, located in too many places, covering too many concepts, changing too fast to be of any long term value to the student. These traditional methods have also failed those students who view situations from divergent perspectives and the risk-takers who like using trial and error problem solving techniques.

Process education refers to educational techniques focussing on development of process skills by the students. The main goal is empowerment of the students to become lifelong learners with the capability and motivation to learn new concepts on their own. Educators will become

facilitators of the learning process assessing student performance in real time to encourage their growth in the use of these essential processes.

A strong indication of the trend towards this performance based assessment became evident when ABET voted to quit evaluating engineering schools on the basis of faculties, facilities, curriculum, and resources. The new criteria, to be used nationally, will look at outcomes, meaning the performance of students and recent graduates. Historically, engineering project based courses have been confined to the senior year. Many schools are now revamping curriculums to create project based courses from the freshman year up. Inherent to the project based approach is the opportunity to work in teams, see the big picture and make technical presentations. The University of Colorado has opened a chalkboard-less Integrated Teaching Laboratory. This facility houses numerous project stations, computers and instrumentation that serves as the nucleus for curriculum reform enabling more hands-on learning.

Performance based approaches to education have been described by Spady and Marshall and placed in three levels: traditional, transitional, and transformational with traits as outlined in Table 1. The traditional approach is best illustrated by the competency based education that has been used in engineering technology programs for years. It is characterized by identification and clarification of learning expectations on the part of students and teachers. Selected competencies are aligned with prerequisite competencies and these expectations are then communicated to students. The clear definition of essential goals provides a legitimacy to the project oriented activities. Research has shown that exercise of these principles as a matter of course yields major increases in student learning accomplishment.

The transitional approach moves beyond simple clarification and alignment of the curriculum content by shifting the focus to higher order learning skills such as critical thinking and complex problem solving. Collaborative skills such as effective communication and team work are also emphasized in addition to making connections and transferring learning across the curriculum. This approach introduces fundamental and positive changes to the traditional educational system while avoiding the major restructuring required by a complete overhaul.

The transformational approach is based on a foundation of strategic planning for the future. The driving vision of the approach is, "What will students need to know and be able to do in order to be competent future citizens?" This approach obviously requires some fundamental rethinking of what should be in the curriculum and how students should be taught and assessed.

Industry Desired Competencies Identified

The American Institute of Constructors and the Constructor Certification Commission developed the Constructor Certification Skills and Knowledge Survey. In 1997 Hauck and Green performed a statistical review and identified those skills and knowledge which industry deems vital to professional constructors. Objectives of the research were to identify whether ten competencies outlined in the AIC Constructor Certification Skills and Knowledge Survey are important to professional constructors; and to identify which of the ten competencies are

most important. Their findings indicate that the array of skills and knowledge outlined on the survey

Table 1: Performance Based Approaches to Education

	Traditional	Transitional	Transformational
Who?	Teacher primarily responsible for competency selection, instruction, and assessment	Increased student involvement in the learning and assessment process	High student involvement in and responsibility for learning. Teachers serve in a “coaching” and “facilitating” role
What?	Numerous competencies identified Tend to be isolated from one another Competencies selected by teacher with advisory council input	Focus on higher order skills Emphasis on knowledge and skill transfer	Derived from strategic planning and future visioning Focus on what students need to know and be able to do in order to function as competent future citizens
Why?	To teach specified content To pass the test Emphasis in covering the content in a specified period of time	To integrate isolated content across disciplines To apply concepts and facts to real world situations	To prepare students to live and successfully function in a rapidly changing, technologically rich world of the 21st century
How well?	Testing (usually written) Some performance assessment, such as project grading	Authentic assessment methods (portfolios, rubrics, performance assessment, realistic settings, etc.) Self and peer assessment	High student involvement in selecting assessment criteria Extensive self-assessment Extensive use of authentic self-assessment techniques
Where?	In classrooms and labs designed for special courses	In multi-purpose classrooms Some community interface such as field trips	Numerous configurations of school and community based learning settings

How it is accomplished	Lectures	Cooperative learning	Investigative learning
	Completing tasks as demonstrated	Problem based learning	Engagement with major societal, global, or community problems
	Reading textbooks	Design situations	
	Taking tests	Reflective analysis	Extensive involvement with the community
		Extensive use of performance tasks	

were in fact very comprehensive, and that the ten identified competencies are indeed important to professional constructors. Three particular competencies, problem solving, estimating/budgeting, and project management, were found to be the most important. The ranked competencies are as follows:

1. Problem Solving
2. Estimating/Budgeting
3. Project Management
4. Work With People
5. Organize People
6. Purchasing/Procurement
7. Cost/Schedule Control
8. Staffing/Subcontractor Coordination and
9. Teamwork/Professional Development
10. Support Operations

A careful review of the above competencies suggests the value of considering a shift from the traditional approach to the transitional approach. Recognizing that these competencies are really describing the overall need for a functioning member of the workforce in a technologically changing environment, a very strong argument can also be made for implementation of the transformational approach.

