Using A Learning Management System to Facilitate Program Accreditation

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ABSTRACT

*In this paper we introduce AssessTrack, a web-based learning management system (LMS) that **Assess**es and **Track**s key elements of engineering education. It is designed to (1) facilitate student learning, (2) ease the rigors of course management and (3) address the daunting task of collecting assessment data for engineering program accreditation. AssessTrack provides an individualized, tailored study guide generated by AssessTrack's intelligent tutor. For educators, the system provides a paperless environment where they can easily post all the key components of the instructional process (course material, lectures, assessments, tutorials, surveys and grades). AssessTrack gives engineering program administrators and accreditation agencies (in our case, the Accreditation Board for Engineering and Technology, ABET) the ability to track the attainment of program objectives and course educational outcomes, both formatively and summatively. AssessTrack is accessible from personal computers, tablets and even smart phones.*

Keywords
LMS (learning management system), assessment, accreditation, computer science education, ITS (intelligent tutoring systems)

1. INTRODUCTION

Currently there are hundreds of computer-based learning and performance tools [1]. For many years, university instructors have employed selected subsets of this software to evaluate and analyze the educational process [2, 3]. However, most of this research has been directed at measuring the acceptance and usability of these technological advancements [4]. Some studies have focused on pedagogical considerations, while others analyze user perceptions to provide insights into how to design and utilize these educational tools [5]. Though there has been some study of the relationship of online courses to learning outcomes [6], there has been little or no research conducted into using web-based learning systems to support the program accreditation process.

Program accreditation is the assurance that a college or university program meets the quality standards established by the profession for which it prepares its students. For example, an accredited computer science program must meet the quality standards set by the computing profession. So, to receive ABET accreditation a program must regularly use processes for assessing and evaluating the extent to which both program and student outcomes are being attained. [7]

To prepare for the program accreditation review process, accreditation agencies, like ABET, require that an educational program conduct a self-study. The self-study documents how well the program is meeting the established accreditation criteria in multiple areas, such as their students, curriculum, faculty, administration, facilities, and institutional support. Assess track is designed to print many of the required self-study reports as well as allowing the external program evaluators access to these reports online. We have not found any other software that provides similar features.

2. TOOL DEVELOPMENT

In 2008, we began researching computer-based assessment tools to assist in our self-study in preparation for an upcoming ABET visit. We found no tools that could meet our needs. So, we began developing prototypes and eventually ended up with a tool that we called the Course Management System (CMS). CMS was used for 2 years and evolved over time. We then decided to discontinue CMS and develop a new, more robust system that could handle the needs of all students, any instructor, and every educational unit of the university.

The features of AssessTrack were added incrementally employing a methodology best described as "evolutionary prototyping". The prototyping effort began with an application that would allow Computer Science I students to take a quiz on lab computers. We wanted to start taking steps towards running a paperless course and to find an easier way to generate the reports about student performance required by ABET. The next prototypes were individual desktop applications. The students would answer

the questions and the system would save them to the computer's hard drive. We would later retrieve the files and use the data to score the answers. After several iterations, the current version of AssessTrack is a web-based .NET application that uses the Model View Controller (MVC) architecture. It uses a central SQL database to store the many tables needed to support a variety of functions. We have recently deployed a cloud version of AssessTrack to address throughput and capacity issues.

3. KEY FUNCTIONS

Within AssessTrack there are many noteworthy functions that serve students, instructors, teaching assistants, administrators and accreditation agencies. Students can perform all of their course work within the AssessTrack LMS with the exception of compiling their computer programs. The system has an embedded C++ compiler, but its use is reserved for online grading of programming assignments, quizzes and exams by teaching assistants and instructors. AssessTrack allows for use of collusion detection software (JPlag) that uncovers students who may have copied others students' submissions.

3.1 Student Online Notebooks

The key function for a student is access to their individual online notebook. AssessTrack gives students the ability to see all the work they have submitted, their detailed grades, and their overall grade in the course at any point in time.

