Using the Moodle Course Management System to Manage Accreditation Tasks

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Abstract – This paper documents work in the School of Computing using the Moodle course management system to assist with accreditation tasks associated with ABET accreditation. We have initiated a pilot project to develop assessment questions for our Operating Systems class and will derive student performance metrics based on results on these questions. We will describe the reasons for selecting Moodle for this project, how the software is used to develop a quiz bank and the metrics available in Moodle. Finally we will report on the results of the pilot project.

Keywords: Moodle course management accreditation on-line

Introduction

The Computer Science Bachelors degree at the University of Southern Mississippi is accredited through ABET, Inc. (formerly known as the Accreditation Board for Engineering and Technology). The accreditation process requires that assessments be performed to determine how well student performance meets the program's objectives and, perhaps more importantly, the assessment process needs to lead to ideas for improvement of instruction.

Faced with these needs we determined that we wanted an objective assessment of success which could be applied repeatedly year after year with different teachers. This assessment needed to be done in a system accessible to multiple instructors and needed to pinpoint particular topics which students failed to understand well so that we could improve the teaching process. We decided to implement a pilot project using the Moodle course management as a possible tool to assist us with the assessment task.

Accreditation Requirements

ABET publishes a document detailing the criteria for accreditation which is updated annually. In the Computer Science part of the document for 2006-2007[Abet, Inc., 1], they list 6 general standards which must be met by each accredited program:

> Standards
>
> I-1. The program must have documented, measurable objectives.
>
> I-2. The program's objectives must include expected outcomes for graduating students.
>
> I-3. Data relative to the objectives must be routinely collected and documented, and used in program assessments**.**
>
> I-4. The extent to which each program objective is being met must be periodically assessed.
>
> I-5. The results of the program's periodic assessments must be used to help identify opportunities for program improvement.

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I-6. The results of the program's assessments and the actions taken based on the results must be documented.

Our pilot project attempts to address Standard I-1 by providing measurements of how well students are learning the material outlined in our objectives. The measurable objectives for a course could include Moodle related objectives like having at least 70% of the students score a minimum of 70% on the quiz. Standard I-3 is the essence of this effort. Having a plan which is simple to administer helps make the periodic assessments required in Standard I-4 easier to implement. To address Standard I-5 we propose having questions in well-defined categories and sub-categories which can be used to identify which topics are in need of better coverage in our courses.

Moodle Course Management Software

Moodle[Dougiamas, 2] is an open-source course management system implemented using a web interface to provide a rich collection of tools to manage online courses. These tools are also useful as an adjunct to traditional courses. Moodle was started by Martin Dougiamas who continues to lead the development process. The first public release was in 2002. The features available in Moodle include

- Web-site management
- User management
- Class management
- News
- Forums
- Chat sessions
- Surveys
- Glossaries
- Lessons
- Quizzes
- Wikis
- Journals

For this paper we are particularly interested in the Moodle quiz facility.

Moodle Quizzes and Questions

Each class in Moodle has a class page which can be arranged week-by-week, by topic or as a social forum. The week-by-week pattern was selected to match the scheduling of traditional classes. On the main page for a class the instructor can add a wide variety of resources such as web pages, lessons, links, char sessions, forums and workshops. In addition the instructor can add graded activities such as homework assignments and quizzes. A quiz can be restricted to a specific network address pattern at a specific time or it can be taken at any time from any network address. For our purposes we are interested in using Moodle quizzes in a computer laboratory at an assigned time to be certain who is answering the questions.

The instructor for a Moodle course can interactively develop a bank of questions. Questions are organized in a hierarchical collection of categories and sub-categories. Quizzes are prepared by selecting questions from the appropriate categories.

Each Moodle question is of one of the following types:

- Calculated
- Essay
- Description
- Matching
- Embedded answers
- Multiple choice
- Short answer

- Numerical
- True/false

For our pilot project we have used multiple choice, multiple choice with multiple answers, short answer, numerical and true/false questions, since these are automatically graded. Embedded answers and matching questions are also graded automatically, but the other types are stand-alone questions making it easier to select questions to prepare a quiz. Figure 1 shows a short quiz with one of each of the five question types used in the project.

