Assessment Measures and Outcomes for Computer Graphics Programs

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Abstract

Computer graphics is a fast growing field of study, which has many variable course offerings to accommodate the ever-changing technology. The differences and ambiguities in course names and degree offerings can best be explained and quantified through assessment measures. The assessment measures identify the scope of each assignment and course and identify program and department learning objectives and outcomes, and show how they are related to each other. Assessment measures also set the stage for future accreditation of a computer graphics program. This paper will discuss how to begin the assessment process for the program as a whole, and how to facilitate and use course embedded assessments within a computer graphics program and within supporting courses in other disciplines. By having a plan and a template of assessment measurement for faculty, beginning course-embedded assessments becomes an easier task for the busy faculty and will greatly improve the continuity of course offerings within the ever changing computer graphics field.

Background

Purdue University Calumet (PUC) is a regional campus of Purdue University located in northwest Indiana. It is primarily a commuter campus, and serves just over 9,000 students. PUC started a program in Computer Graphics Technology (CGT) in the Fall 2000 semester. The course curriculum development was influenced by existing successful course offerings within the Purdue system, by nationally known universities, and by regional job demands, as well as international considerations. Figures 1 and 2 show the growth in credit hours and the increase in students in the CGT program between 2001 and 2004. In the space of a few years, laboratories were built, faculty hired, and many new courses developed to meet this demand. In the face of all this growth, and the number of changes that were occurring, faculty knew that an effective assessment and evaluation system would be required to insure that changes were in fact improving the program.

The Engineering Technology and Organizational Leadership and Supervision programs have had some measurable success with the implementation of course embedded assessment both in the class room and online [1]. Both of those programs provide supporting courses for CGT. The assessment model offered in this paper is adapted from those programs and applied to the expanding and ever-changing field of Computer Graphics and CGT. The assessment measures identify the scope of each assignment, course, program and department learning objective and outcome, and show how they are related to each other. The remainder of this paper describes the process used to create these assessment measures and provides suggestions for implementation.

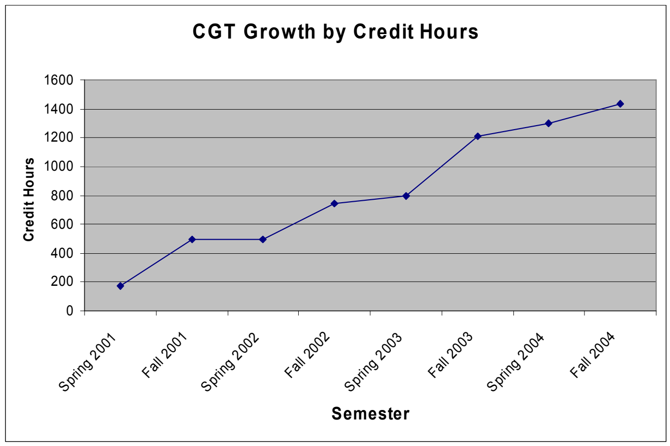


Figure 1 – Credit Hour Growth

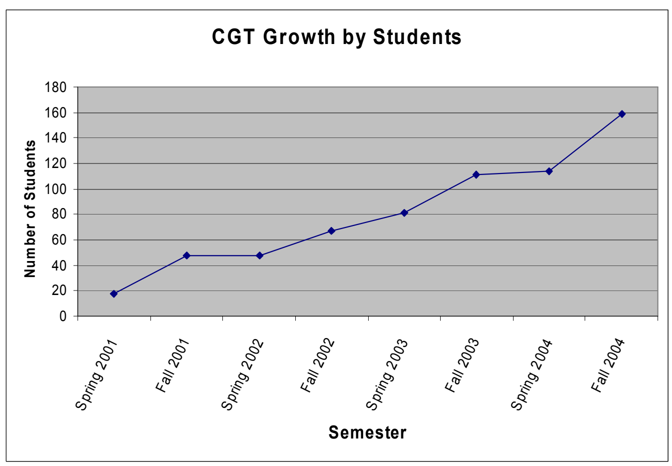


Figure 2 – Number of Students

Starting an Assessment Program

Overall, computer technology related programs in the field of industrial technology represent a rapidly emerging area of study [2]. Rapidly emerging programs must be continuously assessed and monitored to make certain that they are academically appropriate, differentiated from other computer-related programs, and are meeting the needs and expectations of key stakeholders [2].