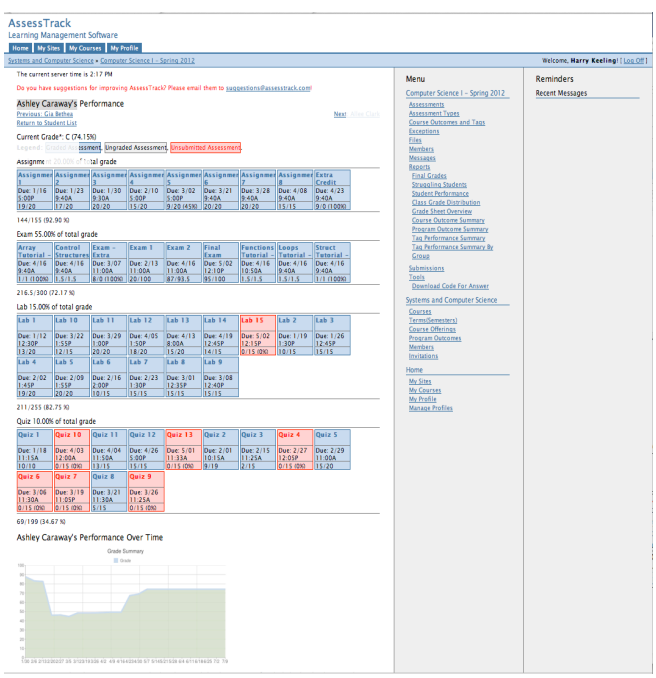

Figure 1: Student "My Grades" Screen

Figure 1 shows a student's "My Grades" screen that only they can see after inputting their username and password. This screen shows students all of their assessments, their grades for each assessment, an aggregate measure of performance for each assessment type and their overall grade for the course based on the work that has been submitted. A student can click on any submitted assessment (blue square) and drill down to see the content on the assessment, their answers, the correct answers, and their grades on each assessment component (question). This screen can be thought of as an electronic notebook containing all of their work during the semester. Any work that has not been submitted and is overdue will appear in red and any submitted work that has not been graded will show up in gray. The graph at the bottom of Figure 1 shows the student's overall performance over time. This student started off good, had a stump for about 2 and a half weeks before mid-term, but brought their grades up afterwards to finally earn a "C" in the course. Students have commented that this screen helps them determine their direction and helps to motivate them to keep making progress. Students no longer have to ask the instructor "How am I doing in your class?" The answer is always available to them, even on their smart phones.

3.2 Drag and Drop Assessment Creation

For instructors, assessments are an important part of a course offering. Assessments can be created for any gradable material that would normally be given to students. This key feature is called the Quiz Builder Tool (Figure 2).

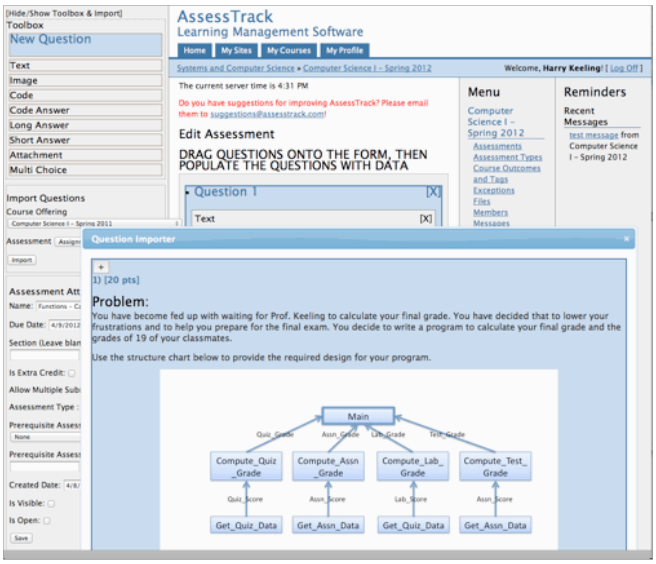

Figure 2: Quiz Builder Tool

It provides instructors the ability to import components of assessments from previous semesters and to add new assessment components to build a variety of multimedia assessments that can be administered to their students and, in part, automatically graded. This tool provides a drag and

drop interface that facilitates the process of creating labs, assignments, quizzes, exams or any other type of assessment instrument that an instructor needs. Survey instruments and multimedia tutorials can also be developed using the Quiz Builder.

The Toolbox, the area inside the gray box in the center of the figure, contains all the items you can use to build an assessment. The first item is the question. An assessment is composed of multiple questions. Each question is composed of one or more of the following: text, images, code, code answer, long answer, short answer, attachment answer, and multiple choice answers. In the center of the figure is a previous assessment that can be imported (in part or in total) into the current assessment and modified as needed. Once saved, assessments can be previewed and modified before deployment. Figure 3, presents a portion of an exam preview screen and the related Quiz Builder screen.

