Teaching Strategies and Assessment Measures for Rapidly Changing Technology Programs

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Abstract

Technology changes rapidly in the Computer Graphics field and the faculty find themselves continually updating and changing their courses to keep step with current changes in the technology, both in hardware and software. Course consistency in the form of learning objectives and outcomes is an important assessment measure. Many problems can arise in assessment while keeping up with the technology, to the point where some assessment measures may become obsolete. In response to that, this paper will explore a number of questions that deal with the issue of rapidly changing technology within the learning situation along with assessing a program in this type of environment. Additionally, this paper will address a number of questions including: How does an educator keep up, and what is the significance in teaching the "old" technology verses the "new" or "upgraded" technology? How do educators assess student success? How does an educator assess the technology skill level and set a base for continued course assessment throughout a degree program? This paper will also explore the possibilities of setting up accreditation options to prepare for future computer graphics accreditation.

Introduction

For our Computer Graphics Technology Program at Purdue University Calumet, we use assessment measures which include faculty evaluation, class critiques and written peer evaluations that individually addresses each level of technical, aesthetic and creative aspects of each project or assignment throughout the degree program. Discussions or critiques first address the success of technical aspects, then moving to the aesthetic aspects and then the overall creative attributes of the students work. This type of evaluation is not only valuable for the student's comprehension, but also provides valuable assessment feedback to the faculty regarding student-learning success.

The Computer Graphics Technology degree program at Purdue University Calumet is relatively new, and began in the year 2000 with 18 students, with current growth of about 200 majors. The program has faced many challenges, not only with the rapid growth of the program, but with the large number of updates, technological advances in that time period and integration of new faculty. Offering a new dynamic Computer Graphics Technology degree that incases the flexibility to accommodate rapid technological changes, rapid growth in student population and at the same time maintaining an effective consistent evaluation method has been our challenge and goal.

Teaching and assessing "old" technology verses the "new" or "upgraded" technology?

The nature of Computer Graphics requires continual upgrading of faculty skills. There are many avenues for keeping current in the field. These avenues include joining professional organizations such as ACM SIGGRAPH, IGDA and others where new technologies are introduced, dissected and explored. These organizations also provide opportunities to meet other professionals with the same interests and concerns. These relationships can be very beneficial when upgrading to new technologies. User groups are another area where the latest technologies are examined and explained. Many of these user groups provide forums, discussion boards and help centers to provide tutorials, explanations and advice on new technologies. Academic institutions, both classroom and online, can also be a mechanism for educational opportunities.

There are specific elements within Computer Graphics that are fundamental regardless of the technology employed. An example can be demonstrated by the earliest animations to the latest computer graphics masterpieces all employed to one degree or another many of the following techniques.

- Squash and Stretch
- Timing and motion
- Anticipation
- Staging
- Follow through
- Straight ahead action
- Exaggeration
- Appeal
- Personality

Without the traditional concepts, an animation would be very unappealing. Along with the fundamental concepts that should be foundational within a curriculum, older and simpler technologies are a good beginning for introducing the student to new ideas and concepts. Simple hand-drawn cell animation can provide an excellent launching point for the introduction of more complex animation technologies. As the professional educator ponders the many options with the expanding technologies available, there are basic concepts and fundamentals that should not be discarded or minimized in the Computer Graphics field.

Rapidly changing technology requires lower level learning in all levels

One of the major problems in rapidly changing technology is the requirement of some form of "lower level" learning such as comprehending and remembering basic information and concepts. The faculty need to make sure that learning goes beyond the "lower level" and includes problem solving, decision making, critical thinking, and creative thinking proficiency within each course, while "keeping up" with the new technology. Courses within a technology degree focus on the hard-core technology where new technological changes are incorporated and updated frequently. Thus, technology degree courses require a certain amount of "lower level" learning or new concept technical skills within all courses of a degree from the 100 to 400 levels, along

with the inclusion of problem solving, decision making, critical thinking, and creative thinking proficiency. Technical change affects course consistency and delivery on a regular basis. Soft skills, technical skills and aesthetic expertise are essential in setting the stage for life-long learning and aid in setting a base for course consistency and assessment.