The cited paper reviews industrial technology, but its observations can be applied to the emerging focus of computer graphics technology as well. Such programs often consider Accreditation Board for Engineering and Technology (ABET) or National Association of Industrial Technology (NAIT) accreditation. Both ABET and NAIT require assessment data. ABET particularly requires outcomes based assessment data [5].

Assessment is authentic when we directly examine student performance on worthy intellectual tasks [3]. Authentic assessments achieve validity and reliability by emphasizing and standardizing the appropriate criteria for scoring varied products—not one-right-answer tests. Authentic tasks involve “ill-structured” challenges, which mirror real life challenges [3]. Performance assessment is a recognized method of classroom assessment in Science, Technology, Engineering and Math, (STEM) [4]. Performance assessment can mirror the ill-structured real life challenges of authentic assessment.

To acquire course consistency throughout a program it is imperative to develop comprehensive program–wide assessment tools. The objectives are to develop learning-outcome-based assessment tools and adapt them for the use of a specific CGT program. These learning outcome-based tools are then built into a comprehensive program assessment, which ultimately forms the basis of accreditation for a program. This task can be daunting to new and existing CGT programs, and needs to be implemented in a way that all faculty can easily understand and perform. Providing a platform where all faculty have input within their charge courses is important, but consistency within the overall evaluation process is also essential. To obtain the commitment of all faculty it is best to start out with a designated number of courses within various levels of the degree and create a “project team”. For example: in a CGT bachelor’s degree program, develop six performance assessments (critiques) and rubrics, two in each of three successive courses within the program.

This approach uses six flexible, adaptable assessment tools, consisting of a critique and rubric for two projects in each of three successive courses. The project team produces valid, reliable assessment tools in the form of performance assessment based critiques and rubrics which document student learning. The team documents the validity and reliability of the developed assessment tools, in a way appropriate for this type of assessment tool, and also prepares all necessary documentation to prepare other faculty to use the assessment tools in a responsible manner. The team contributes to the literature on assessment practices, which is then disseminated to all program faculty for use in their target courses.

For example, in order to develop learning outcomes based assessments for a cutting edge CG or CGT program, the following could be accomplished over a three-year period:

1. Create a classroom environment that incorporates cooperative or clustered learning and experimentation by students;
2. Create a structured critique process based on performance assessment for CG, developing a rubric for the critique which takes into account program objectives and which documents student learning; and,
3. Eventual integration of the critique-based learning outcome assessment into the program assessment for eventual accreditation.

The CGT program at PUC is currently in year one of the three year process described above. PUC's initial example of this process was to create an integrated set of rubrics for a mid-semester and a final project in each class (total of six critiques and rubrics) for the following courses: CGT 111, CGT 211, and CGT 346 (see course descriptions and sample rubric below). The rubrics and assessment tools will document progressive student learning throughout the program. The rubric and critique method could be adapted to any CG program by choosing an entry-level course, a mid key course and a comprehensive course that incorporates and builds on the previous two course levels.

To further explain the above example, the critique and rubric would be created for the following courses, for a mid-semester and a final project in each class (total of six critiques and rubrics):

CGT 111: **Design for Communication and Visualization:** An introductory design course for computer graphics majors. Students develop an understanding of the basic design elements, principles of composition and typography through exercises and projects. The focus is on visuals thinking, exploring the relationship between type and image, and developing multiple design solutions to a given problem.

CGT 211: **Raster Imaging For Computer Graphics:** Digital images are produced using a variety of computer technologies focusing on raster imaging and process. Advanced color theory, surface rendering, and light control are emphasized in relation to technical illustration, hardware characteristics, and software capabilities.

