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Towards A Model for Evaluating Student Learning via eAssessment

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ABSTRACT

The need for practical tools to assess student learning at the course level is becoming a more pressing goal for all academic institutions. This is because learning assessment tools which monitor both student performance and conceptual change events that lead to improved learning ultimately provide the basis for the subsequent assessments of programs and institutions. In performing effectively in this capacity, a viable and efficient assessment tool at the course level possesses the following characteristics; 1) the ability to be integrated effectively within the existing course structure, 2) the ability to generate quantitative, measurable results, and 3) the ability to provide timely feedback. This paper proposes a model for assessing student learning at the course level which utilizes, in part, online assessment methods (eAssessments) to achieve these characteristics. More specifically, the model provides a description of how assessment may be embedded into an existing course and illustrates the utilization of online pre/post-tests and knowledge surveys as a source of assessment data. The data analysis, based in part upon Bloom's revised taxonomy, is then discussed together with how the results are used to determine the level of learning achieved. The paper concludes with a proposal for an experiment wherein the model is tested to determine its ability to detect changes in student learning originating from the implementation of a pedagogical strategy such as online tutoring.

INTRODUCTION

The purpose of assessment is to "engage a campus community collectively in a systematic and continuing process to create shared learning goals and to enhance learning" (Student Learning, 2007). In an era of increased public support for education being subjective to increased student outcomes, the need to define and measure learning has increased as well. In particular, the United States government mandated-program "No Child Left Behind" (No child, 2001) serves as an excellent example of this trend. The use of technology to deliver and analyze assessments in an effective and efficient manner has been the focus of current research. More specifically, one of the authors of this paper has looked extensively at the use of e-assessment and the learning process (Whitelock, 2007). Furthermore, the Joint Information Systems Committee (e-Assessment Introduction, 2008) in the United Kingdom has supported the innovative use of e-Assessment which they define as "the end-to-end electronic assessment processes where ICT is used for the presentation of assessment and the recording of responses". Regardless of how the assessment is performed, any e-Assessment tool must possess the following characteristics; 1) the ability to be integrated effectively within the existing course structure, 2) the ability to generate quantitative, measurable results, and 3) the ability to provide timely feedback. In view of both the need and content of assessment tools, a model for evaluating student learning

through e-assessments is developed and presented.

A MODEL FOR EVALUATING STUDENT LEARNING VIA eASSESSMENT

Before a model to assess student learning is presented, what is meant by learning must be defined. In addition, learning as thus defined must possess the two important characteristics; 1) The definition must be based upon and consistent with accepted concepts and 2) the learning as defined must be quantifiable (i.e., measurable).

A definition of learning having those characteristics may be constructed from the revised Bloom's taxonomy illustrated graphically in Figure 1. In this new view, the relationship among cognitive processes (remembering, understanding, applying, analyzing, evaluating, and creating) and knowledge outcomes (factual, conceptual, procedural, and metacognitive knowledge) is set forth and further described in Table 1 (Pickard, 2007). In particular, higher levels of knowledge are acquired as a result of a student mastering successive cognitive processes. Pervading this learning sequence is the metacognitive knowledge possessed by the student.
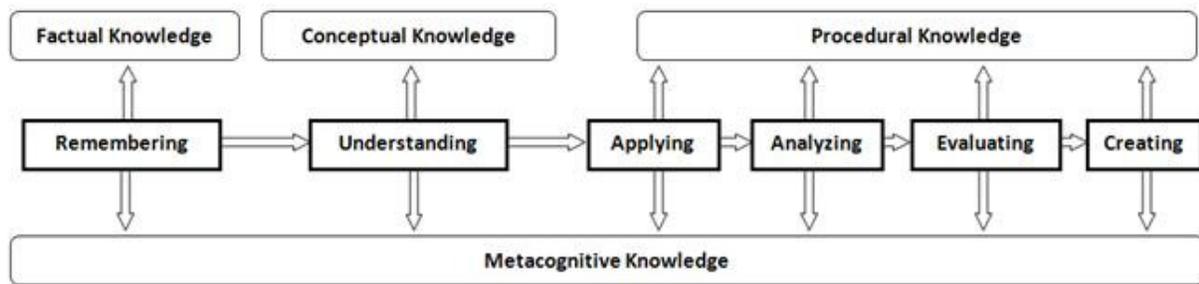

Figure 1. Bloom's Revised Taxonomy

Factual Knowledge	The basic elements students must know to be acquainted with a discipline or solve problems in it
Conceptual Knowledge	The interrelationships among basic elements within a larger structure that enable them to function together
Procedural Knowledge	How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods
Metacognitive Knowledge	Awareness of cognition in general as well as awareness of one's own cognition

Table 1. Knowledge outcomes

From this taxonomy the following definitions of knowledge and knowledge level are inferred -

Knowledge is the acquisition, comprehension, or manipulation of information and the awareness of the cognitive processes used and

Knowledge level is the measure of the degree to which knowledge has been achieved,

From these learning is then defined as follows -

Learning represents a change in knowledge level toward higher order skills.