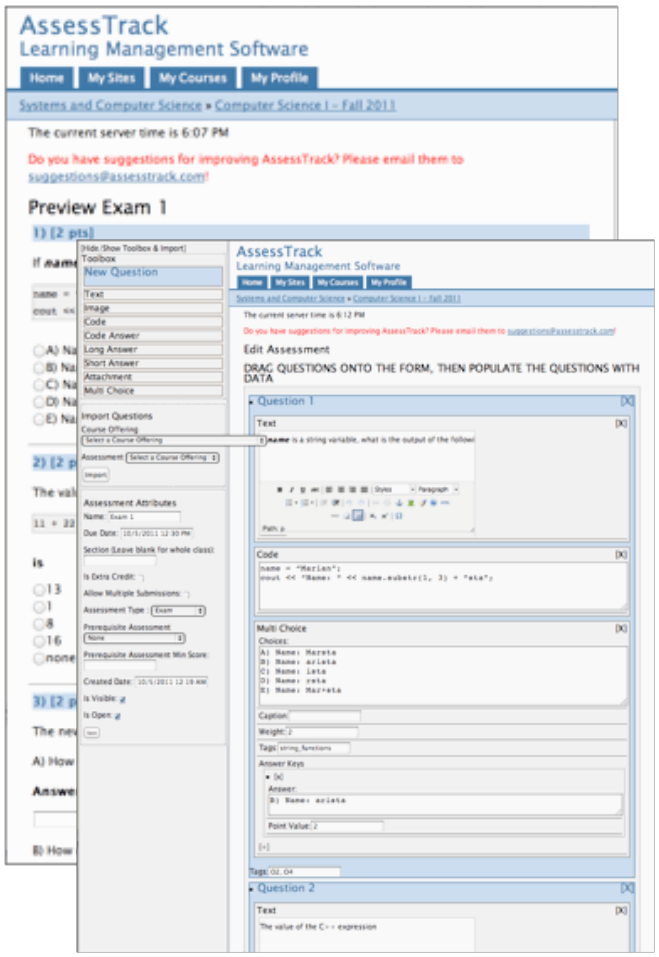

Figure 3: Assessment Preview Screen and Corresponding Quiz Builder Screen

Notice that in the Quiz Builder screen above, Question 1 components are shown with the correct answer "B) Name: arista" indicated in the Answer Keys area. There can be multiple correct answers to a question, each with a separate point value specified. This allows for partial or full credit to be awarded by the automated grading functions of AssessTrack. Also, notice the topic and educational outcome tags that have been entered to associate this question with the topic "string functions" and course outcomes O2 and O4.

3.3 Online Reporting Functions

Another key function of AssessTrack is the set of online reports that can be generated. The instructor's course home page, the Struggling Student screen and the Final Grades screen are shown in Figure 4.

Figure 4: Course Home Page Screen

3.4 Topic and Course Outcome Tags

Once a program administrator (department Chair) has entered their program outcomes, instructors can associate these outcomes with their individual course educational outcomes. Figure 5 illustrates the Program Outcomes screen and the Edit Tags Screen. The Edit Tags screen shows how education course outcomes are associated with one or more program outcomes.

By "tagging" each assessment item to indicate the course topic(s) and/or the educational outcomes that it is intended to assess (see Figure 3), the instructor designates a purpose(s) for each assessment item. This important function makes the assessment and tracking of course topics and educational outcomes possible. Further, this tagging process allows AssessTrack to generate key program self-study reports. Also, the tagging of assessment items with course topics using the Quiz Builder tool provides the basis for AssessTrack's intelligent tutor. Each student's scores on assessment items form a "student model" of each student's competencies and their understanding of the course content. The system's tutoring component uses this student model and the topic tags on each assessment component to generate an individualized study guide for each student.

Figure 5: Program Outcomes screen and Edit Tag screen

3.5 Intelligent Tutoring

Building on research conducted by the author earlier [8, 9], an intelligent tutoring feature was added to the system last year. Figure 6 presents an example of a study guide for a student who performed poorly on several topics on exams and quizzes. This figure illustrates the Tutoring screen (middle right). This screen is generated by the intelligent tutoring feature and presents the list of topics in which the student has shown a lack of understanding. The Topic Review screen (upper right) shows the topic-related questions that the student answered incorrectly along with the correct answers. The Tutorial screen shows the system-selected remediation (video clips, course material, and book references) collected to address this student's illustrated lack of understanding of "operator precedence".

