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Abstract

As educators we are charged with a higher mission than current knowledge delivery: We are additionally charged to prepare today's student for self-management of their life-long learning needs. Organizing knowledge for presentation, creating activities for discovery and insight, providing performance feedback, and identifying new knowledge areas to incorporate in the curriculum are fundamental to the short-term goal of educating students. How can we go beyond content, beyond skill mastery? How can we teach them to learn and understand what they have learned? In this paper we discuss an approach that assists in developing habits of life-long learning through active participation in the exam development process.

Introduction

Recent CIS curricula documents [ACM 1991] [IS 1997] call for more than structured knowledge delivery: They also call for greater skill development in problem solving, teaming, and all forms of communication. Successful approaches to satisfying curricula objectives include placing a greater emphasis on problem solving in conjunction with individual and group problem-solving models, increasing the use of cooperative and collaborative in-class assignments, adopting active learning approaches, incorporating consideration of different student learning styles, and attaching a greater importance to the development of written and oral communication skills [Pardue 1991, 1994], [Doran 1993, 1996], [Denton 1996], [Daigle 1995, 1996, 1997], [Longenecker, 1996]. Another requirement identified by the curricula documents is the cultivation of a life-long approach to learning by students. While most of the curricula document requirements are specified clearly enough to facilitate implementation, this requirement is less clearly specified.

Levels of Comprehension

A recent trend in curricula documents has been to specify curricula objectives by identifying *what* and *how much* to deliver at various points in the curriculum. The *what* is specified by means of self-contained knowledge units; the *how much* is specified through target comprehension levels for the associated knowledge unit. The definition of the comprehension levels is a slight variation of Bloom's taxonomy of comprehension [Bloom, 1956] that identifies six increasing levels of comprehension proceeding from fact-based knowledge through creation of new knowledge. Bloom defines the levels as follows: Level 1 - recite the basic facts, Level 2 - use the facts when told to do so, Level 3 - application of the facts in a new situation, Level 4 - analysis of new structures, Level 5 - synthesis of creating new structures, Level 6 - evaluation of new facts when compared to existing knowledge.

Over the last several years, funded by NSF, we have applied a cognitive based approach, based in part on Bloom's taxonomy of comprehension, to define course objectives in the beginning courses of our CIS curriculum [Doran 1995, 1997], [Langan 1996]. Fundamental to the success of the approach is an active learning environment achieved through a daily hands-on lab component supplemented with in-class collaborative assignments. Another element of success is educating the student about the learning process: We provide specific behavioral objectives, information about Bloom's taxonomy, and the relationship between the taxonomy and behavioral objectives (Bloom's Level 1 about learning). Providing information about learning furnishes additional insight for the process of learning but it is not enough. From our observations, we believe that the ability to self-manage life-long learning requires a transition from Level 1 (fact) to Level 2 (use) and then to Level 3 (application) regarding this comprehension about the learning process. Moreover, we believe that explicit guidance in later courses would more likely result in transitioning through these levels.

Reaching Bloom levels 2 (use) and 3 (application) for the learning process can be achieved by providing students the opportunity for active participation in examination materials development for project-based courses in the later stages of the curriculum. By participating in the process of examination generation, students are challenged to reflect in a different way about what they know and what they need to know about the course material and activities, i.e. understanding the standard of assessment and being able to perform self-assessment of their knowledge. Moreover they have ownership in the final product, the examination. An active participation on the part of the user has been described in several areas [Gronbaek 1993]. The remainder of the paper will discuss the courses involved and how the approach was incorporated into various courses.

The Approach

Many courses in the later stages of the curriculum are a combination of theory and application in the form of complex projects. Courses with these characteristics include applications development, database, systems analysis and design, senior project, applied software engineering, etc. When in a project implementation phase, it is easy to lose the big picture view: What is the relationship to concepts and content? What is the process about? What are the important/essential characteristics of the project? How can a solution be generalized for reuse with similar projects? By providing students with the opportunity to participate in the examination generation process, they are given the chance to reflect on the meaning of the project in academic terms, to discover a standard by which their understanding might be measured, and to apply that standard in self-assessment.

Our approach involves an examination generation activity consisting of several phases. Students are advised that a decision to be passive is interpreted as a willingness to accept whatever final product is produced. The phases that are involved in the process are:

1. Call for Item Submission: Students are instructed to prepare a file containing appropriate examination items in a common denominator file format (WordPerfect 5x, ASCII, or RichText). Item submission must be general, not specific to a particular project; appropriate items might address concepts covered in class or used on the project and any skills, methods, techniques used on the project.
2. Class Integration and Review: Using a single file containing all submitted items and an LCD and projector, a student facilitator works with the class to remove duplicated items, edit remaining items for statement clarity, and check for completeness and appropriateness
3. Instructor Review: The instructor, using an LCD and projector, in the presence of the class, reviews each test item for appropriateness and clarity. The instructor reviews the resulting document for completeness, fairness, and quality control. A printed copy of the document is distributed to the class for individual review. Any suggested modifications by student or instructor must be presented to the class.
4. Examination Preparation: The instructor prepares the examination by mapping the examination items to an instructor-generated problem scenario similar to current class project. The format consists of two sections: a *must respond* section (60%-70%) and a *choose from* section (30%-40%); examination item distribution is determined by the instructor based on importance to the course

Usually the process takes longer for the first application--students need to become accustomed to the requirements and the constraints. The approach works best for class sizes between 10 and 25; too few ideas for less than 10 students--too much time required for classes exceeding 25 in number. The process takes no more time than would be devoted to a review session. The approach has been used for two exams in each of four applications development courses and six or more database courses.

Observations

This approach provides many benefits to students and instructor. This is a different method of studying and preparing for examination. Students are required to extend beyond a specific project and understand a more generalized viewpoint. The students must understand how to apply this generalization to similar circumstances and projects in the future; they are compelled to reflect about techniques, activities and lessons learned and how to articulate and apply that knowledge. Therefore, an individual student, though their own initiative and in collaboration with class members and the instructor, discovers and gains a deeper understanding of the course behavioral objectives and their associated levels of comprehension. While an individual student might focus on only one or two areas, a larger perspective is obtained from the contributions made by peers. To encourage and reward individual initiative, one of the examination items in the *select from* section permits students to enter and answer, at exam time, an item believed to be important by the individual but perceived by peers as not being required knowledge of all.

The instructor is responsible for fairness, completeness, and quality control for the process through the review process and the mapping to a similar problem scenario. Students who understand what is expected of them will perform at a higher level. Students who do not perform well on the examination accept responsibility for their performance rather than assessing blame on someone else. Individual student objection to exam items are non-existent since consensus reached by the class members and the instructor results in peer pressure to overcome an identified area of deficiency.

Overall the standard of testing and learning is higher than was achievable in the past. A more active learning environment is fostered; the process builds upon prior learning experiences in earlier courses. As a consequence of the approach, students possess a foundation of knowledge about learning (through Bloom's Level 3) to build upon. The approach provides a framework that can be reused in for identifying a standard of assessment and for self-assessment against the standard, critical skills for self-management for life-long learning.

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