

Work In Progress - An Evidence-Based Intervention System to Enhance Engineering Education

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Abstract - Educational assessment using process management approaches is tacitly built upon business models which envision student learning outcomes as product specifications. These approaches often pay insufficient attention to student personality and lifestyle parameters and how these parameters interact with instructional approaches to affect student performance. To complicate matters, student attributes and their interactions with teaching approaches are not fixed and may change within the development of a single student and certainly do change from generation to generation. What is needed is a methodology that allows educators to assess important student parameters, monitor those parameters' interactions with teaching approaches and provide for timely intervention to ensure superior student learning achievement. The goal of the present work is to develop, test and implement a scalable and transferrable information technology-assisted knowledge management system that monitors important student characteristics and analyzes the impact of those factors on learning in time for effective intervention.

I. PROJECT OVERVIEW AND FEASIBILITY

The main thrust of our efforts is to increase program success in attaining student learning outcomes and engineering program objectives by correlating selected characteristics of students, instructors, courses and curricula with student academic performance. To accomplish this, we will design, implement and test a knowledge management (KM) system that obtains high quality, high resolution, statistically significant information to facilitate decisions concerning the most critical factors in student learning and how and when they can be most impacted by intervention and instructional innovation. The kind of intervention and/or innovation can then be approached with a high degree of confidence and reliability. Three types of studies are currently underway in our School.

- 1) *Correlational Studies* investigating the impact of student, instructor and course/curricular attributes and

characteristics on student learning outcomes and program objectives;

- 2) *Chronobiological Studies* examining the effects of sleep and scheduling on student performance and
- 3) *Instructional Methods Studies* employing an *Experimental Instructional Laboratory* to demonstrate how educational interventions may be accurately assessed.

Each of these studies depends on an integrated KM system to collect and evaluate relevant data.

The design and implementation of an on-going, semi-automatic system using information technology and statistical analysis which can be integrated with Accreditation Board for Engineering and Technology (ABET)-mandated assessment and evaluation procedures will allow an academic unit to conduct regular and timely surveillance, assessment and improvement of any engineering education program in any college or university. Too often, innovative designs for educational enhancement fall into disrepair because those designs embody the unintended consequences of built-in obsolescence. Many designs have failed due to their static view of learning and teaching styles, their personnel-dependence, their inability to manage changes in program size, and/or the lack of portability and adoption by the larger educational community. Our design aims to avoid these specific pitfalls in our process design by: (1) employing a dynamic view of learning and teaching styles via periodic measurements of student and faculty characteristics to establish an assessment process calibration and (2) using automated but customizable KM systems to process voluminous data collection and analysis in an efficient and flexible manner.

II. EXPECTED OUTCOMES AND EVALUATION PLAN

The primary outcome of this project will be a scalable and transferrable KM system created using the latest information systems and technology capable of collecting, maintaining, and analyzing student, instructor, course and curricular characteristics. This information will be used to evaluate the

effect of these parameters on student performance. The outcome of this analysis will be a methodology for evaluating and assessing educational approaches and innovations applicable to any engineering program. When populated with characteristic data specific to their student population, any program will be able to perform this analysis using our methodology.

Independent variables include student and faculty characteristics that may affect learning outcomes. We will use several well-established and some newly researched instruments to identify the key characteristics that may correlate best with student learning. The current battery of tests for students includes the Index of Learning Styles [1], Myers-Briggs Personality Inventory [2], Student Developmental Task and Lifestyle Inventory [3], a Multiple Intelligence Inventory, a new motivational assessment [4] and a workload and scheduling assessment developed in house. Instructors complete the Myers-Briggs, Multiple Intelligence, motivational assessment as well as teaching styles and teaching goals inventories.

In order to gain quantitative information on the value of educational interventions in engineering education, we are conducting a pilot Experimental Instructional Laboratory where the efficacy of the level of guidance offered to students will be evaluated and compared. This laboratory is a modular transferrable and customizable lab that can be implemented at various educational levels and offers a platform for testing new innovations in educational pedagogy.

To assess the affects of chronobiological factors on student performance we will collect data on students' sleep and workload schedules in anticipation that this aspect of student lifestyles will have a significant impact on student performance. This could serve as the basis for methods to create a more effective learning environment in higher education.

The main dependent variables are an educational program's performance criteria. Performance criteria relate to student learning outcomes that support the program's objectives. Student learning outcomes are attributes and levels of knowledge and skills demonstrable by students upon graduation while program objectives are characteristics or attributes displayed by graduates of the program three and five years post-graduation. Each learning outcome is subdivided into a number of performance criteria. Each performance criterion is associated with a number of measurable achievement levels. The achievement levels, called *rubrics*, are used to assess the level of learning achieved by each student on each performance criterion.

For evaluation of the KM system, the central metric will be the implementation of a semi-automated IT-based system capable of recording, storing and analyzing data on student and instructor characteristics in relation to student achievement on performance criteria. The system will have to be used to improve student achievement in order to be considered successful.

Finally, a demonstration that an innovative teaching approach can be tested and validated for use in a curriculum

would be an evaluation metric for the development of the educational laboratory component.

III. IMPORTANCE TO THE EDUCATIONAL COMMUNITY

We hope to create a systematic approach and KM system which will allow any program to be able to measure the landscape of student and instructional characteristics and relate those characteristics to curricular outcomes in a manner which supports effective intervention and improvement. When using such a system, it becomes possible (and traceable) to adjust instructional approaches to current student abilities, attitudes and learning approaches. This provides a knowledge base and support system that allows instructors to regularly adjust their instructional delivery systems to current students and test the efficacy of various approaches. More importantly, assuming adoption of this system across many schools and educational environments, cross-fertilization of ideas and implementation of "best practices" becomes possible by comparing data among different student populations or engineering disciplines.

One significant aspect of the present study is that the dependent variables – student achievement on performance criteria – are not solely linked to a course or course sequence but are overall curricular or program outcomes. This allows the data to be used for coordinated curricular enhancement and not just the improvement of a single course or course sequence.

IV. PROJECT STATUS/PRELIMINARY RESULTS

The project began on January 1, 2009. A preliminary semi-automated data collection system called AEFIS (*Academic Evaluation, Feedback and Intervention System*) has already been implemented and successfully tested for standard data collection (student course evaluations, faculty course evaluations, senior exit interviews, etc.). The current version includes survey creation and implementation tools and a curriculum mapping tool which enables the user to assign performance criteria to various educational experiences, pivot the data to provide alternate views and assign assessment tools from an evaluation toolbox. Multiple queries for advanced analysis are currently being implemented.

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