The kinesthetic and visual learner

A student learns more effectively when information is presented in a manner consistent with their favored method of acquiring and processing information. Keeping in mind that computer graphics students have a propensity to be kinesthetic and visual learners, faculty teaching in technology needs to deliver new materials in the favored method. Thus auditory learning will be enhanced by kinesthetic and visual hands-on demonstrations and discussions. A teaching style that incorporates open class discussions, verbal participation, and active demonstrations (where students participate with the lecture) will enhance learning and discovery of new technology. This will open the door to active participation in group projects, critiques and peer discussions. Teaching styles which incorporate active learning aids in self-discovery, which is not only valuable to students in the class room, but also to faculty who must also keep up with the new technology.

Susan M. Montgomery points out the learning styles of today's students in her paper "Addressing Diverse Learning Styles Through the Use of Multimedia." She states that the current college students grew up with television, movies, video, and video-games. Visually displayed information is prominent in our society. She also points out that "these people have developed an intuitive "feel" for the new media, along with heightened impatience". The following table exhibits the learning styles of today's students' favored teaching formats, other than lecture. [Montgomery 1995]

Table 1 - Learning Styles vs. Lecture

Learning Styles	Lecture Characteristics
67% Active	32% Reflective (Passive)
57% Sensing	42% Intuitive
69% Visual	30% Verbal
28% Global	71% Sequential

Students need guidance, leadership and delivery of new technology concepts as well as soft skills and aesthetic expertise. Delivery of these concepts often puts faculty in the role of "teacher or facilitator". Self-discovery and practice with application of these concepts is enhanced through research, comprehensive projects and group projects. With students actively learning, and experiencing self-discovery of new concepts, they can claim ownership of their accomplishments and creative application. This is important in student retention, helping the student discover in steps, integrate and participate in the exciting new technology. Continued assessment of soft skills, aesthetic, and technology helps the student discover strengths and weaknesses, providing a platform for continued improvement and discovery. It also aids in course and program evaluation as well as defining successful teaching styles.

Soft Skills

The soft skills such as communication, teamwork, decision-making, critical thinking and problem solving skills are important concepts. A rapidly changing computer graphics course can be evaluated through assessment measures by incorporating and evaluating specific soft skills. These soft skills can be put into practice and applied within the specific technical course degree offering. Within our computer graphics technology degree at Purdue Calumet students take five to seven courses that focus on the development of soft skills. The soft skills such as communication, teamwork, decision-making, critical thinking and problem solving skills are important concepts in Computer Graphics. Each consecutive computer graphics course then builds on learned soft skills or "puts-them-to-work" within a specific technology genre of the computer graphics course. A good avenue for practicing and assessing soft skills is through group projects, critiques, discussions and "real-world" projects, including issues of ethics, and allowing students to practice critical thinking, problem solving, creativity, and communication skills.

Evaluating Aesthetic Expertise

The need for creativity and professional aesthetic competence is prominent in Computer Graphics and should be addressed and built upon in each sequential course. This also provides a basis for establishing course consistency through assessment. Aesthetic competence is acquired through an understanding of the composition and design principles as well as hands-on practice with each, using traditional and technological tools. Good assessment measures begin with weekly class assignments, both group and individual, which apply the composition and design principles in small concepts. In the lower level courses composition and design principles are heavily addressed and practiced on a new concept level. In the upper level courses they are still addressed, but combined and built upon to aid in design maturity among the students. Weekly assessments include class assignments, quizzes, research, and historical and contemporary observation, as well as written and oral discussions of others works to gain an understanding of the application of compositional and design concepts.