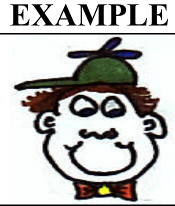
CGT 346: **Digital Video And Audio:** Covers the use of digital technologies for video and audio focused on raster imaging, vector imaging, design, composition, motion graphics, multimedia, hypermedia and animation. Students examine the methods of creating, sampling and storing digital audio and the constraints placed on these media assets when used for media based products. Emphasis is placed upon the technology of digital video and audio including formats, data rates, compressors, and the advantages and disadvantages of the different technologies.

The third course, CGT 346, incorporates learning from the CGT 111 and CGT 211 into new concepts, thus building on previous learning based outcomes and creating further assessment measures for all courses. Because the courses are sequential levels in the program, the critiques and rubrics will document progressive student learning within the program. The performance assessment critiques and rubrics will be linked to course objectives for each course, and also to overall program objectives.

Rubrics (or "*scoring tools*") are a way of describing evaluation criteria (or "*grading standards*") based on the expected outcomes and performances of students [6]. Typically, rubrics are used in scoring or grading written assignments or oral presentations; however, they may be used to score any form of student performance [6]. Each rubric consists of a set of scoring criteria and point values associated with these criteria. In most rubrics the criteria are grouped into categories so the instructor and the student can discriminate among the categories by level of performance [6]. In classroom use, the rubric provides an "objective" *external standard* against which student performance may be compared [6]. Students learn to communicate about science or the relevant subject matter in a variety of ways and especially improve their writing skills. The quality of students' reasoning and logic increases. Instructors gather a variety of data about students' understanding and performance [6]. Rubrics are most effective when we practice using them with our students over and over again. Developing effective rubrics requires revision based on feedback from students: the best rubrics are products of an iterative effort [6].

Objectives written for rubrics should describe measurable student outcomes [7]. When the goals and objectives of the assessment are focused upon complex learning outcomes, a performance assessment is likely to be appropriate [7]. Performance assessments require students to demonstrate the application of knowledge to a particular context [7].Through observation or analysis of a student's response, the teacher can determine what the student knows and does not know and what misconceptions the student might hold with respect to the purpose of the assessment [7]. Scoring rubrics are one method, which may be used to evaluate students' responses to performance assessments [7]. Rubrics may be either analytic or holistic [7]. Analytic scoring rubrics divide a performance into separate facets and each facet is evaluated using a separate scale [7]. Holistic scoring rubrics use a single scale to evaluate a larger process. In a holistic scoring rubric, all of the facets that make up a task are evaluated in combination [7].

Figure 3: Sample scoring rubric taken from Encyclopedia of Educational Technology [8]

HAPPY FACE QUALITY	**EXAMPLE**
4 - Displays amazing detail and color; highly elaborate theme; unique and original	

3 - Displays detail and color; theme is present with some elaboration; displays initiative to develop original work	
2 - Displays some detail and/or color; theme is present but not fully developed; evidence of some initiative to develop original work	
1 - Displays a lack of detail, color, and theme; very little or no initiative in developing original work	

Sample critique questions for the assessment of projects are contained in Table 1 below.

These questions relate to midterm and final projects in the course CGT 211 mentioned above. The tables which follow contain follow up questions for the critiques for later in the semester. These critique questions were developed by J. Whittington for use in her CGT courses [11].

Table 1: Sample critique questions

Critique assessment The following are general assessment questions an instructor might ask.
• What do you (the student) feel was your most successful concept of this project?
• What was the most challenging but rewarding part of the project?
• Was there a particular required concept or technical skill that you feel was not relevant to this project?

In the latter part of the semester the instructor may ask for more course assessment type feedback.

Table 2: Course assessment critique questions

Course Assessment critique questions
• Did any project relate directly to another course you have taken or are currently taking? Were the objectives of the projects helpful in other courses?

• What aspects of a specific project helped you at work or in another course?
• Were there any technical skills you felt you needed to complete the assignment?
• Are there any projects in this course that helped you accomplish a goal at your present place of employment?
• As a result of what you have learned in this project is there another new concept you would like to learn to build your skills?