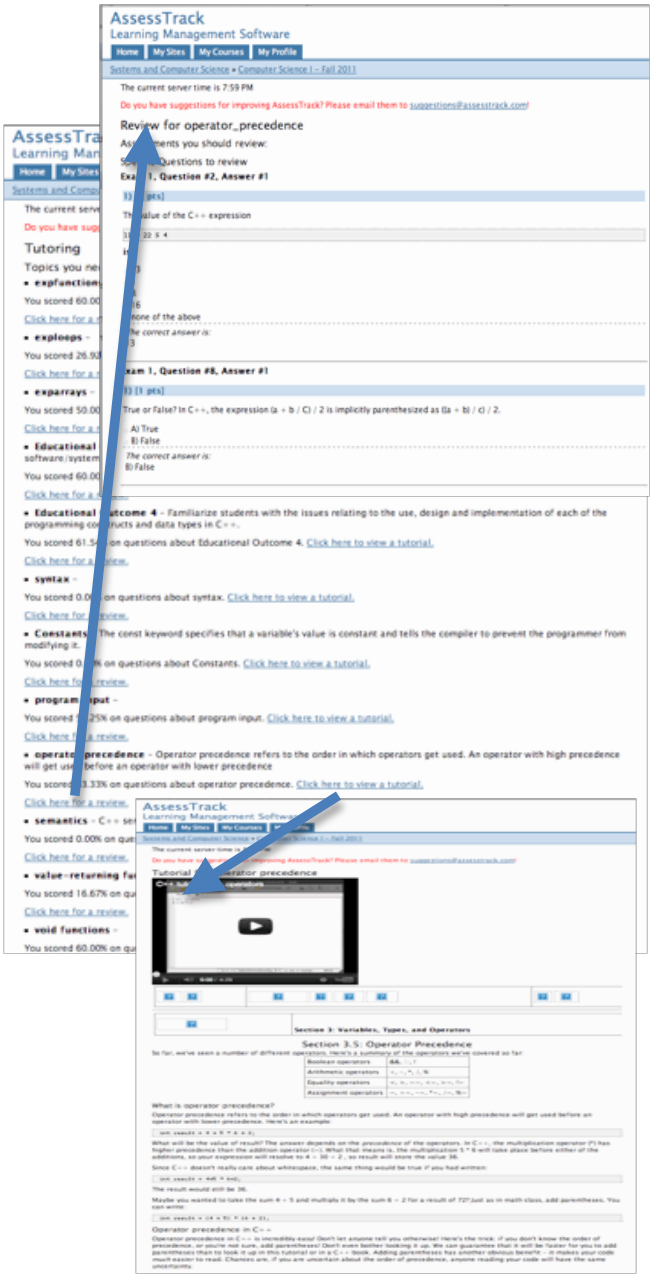

Figure 6: Tutoring, Topic Review and Tutorial screens

This feature gives each student a system-generated, online study guide that focuses on his or her topic-related deficiencies.

3.6 Self-Study Reports

Several reports are printed by AssessTrack for entry into the Course Books that are required by ABET as a result of institutional self-study. Figure 7 presents one of the most important reports required by ABET, the Course Outcome Summary Report. This report analyzes attainment of each course outcome. The metric used (1 to 5) is computed from the student's percent of accuracy on assessment items associated with each course outcome. The average measure of all students for each course outcome is shown on the far right.