Projects and comprehensive exams should build and combine the aesthetic skills sequentially throughout the semester as well as throughout the degree. Thus the lower level courses will teach beginning technical skills and the upper level courses a combination of advanced technical skills, aesthetic skills, and creative application of composition and design principles. Critiques, class discussions and group project discussions should involve more advanced design and composition vocabulary and relay a deeper understanding of technical and aesthetic resolve. This teaches not only the technological, aesthetic and soft skills but provides feedback to the students and assessments for the teachers at the various levels. Projects emphasize portfolio material and faculty, at various levels in the degree, evaluates student portfolios. By individually assessing aesthetic, technical and soft skills faculty can also better evaluate not only the course, but the degree program objectives and outcomes. For example, if a specific course has undergone a major technology change and new graphical interface concepts are being taught, (lower-level learning), the faculty can assess the students continued maturity in aesthetic concepts regardless of the class level.

Traditional art classes have always incorporated lab and hands-on practice to master techniques in their choice of medium. Critiques and open class discussions historically have been valuable assessment tools for faculty and student. The onset of rapidly changing technology and the computer as a new medium has added a new layer to the quest for creative maturity and an understanding aesthetic resolve. Faculty in their quest to keep-up

and learn new technology have had to give-way to pure creative "studio" time, now called lab time. Teaching styles, which incorporated open discussion and creative studio time, have been divided into more demonstration of computer interface and new technology concepts.

Evaluating and assessing technical skills

Technical skills are easier to assess within a specific course, but the overall program assessment is much more difficult due to the continual change. One hundred level technology courses may have changed drastically by the time a student reaches the 400 level. Basic skills such as saving or archiving files for frequent use, compression and delivery methods do have some consistencies. Once learned, they can be adapted to the change. Software, hardware and coding also have consistencies, but graphical user interface and options from various programs or upgrades to similar programs often require lower level learning in upper level courses. This is where students need self-assessment, self-discovery, active learning and problem-based learning skills to continue to progress to a mature learning level. As faculty, continuously learning the new technological concepts, it is easy to fall into the trap of only teaching lower level learning to "keep-up" with new technology advancements in upper level courses. Communication among faculty and continued assessment of soft skills, technical skills and aesthetic expertise is key.

Feedback from students and among faculty within their specific degree option is essential to assess course consistency. This can be documented through assessment measures and addressed by faculty on a semester-to-semester basis. Frequent and immediate feedback from students within the classroom is necessary on a weekly basis to make sure the technical "craft" or "hands-on" skills are being integrated into cognitive learning. A base of soft skills, technical skills and aesthetic expertise needs to be established through objectives and outcomes on assignment, project, course, and degree program level. The assignment and project level objectives and outcomes can be evaluated through quizzes, critiques and presentations. Often it is found that the students did not cognitively integrate important concepts and they need to be repeated in the next assignment, discussion, lecture or project. The course objectives and outcomes will be more accessible when they are addressed on a weekly basis. This assessment then trickles up the ladder to a comprehensive project, course and degree program evaluation of objectives and outcomes.

When faculty at Purdue Calumet meet to discuss the progress of project and course assessment, we often find that on congruent course offerings where the same group of students are in both courses, similar skills in different courses are lacking. As most seasoned faculty know, classes have a personality of their own, and flexibility in course offerings is necessary to implement the overall course and program objectives. By breaking up the evaluations into sections, a specific skill can be addressed in consecutive courses. An example of this would be where a group of core students taking two or three Computer Graphics courses may be lacking in aesthetic skills, even after they have been addressed and taught. By addressing this with other faculty in congruent and consecutive courses, a program can emphasize the aesthetic skills and push for a more cognitive understanding of them, while advancing the students in the technical and soft skills. Making sure that all faculty are on board the assessment evaluation process can sometimes be a challenge, especially with new faculty and guest lecturers. Having a map of the assignments, course objectives, program objectives and outcomes, along with meetings to discuss them on a mid-semester and semester-end basis helps considerably in the evaluation process.