Table 3 contains questions which are student-focused.

Table 3: Student focused critique questions

As you (the student) are working ask yourself these questions about your design
• Does the project have a focal point?
• Where does the eye go at first glance?
• Does the eye move to a secondary position?
• How do the hues and textures effect the overall composition? • What is the prominent color composition?
• What are the prominent shapes?
• What makes the design interesting?
• What gives the design unity?
• Does it have rhythm and balance?

Tracking Assessment Results

In the fall 2002 semester, PUC began a trial of online course assessment tools using the survey function in Blackboard. Blackboard is software used for online teaching and learning within campus communities. With the Blackboard survey feature, the instructor knows if a student has taken the assessment, but all student answers are grouped together so individual student responses remain anonymous. This tool is broken down into four parts: Student Self-assessment, Program, Course Management, and Course Objectives. Although much modified, it is based on the work of Land and Hager [9]. The course assessment tool is part of a larger project to perform integrated, on-line assessment of all courses in the Manufacturing Engineering Technology and Supervision (METS) Department.

To compare the instructor's assessment of the course with the students', an Excel spreadsheet consisting of three parts has been developed to track the data. Much research on course assessment tools of this type is available [10], and this is among the simpler types. The authors intentionally created a simple form because these forms must be generated for many courses at the same time, and the faculty felt a short, simple form would be the best place to start. These forms have been refined and continuously improved for the past three years.

Part 1, shown in Table 4, lists the scores from specific assignments that the instructor uses to measure each course objective. The students' evaluation of how well they felt the course met each objective is listed as well. Part 2, shown in Table 5, lists the students' perception of how well the course met the ABET a-k criterion. The last part, shown in Table 6, provides a place for the instructor to record course changes and improvements. The METS Department plans on having similar forms for each course and then linking the data to the web page for each course. This will provide a convenient method for storing course data and making it easily available to instructors and ABET teams.

A sample Excel spreadsheet with the most recent three page assessment form is available at:

/http://technology.calumet.purdue.edu/met/abet/METbachelor/METCourseupdateandassessmentformsampleDecember2004.xls

A sample course with assessment data is available at:

http://technology.calumet.purdue.edu/cgt/cgt116/index.html

and then clicking on "Course Assessment Data."

Conclusions

The information in Tables 4-6 above is gathered for all courses supporting the CGT program in the Engineering Technology and Organizational Leadership and Supervision programs. Table 7 is a blank template for others to use. Other templates are available at the websites listed above. The rubrics and critiques will be developed and refined for the CGT program courses, and can be further developed and refined as assessment tools in other CG/CGT courses. The critiques and rubrics lend themselves to flexibility, a requirement in a rapidly evolving field like CG. These assessment measures can help track the changes in and improvement in the program, and also form the basis for an eventual accreditation effort.

Table 4 - Course Objective Assessment

CGT116 Geometric Modeling for Visualization & Communication – Instructor and Student Course Objective Assessment

Semester: Spring 2004 | **Instructor: Rickerson/Higley**

Course Objective	Supported Criterion	Supported Related Outcome	Course Embedded Assessment of Student Performance: Assessment Tool 1	Score (%)	Assessment Tool 2	Score (%)	Assessment Tool 3	Score (%)	Student Evaluation (%): E	G	A	P	NA	Composite
1. To understand the primary differences between wireframe, surface, and solid modeling and their application to various communicative problems and tasks.	a g	1.1 Technical Proficiency	Week 5 Team Assignment	89	Week 6 Team Assignment	89			47	34	6	3	9	**4.0**
2. To develop 3D spatial environment understanding and mental visualization ability.	a d g	1.4 Open-ended Problems 2.3 Project Management 2.4 Self-Learning	Lab Assignment 1	89	Lab Assignment 2	96	Group Project	89	38	50	6	0	6	**4.1**
3. To develop an understanding of 2D and 3D geometric entities and their application in graphic communication.	a b	1.1 Technical Proficiency	Week 4 Team Assignment	87	Week 5 Team Assignment	89			38	44	12	0	3	**4.1**
4. To achieve competence in utilizing CAD tools to develop wireframe, surface, and solid models through demonstrations, assignments, tutorials and practical examinations.	a b g	1.1 Technical Proficiency a,b,c,d,f 1.3 Computer Applications 2.4 Self-Learning	Inventor Lessons	80	Midterm Practical	89			53	22	19	0	6	**4.2**
5. To develop an appreciation for graphics as a communication medium in various application areas through demonstrations and assignments.	g	1.1 Technical Proficiency a,b,c,d,f	Midterm Written	83	Final	84			31	50	12	0	6	**4.0**
Instructor Comments for needed changes: This class went well with the objectives covered appropriately.									Number of responses:				32	