Additional support for this argument can be found in several other recent initiatives addressing educational reform. Reports from the Department of Education and the Hudson Institute have focused on the question: "What do students need to know and be able to do to live and function successfully in the 21st century?" The skills most typically identified included:

1. Creative thinker
2. Critical thinker
3. Contributing citizen
4. Self-directed learner
5. Problem-solver
6. Effective communicator
7. Quality producer

Student attainment of these skills and the specific technical competencies cited by the AIC study should indeed be the goal of a quality construction education program.

The Assessment Challenge

It is important to recognize that student assessment is an essential component of performance standards education. Some of our old assessment tools will no longer do but there are also existing tools and techniques that are quite adequate for assessing performance standards. For many, the term “assessment” is a synonym for the word “test” which in turn is associated with the even more important term “grades.”

There are many diverse views in the literature about the purposes and suitability of grading methods used in colleges. Grades often serve as rewards or penalties for student accomplishment. They also communicate to others what the student has accomplished and are called on as a predictor of future performance. This multi-faceted function is often confusing in that there is no generally agreed-upon definition of what a grade means.

If the major and minor objectives of a course are well defined, the grade communicates to the student and to others what fraction of the course objectives has been achieved. For example, if an “A” indicates all major and minor objectives were achieved, a “B” might indicate that most major and many minor objectives were achieved, while a “C” denotes acceptable performance, and a D suggests the student is not prepared for advanced work requiring the specific course. This process is very dependent on subjective decisions and loaded with ambiguity.

Assessment can be much more than end of a unit or course testing. Rather it should be formative in nature, helping students develop skills in the evaluation of the quality of their own and others work.

Authentic Assessment

Authentic assessment refers to a wide variety of measurement techniques that have been developed to correspond as closely as possible to “real world” student experiences. Rather than being a contrived event, occurring at a certain point in time, assessment should be an ongoing and woven naturally throughout the whole teaching and learning process. The compartmentalization that exists between teaching, learning, and assessment is thereby eliminated and they are treated as a coherent whole rather than individual aspects. The process can be likened to a video as opposed to a collection of snapshots. It is something teachers do “with” students rather than “to” students.

There are many tools available for authentic assessment, they include: portfolios, rubrics, group and individual projects, interviews, informal and formal observations, peer assessment, self assessment, oral examinations, writing samples, and others. Rubrics and portfolios will be further described.

Rubrics

Rubrics are simply scoring devices, designed to assist in the process of clarifying, communicating and assessing expectations. Rubrics are grading matrices with specific

information about what is expected of students for every performance standard. They are designed to make the criteria very objective, clear and specific. Other beneficial characteristics include:

1. Identifies important outcomes to evaluators with an assignment of values for each of the outcomes.
2. Clarifies student expectations for a project, thereby reducing or eliminating any “guesswork factor.”
3. Directs students attention to weaknesses and allows them to revisit problem areas while also emphasizing strengths.
4. Encourages students to develop an awareness of the criteria they use to assess their own abilities and performance as well as that of their peers.
5. Promotes formative as well as summative evaluation.
6. Provides benchmarks for the measurement and documentation of progress.

Rubrics exist in a variety of forms and can vary in complexity. Most simply stated they are checklists with three essential features : (1) the stated performance standard, objective, behavior, or quality; (2) some form of scale to rate student performance or characteristics; and (3) specific and identifiable performance characteristics arranged in levels indicating the degree to which a standard has been met. Rubrics can be developed for broadly stated goals as well as specific criteria. The rubric of Figure 1 could be used by other students to assess team membership.