On a program assessment level, the flexibility for students to repeat courses due to technical updates and need to revisit aesthetic and soft skill requirements is necessary. This is done in the Purdue University Calumet Computer Graphics Program through selectives and special interest course offerings. Therefore a senior level student can take an overhauled 100 or 200 level course and apply new technical concepts along with the ability to refresh aesthetic concepts and improve portfolio material.

Assessment

The Engineering Technology and Organizational Leadership and Supervision programs at Purdue University Calumet have had some measurable success with the implementation of course embedded assessment both in the class room and online [Colwell, et. al., 2004]. Both of those programs provide supporting courses for the Computer Graphics Technology program at Purdue University Calumet. The example of the assessment model offered in this paper is adapted from those programs and applied to the expanding and ever-changing field of Computer Graphics. 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.

Rubrics (or "*scoring tools*") are a way of describing evaluation criteria (or "*grading standards*") based on the expected outcomes and performances of students [Ebert-May]. 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 [Ebert-May]. 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 [Ebert-May]. In classroom use, the rubric provides an "objective" *external standard* against which student performance may be compared [Ebert-May]. 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 [Ebert-May]. 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 [Ebert-May].

Objectives written for rubrics should describe measurable student outcomes [Moskel2003]. When the goals and objectives of the assessment are focused upon complex learning outcomes, a performance assessment is likely to be appropriate [Moskel2003]. Performance assessments require students to demonstrate the application of knowledge to a particular context [Moskel2003]. During 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 [Moskel2003]. Scoring rubrics are one method, which may be used to evaluate students' responses to performance assessments [Moskel2003]. Rubrics may be either analytic or holistic [Moskel2003]. Analytic scoring rubrics divide a performance into separate facets and each facet is evaluated using a separate scale [Moskel2003]. 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 [Moskel2003].

Figure 3: Sample scoring rubric taken from Encyclopedia of Educational Technology [Schafer 1999-2004]

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 following tables.

These questions relate to midterm and final projects in a raster imaging computer graphics course. The tables, which follow, contain follow up questions for the critiques for later in the semester. J. Whittington developed these critique questions for use in her CGT courses [Whittington 2004]

Critique assessment

Table 1: Sample critique questions

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.

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?

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 [Henderson 2002], 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.

The spreadsheet available in the links below exhibit examples of how the Mechanical Engineering Technology and Supervision (METS) department at Purdue University Calumet has organized the required ABET criterion. This format offers an effective format to assess and document progress and areas of improvement. Each level of evaluation reveals scores from specific assignments that the instructor uses to measure each course objective; students' evaluation of how well they felt the course met each objective; students' perception of how well the course met the ABET a-k criterion; and 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.htmland then clicking on "Course Assessment Data."

Conclusion

Computer graphics technology students are often visual and kinesthetic learners requiring learning methods that are more active or hands-on rather than passive or lecture based. Immediate feedback is provided by hands-on demonstrations where faculty require students to work along with them as they demonstrate new technology skills. To integrate cognitive thinking and combine hands-on demonstrations, class assignments are assigned based on the specific demonstration and participation skills. This class-by class assignment and assessment method help faculty to assess how the students are learning with each concept on a smaller scale. Additionally, this method requires students to have notes and small-scale assignment experience to refer back to when working on comprehensive projects. Students can also have small successes throughout the learning process, through weekly assignments and assessments, thus helping with student retention and confidence within the program. By providing weekly assessments they have time to improve and integrate new concepts before major projects are assigned. Often faculty perception of a student's progress and learning can differ from the actual student progress. Assessment measures that evaluate progress in soft skills, aesthetic and technical expertise help the faculty to adjust with each assignment and project on a class by class basis; but at the same time keep consistency in course delivery throughout the program.

The development and refinement of rubrics, critiques and other course assessment methods are is an ongoing project for computer graphics program but it is also a valuable tool in assessing the adaptation and success of rapidly changing technology. These assessment measures can help track the changes and provide valuable assessment feedback to improve a degree program, as well as faculty expertise. In addition, the process of evaluation can also form the basis for an eventual accreditation effort.

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