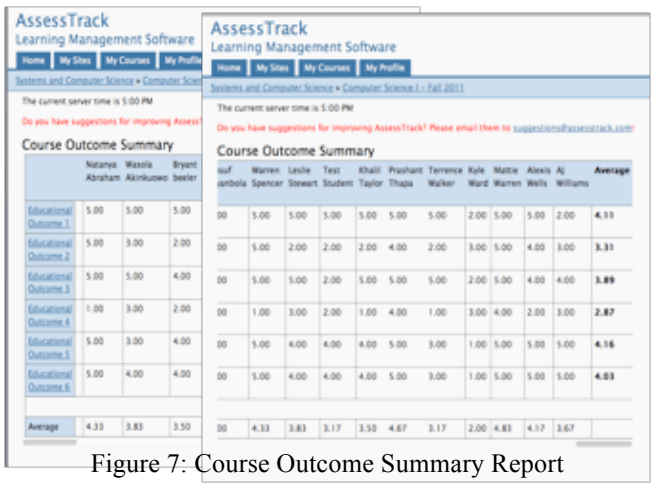

Figure 7: Course Outcome Summary Report

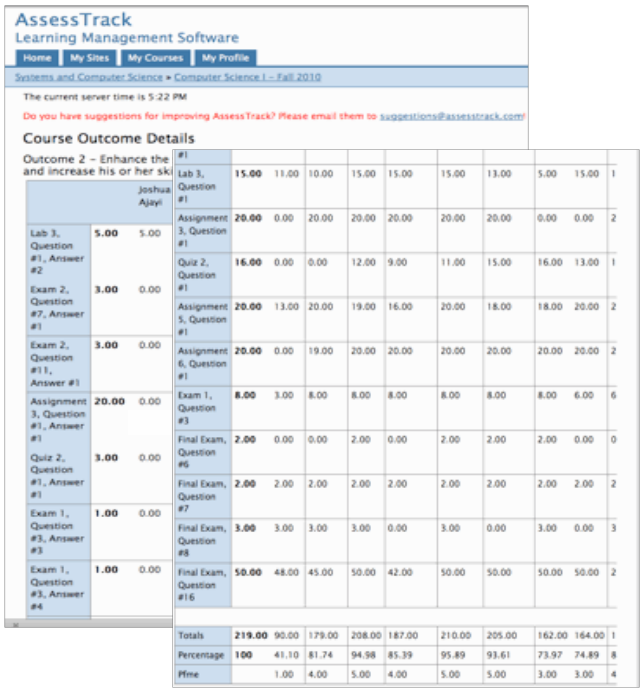

Figure 8: Details for Course Educational Outcome 2

Figure 8 shows the details for Outcome 2. The averages at the end of this report are computed per ABET instructions. Figure 9 presents another report used by instructors to determine how well students have understood the concepts and topics taught in a course.

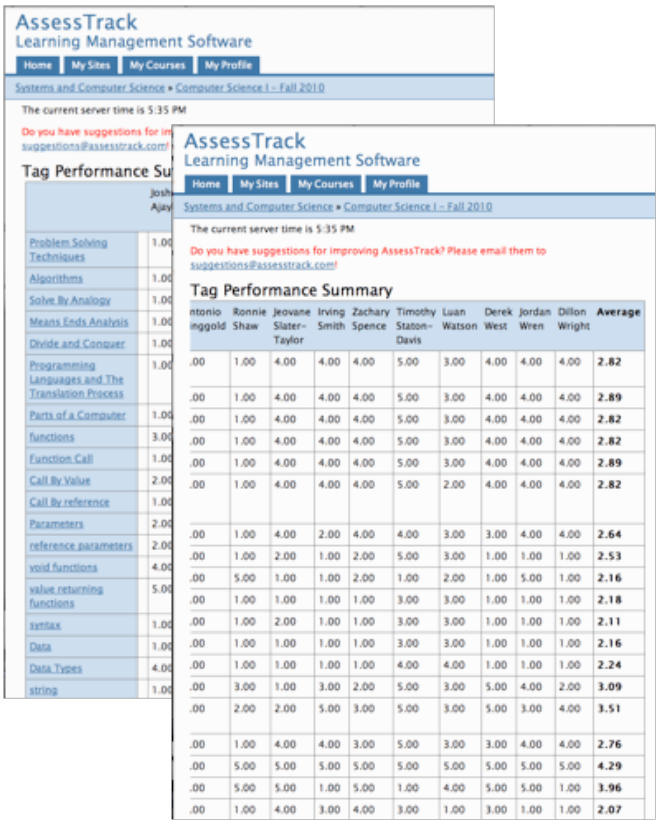

Figure 9: Tag Performance Summary (beginning and end)

These reports (Figures 7, 8, and 9) show analyses of student performance and educational outcomes. These reports can be viewed at any point in the semester. Subsequently, the instructor can modify the instructional process to address any indicated deficiencies. This type of formative evaluation has been encouraged by ABET.

4.0 EVALUATION

Last year, students responded to a survey directed, in part, at measuring their impressions of AssessTrack. The survey itself was developed using AssessTrack's QuizBuilder feature and was analyzed using question tags and the software's tag-based reporting feature. Using a 5-point Likert scale (5-strongly agree, 4-agree, 3-neither agree or disagree, 2-disagree, 1-strongly disagree) the survey results on the next page were tabulated.

Average Response	Question
3.7	Taking exams, quizzes and assignments online made the work more enjoyable and fun
3.96	The online course management system improved communication between the teacher and student
4.37	The website was easy to manage and understand
4.63	Seeing your grades displayed immediately on the website helped give you a true understanding of where you stood in the class

The results above indicate clearly that students enjoy the fact that AssessTrack provides easy, online access to educational material and assessment results. There was also a noticeable improvement with timely submission of student assignments. This improvement, we believe, was due to the submission deadlines enforced by the AssessTrack software. Also, the survey asked two questions directed at measuring the software's impact on studying.