Figure 1: Sample Team Membership Rubric

Areas Evaluated	3	2	1
COURTESY	Treated each member with complete courtesy and respect at all times	Treated each member with courtesy and respect most of the time	Courtesy and respect of others was lacking
RULES FOLLOWED	Responded well to all rules	Responded well to rules most of the time with few lapses	Seldom stayed within the rules on his/her own
PERFORMANCE OF TASK	Worked diligently to do his/her part of the task	Needed some prompting to stay on or complete task	Caused confusion due to lack of staying on task
COOPERATION WITH TEAM MEMBERS	Cooperated with team at all times to make completion of task smooth	Cooperated with team most of the time but needed reminding	Rarely cooperated with team without constant reminding

The partially completed sample shell of Figure 2 illustrates the incorporation of higher order thinking skills into the assessment process in addition to technical criteria. It is also possible to embed a rubric within another rubric. For example, the effective communicator outcome as shown in Figure 2 is based on another rubric developed for communications or report writing. The final score is based on the sum of the weighted scores for each outcome.

Portfolios

Portfolios are packages of materials assembled as a means of communicating student abilities. Their value as an assessment tool is maximized only when they reflect thoughtful selection of content as well as the careful organization and presentation of materials in connection with established performance standards for a course. Advantages of portfolios include:

1. Injection of rich, real-world data into the assessment process.
2. Encourages students to develop and take responsibility for self reflective qualities.
3. Assesses learning while it is still in process.
4. Connects doing, thinking, and writing.
5. Develops organizational skills.
6. Encourages goal setting.

For assessment purposes, the information rich documentation of portfolios can be used for both “in-process” and summative scoring of student progress and growth. The portfolio can also be used by students to demonstrate abilities to potential employers. The value of portfolios as assessment tools ultimately depends on how carefully they are designed, maintained and connected to objective criteria which have been selected for the course.

Figure 2: Sample Generic Rubric for Higher Order Thinking Skills

OUTCOME	WG T	EXEMPLARY 2 pts	ACCEPTABLE 1 pt	NOT YET ACCEPTABLE 0 pts	SUB TOTAL
CREATIVE THINKER	x 1	Fluency is demonstrated by considering many ideas or options	Several ideas or options were explored	Only one option considered	
CONTRIBUTING CITIZEN					
SELF-DIRECTED LEARNER					
CRITICAL THINKER					
PROBLEM SOLVER	x 3	Identifies problems Generates a variety of solutions Develops criteria for evaluating solutions	Generated a few solutions Uses teacher’s criteria for evaluating solutions	No evidence that a problem solving process was used	

EFFECTIVE COMMUNICATOR	x 2	Prepares error free technical report	Prepares well written technical report (see technical report rubric)	Prepares technical report with errors	
QUALITY PRODUCER					
TECHNICAL KNOWLEDGE					

Implementation

The concepts and tools described herein were implemented this past year in the Construction Management Technology Program at Weber State University. The first step of the process was to include a description of the transformational approach as part of the instructors philosophy statement in the course syllabus.

Further emphasis was placed on each students responsibility for learning and the cultivation of a learning environment as opposed to the traditional teaching environment. This was formalized through the development by the students of “learning contracts” which were quite simply rubrics for the assessment of individual progress. With these contracts each student was also given the opportunity to customize how they learned within the framework of the course objectives. The development of additional rubrics for labs, presentations, and reports prepared students for the assessment of their chosen activities. In addition, there was some self reporting blended into the system to force the students to honestly evaluate their contributions to the class.

At the conclusion of these courses students were given an opportunity to evaluate their learning with respect to a comparable traditionally taught course. The results speak highly for the adoption of this process. Over 50% of the students felt that they had learned more using this approach while the remaining students felt that they had learned at least as much as they would have in a traditional course. The significant number here is that none of the students felt as if they learned less than in a traditionally taught course. The sample for this survey included all of the students in the CMT program and covered all of the courses being taught in this manner.

Summary

We are clearly in the midst of a dynamic and imaginative period of educational reform where industry and research have provided a clear indication of societal needs. The performance based approach has proven to be an effective means for the fulfillment of these needs and authentic assessment tools have been shown to enrich the learning process. Rubrics and

portfolios can be used for both formative and summative evaluations while preparing students to live and function successfully in the 21st century.

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The Author

Dr. Scott Amos is the Construction Management Technology Program Coordinator at Weber State University in Ogden, UT. Degrees include a Bachelor of Science in Electrical Engineering from the University of Utah in 1977, a Master of Science in Electrical Engineering from the Georgia Institute of Technology in 1985, and Doctor of Philosophy from the University of Florida. He is an active member of ASEE and has served as a Campus Representative.