1
Marks: 1

What is the single word for the one program running at all times on a computer?

Answer:

2
Marks: 1

What is the average waiting time for the following set of processes assuming that they all arrive at time 0 and that priority scheduling is used? Enter just the number.

Process	Burst Time	Priority
P_1	5	3
P_2	7	2
P_3	3	4
P_4	2	1
P_5	8	5

Answer:

3
Marks: 1

Which of the following are mechanisms for passing parameters from a user program to the operating system in a system call?

Choose at least one answer.

- a. placing the parameters in registers
- b. placing the parameters in global variables
- c. placing the parameters in a block of memory with the block address in a register
- d. placing the parameters in local variables

4
Marks: 1

VMware runs as an application on either Linux or Windows.

Answer:

- True
- False

Figure 1. Moodle Questions (part 1)

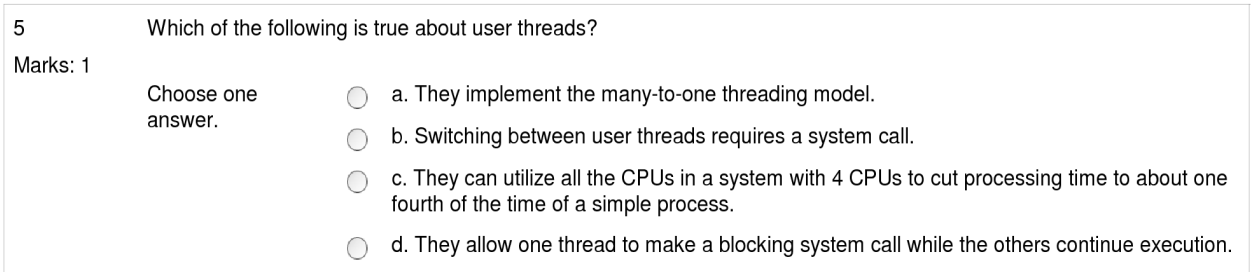

Figure 1. Moodle Questions (part 2)

Moodle Quiz Item Analysis

The Moodle quiz software offers an item analysis for quizzes which is quite useful for assessment purposes. The item analysis displays the results for each question on a quiz. It reports the number of students selecting or entering each answer given on the quiz. The analysis also include a Discrimination Index (DI) and a Discrimination Coefficient (DC) for each question. These two metrics generally indicate how well a particular question discriminates between strong students and poor students. The values range from -1 to 1 with positive scores meaning that a question discriminates well. A negative score means that poor students tended to do better than strong students, which might indicate a poorly-chosen question. A sample of the item analysis from the pilot project is shown in Figure 2.

The DI value is computed by determining the top third and the lowest third of the students on the quiz. Then the average of the top students (X_{hi}) for a question is computed and the average for the low students (X_{lo}) . Then we get $DI = X_{hi} - X_{lo}$.

The DC value is the correlation coefficient between scores on a question versus scores on the test as a whole. In cases where all the answers for a question are correct the software reports an artificial result of -999.

Pilot Project

In the Fall 2006 semester the author has participated in a pilot project in an undergraduate operating systems class. Moodle was already being used by the author to manage assignments and to provide a web site for the class. The class has 11 students enrolled and, at the time of writing, there are results for two quizzes for these 11 students. Each quiz was given in a lab environment where each student used a computer to take the quiz. There were 50 questions on each quiz, which is enough to perform a reasonable assessment of student learning.

Question Categories and Sub-categories

The questions for the operating systems class are organized into categories and sub-categories. The categories correspond to chapters in the textbook [Silberschatz, 3] and the sub-categories are generally sections with chapters. Each question in Moodle is also given a name in which we are repeating the category and sub-category along with a little more description of the question.

Results

At the time of writing the students in the operating system class have taken two Moodle quizzes in a monitored on-line environment. Student response has been very positive. There have been very few questions by students when taking the quizzes and they are satisfied with the immediate feedback from the automatic grading.

The results by category for Test 2 are show in Table 1 below. From the results one can conclude that the students performed well on these categories. Assuming that a specific measurable objective was that the average score on all topics be at least 75%, then we could provide evidence of achieving that goal.