Average Response	Question
4.63	Having everything located online made things easier to access and catch up when absent from school
4.11	The class slides, lectures, notes, etc. available online made things more maintainable for studying

The students indicated that the tutoring materials (short videos, text references, and other material) help them study by providing access from anywhere there is web access.

Learners utilized the tutoring functions of AssessTrack for two semesters last year and there was clear evidence that it enhances student learning. In co-developer Robert Person's master thesis [10] he studied the impact of the tutorials from AssessTrack's intelligent tutor. He found that the introduction of supplemental teaching materials have had a positive impact on student learning. The data revealed that there was a 12% increase in performance among those students who made use of these tutorials.

5. CONCLUSIONS

Clearly, the accreditation self-study reports that are generated by this LMS will be an enormous benefit to both the instructors and the ABET accreditation team on their next visit. Moreover, overall teaching effectiveness has improved with the advent of AssessTrack. The improved ability to prepare, disseminate and automatically grade some assessment items provides immediate feedback to both student and teacher. The software improved the way that we conceptualize our students by providing a "student model" showing their individual weaknesses and, by default, their strengths. Being able to analyze the class's performance at the question level helps the teacher prepare better assessment items. Further, the ability to see the class's performance by course educational outcome gives the instructor a unique view of their teaching effectiveness in a formative manner that can directly affect the time spent on course topics and the manner in which course content is delivered.

For students, AssessTrack gives online access to course materials including video taped lectures. Via any web-accessible device, students currently receive assignments, submit their work, and take traditional assessments (labs, quizzes, and exams). Further, AssessTrack gives learners 24/7 access to detailed analysis about how well they are doing in a course and perhaps more importantly, it helps them clearly identify their areas of weakness. There is a mobile version near completion designed specifically for use on tablets and smart phones. We look forward to continuing this research advancing our tutoring methods and adding elements of social networking.

6. REFERENCES

[1] Hart, J. Directory of Learning & Performance Tools, 2012, Retrieved Aug 2, 2012 from Centre for learning & Performance Technologies: http://c4lpt.co.uk/directory-of-learning-performance-tools/.

[2] Harrington, C., Gordon, S. and Schibik, T. Course Management System Utilization and Implications for Practice: A National Survey of Department Chairpersons, *Online Journal of Distance Learning Administration, 7*(4) (2004). Retrieved July 15, 2012 from State University of West Georgia, Distance Education Center: http://www.westga.edu/~distance/ojdla/winter74/harrington74.htm.

[3] Nijhuis, G. and Collis, B. Using a web-based course-management system: an evaluation of management tasks and time implications for the instructor. *Evaluation and Program Planning, 26* (2). 193-201.

[4] Unal, Z. and Unal, A. Evaluating and Comparing the Usability of Web-based Course Management Systems. *Journal of Information Technology Education, 10*, (2011). Retrieved Jan. 5, 2012: http://www.jite.org/documents/Vol10/JITEv10p019-038Unal904.pdf.

[5] Johnson, D., Means, T., and Graff, R. Student Perceptions of Course Management Systems Tools – Implications for evaluation and adoption of online Tools in Higher Education, Retrieved June 14, 2012 from EDUCAUSE, Center for Applied Research: http://net.educause.edu/ir/library/pdf/ERB1202.pdf.

[6] Swan, K., Matthews, D., Boles, E. and Day, S. Linking online course design and implementation to learning outcomes: A design experiment. *The Internet and Higher Education*, *15*(2). 81–88.

[7] Information Technology ABET Accreditation Summary, ACM Special Interest Group for Information Technology Education, Retrieved Jan. 5, 2012, from http://www.acm.org/search?SearchableText=program+Accreditation.

[8] Keeling, H. A Methodology for Building Intelligent Educational Agents. in *9th International Conference on Artificial Intelligence in Education,* (Lemans, France, 1999), Springer Publishers, 183-204.

[9] Keeling, H. Developing an Intelligent Educational Agent with Disciple. *In The International Journal of Artificial Intelligence in Education, 10*(2) 5-16.

[10] Person, R. A Framework for Measuring the Impact of Supplementary Learning Content in Online Learning Management Systems. *Masters Thesis*, Dept. Systems and Computer Science, Howard University.