Table 5 - ABET Criterion Assessment

CGT116 Geometric Modeling for Visualization & Communication Course Assessment Tool ABET Criterion Assessment Proposed ABET Criterion Satisfied: a,b,d,g						
Instructor: Rickerson/Higley		**Semester: Spring 04**				
	Student Evaluation (%)					
Criteria	**E**	**G**	**A**	**P**	**NA**	**Composite**
a. As a result of this course, my mastery of the knowledge, techniques, skills, and modern tools of the Mechanical Engineering Technology discipline can be described as,	34	31	16	0	19	**3.6**
b. As a result of this course, my ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology can be rated as,	22	25	19	0	31	**3.0**
c. As a result of this course my ability to conduct, analyze, and interpret experiments and apply results to improve processes can be rated as,	16	31	16	0	34	**2.9**
d. As a result of this course, my ability to apply creativity in the design of systems, components, or processes appropriate to program objectives can be rated as,	34	44	12	0	9	**3.9**
e. As a result of this course, my ability to function effectively on teams can be rated as,	50	38	6	3	3	**4.3**
f. As a result of this course, my ability to identify, analyze, and solve technical problems can be rated as,	41	31	16	0	12	**3.9**
g. As a result of this course, my ability to communicate effectively can be rated as,	38	31	22	0	9	**3.9**
h. As a result of this course, my recognition of the need for, and an ability to engage in lifelong learning can be rated as,	44	28	3	0	25	**3.7**
i. As a result of this course, my ability to understand professional, ethical, and social responsibilities can be rated as,	25	28	9	3	34	**3.0**
j. As a result of this course, my respect for diversity and knowledge of contemporary professional, societal, and global issues can be rated as,	25	31	3	3	38	**3.0**
k. As a result of this course, my commitment to quality, timeliness and continuous improvement can be rated as,	41	38	12	0	9	**4.0**
Instructor Comments: The scores agree well with the intended criterion except for b. e, f, and k scored well as secondaries.						

Table 6 - Course Update Form

CGT116 Instructor Update Information			
Date Submitted: 05-12-04		**Date to be Reviewed: 08-23-04**	
Responsible faculty for the review: Rickerson			
Type of Update			
☐ New Edition of the Text	☐ New Text Adopted	☐ New Software	☑ Teaching Method
☐ New Laboratory Equipment	☐ Lab Material Update	☑ Teaching Initiative	☑ Other
Description of Condition Prior to / After Update: Rick Rickerson and Jim Higley each taught this course this semester, and all data is pooled. We tried modifying the class project to have the individual groups pick topics, and it went well. There was a good variety of projects. We'll do this again next semester.			
Assessment Method Used to Evaluate Short or Long Term Results:			

Table 7 Sample Blank Template

(Course Name/Number) Course Assessment Tool Š Instructor and Student Course Objective Assessment														
Semester: Fall 2002			Instructor:											
			Course Embedded Assessment of Student Performance						Student Evaluation (%)					
Course Objective	Supported Criterion	Supported Related Outcome	Assessment Tool 1	Score (%)	Assessment Tool 2	Score (%)	Assessment Tool 3	Score (%)	E	G	A	P	NA	Composite
														#VALUE!
														0.0
														0.0
														0.0
														0.0
														0.0
Instructor Comments for needed changes:													Number of responses:	

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Biographical Information

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