Category	Number of Questions	Percent Correct
Deadlock	16	81.16
Scheduling	19	78.71
Synchronization	15	81.93

Table 1

The results by category might be sufficient to document success in the class, but it is not sufficient to determine "opportunities for improvement." We can view the results for the sub-categories for the quiz (Table 2) and discover that the class did poorly on the questions about deadlock detection with only 35.35% correct. This is clearly a topic which needs to be covered more thoroughly in future classes.

Category	Number of Questions	Percent Correct
Deadlock General	3	92.73
Deadlock Avoidance	7	87.01
Deadlock Detection	2	36.36
Deadlock Handling	1	100.00
Deadlock Prevention	2	72.73
Deadlock Recovery	1	93.18
Scheduling Algorithms	5	74.55
Scheduling Basics	3	95.45
Scheduling Critical Section	2	86.36
Scheduling Example	1	100.00
Scheduling Multiprocessors	6	69.70
Scheduling Threads	2	72.73
Synchronization General	1	100.00
Synchronization Critical Section	2	72.41
Synchronization Hardware Support	1	93.18
Synchronization Monitors	2	72.73
Synchronization Semaphores	4	86.36
Synchronization Transactions	5	80.00

Table 2

Item Analysis Table

Page: 1 2 3 4 5 (Next)

Q#	Question text	Answer's text	partial credit	R. Counts	R.%	% Correct Facility	SD	Disc. Index	Disc. Coeff.
(271)	SCHED MULTI: affinity : Why do SMP systems tend to implement some form of processor affinity?	**To avoid the cost of cache invalidation and re-population.**	**(1.00)**	5/11	(45%)	45 %	0.522	0.67	0.57
		To avoid the cost of copying the program from one CPU to another.	(0.00)	3/11	(27%)				
		To achieve load balancing.	(0.00)	3/11	(27%)				
		Because the code is simpler.	(0.00)	0/11	(0%)				
(276)	SCHED THREAD: PCS : What is process contention scope?	When the kernel schedules user threads to run on a CPU.	(0.00)	2/11	(18%)	45 %	0.522	0.00	0.01
		When the thread library schedules user threads onto light-weight processes.	**(1.00)**	5/11	(45%)				
		When two or more processes are attempting to access the same resource.	(0.00)	2/11	(18%)				
		When a process attempts to take away memory from another process.	(0.00)	2/11	(18%)				
(284)	SYNC SEM: spinlock : When is a spinlock a suitable mechanism for implementing a semaphore?	**When locks are expected to be held for short times**	**(1.00)**	5/11	(45%)	45 %	0.522	1.00	0.62
		When there are no more than 2 processes using the spinlock	(0.00)	2/11	(18%)				
		When the computer has a single processor	(0.00)	2/11	(18%)				
		When the number of processes exceeds the number of CPUs	(0.00)	2/11	(18%)				
(286)	SYNC MON: def : Which of the following is true about a monitor?	**Only one process at a time can be active in a monitor.**	**(1.00)**	7/11	(64%)	64 %	0.505	1.00	0.70
		A monitor is just like a C++ class.	(0.00)	0/11	(0%)				
		A monitor is used to identify deadlocked processes.	(0.00)	1/11	(9%)				
		A monitor is used to adjust priority values based on recent process activity.	(0.00)	3/11	(27%)				

FIGURE 2

Conclusions

We have demonstrated that Moodle's quiz facility offers a convenient way to prepare tests for courses which results in data useful for assessment purposes. This data can be used to document student progress and also to determine which topics are not being learned well so that teaching can improve over time. More work is needed to prepare more questions for the operating systems course and the other courses in our curriculum. Each instructor must decide whether or not Moodle fits into their plans for class management. In addition we need to invest more effort in assessing the validity and reliability of the method. We are hopeful that Moodle will be accepted by our faculty as an effective method of assessment.

References

[1] ABET Board of Directors., "Criteria for Accrediting Computing Programs" , ABET, Inc., Baltimore, MD, 2005, pg 2.

[2] Dougiamas, Martin, "Moodle - A Free, Open Source Course Management System for Online Learning," *http://moodle.org*, 2006.

[3] Silberschatz, Galvin and Gagne, "Operating System Concepts", John Wiley and Sons, Hoboken, NJ, 2005.

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