Having thus defined learning, its quantification is addressed. Inasmuch as the knowledge level comprises factual, conceptual, or procedural knowledge and metacognitive knowledge, its measurement is accomplished by first determining the performance level (PL) achieved by a student in obtaining a specific knowledge (factual, conceptual, or procedural) outcome. This performance level is then compared to the awareness of the student's cognitive knowledge though the measurement of the confidence level (CL) in that achievement. The relationship between these two levels is illustrated in PL/CL diagram shown in Figure 2. (Here, the minimum acceptable performance level of 0.70 and confidence level of 2.0 are arbitrarily set).
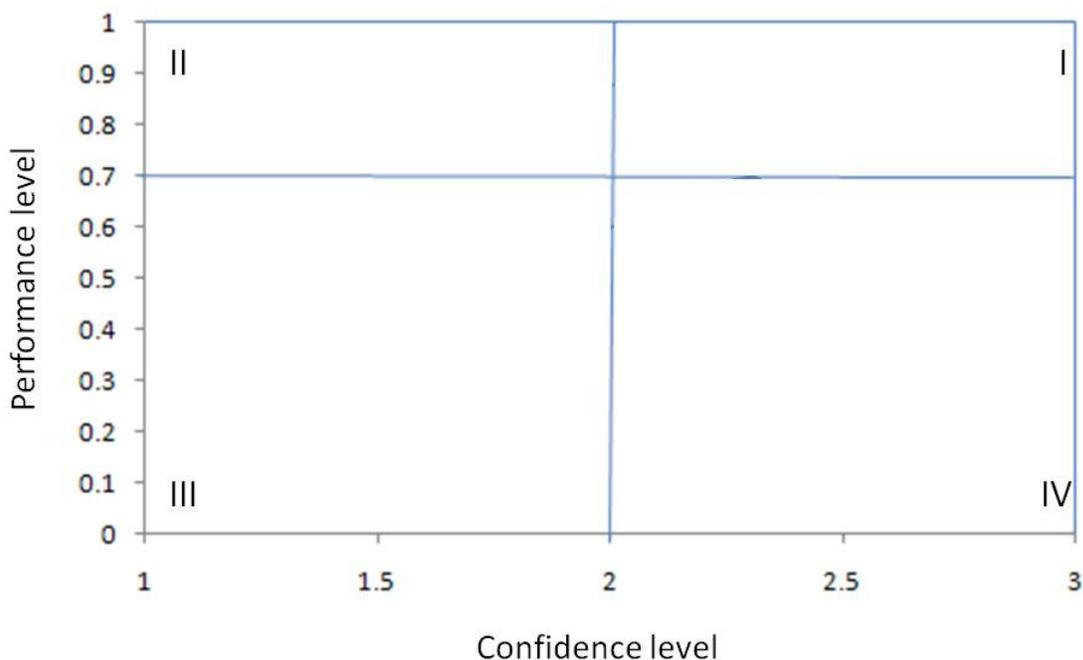

Figure 2. Confidence/Performance Level diagram

More specifically, the potential progress of a student's knowledge level toward higher order skills may be tracked, with the goal of instruction to move the student's knowledge level as far as possible to the upper right-hand corner of quadrant I. The characteristics of the knowledge level corresponding to each quadrant are shown in Table 2.

Quadrant **I**	The student demonstrates an acceptable level of achievement for the knowledge outcome assessed and possesses the associated metacognitive knowledge skills.
Quadrant **II**	The student demonstrates an acceptable level of achievement for the knowledge outcome assessed, possesses acceptable strategic or conditional knowledge skills, but lacks confidence in those skills.
Quadrant **III**	The student demonstrates an unacceptable level of achievement for the knowledge outcome assessed and while indicating confidence in the metacognitive knowledge skills possesses unacceptable strategic and/or conditional knowledge.
Quadrant **IV**	The student demonstrates an unacceptable level of achievement for the knowledge outcome assessed and possesses unacceptable strategic and conditional knowledge skills.

Table 2. Knowledge level quadrants of CL/PL diagram

IMPLEMENTING THE MODEL – AN EXAMPLE

An example of how the model may be implemented is illustrated for a calculus-based physics course for a unit covering Coulomb's Law. In this application, the level of learning as regards factual and conceptual knowledge is addressed by the use of an online survey of knowledge levels both before and after the material is covered in class (Figure 3). As seen in the figure, the student is asked to indicate the confidence level in cognitive processes corresponding to the six processes of Bloom's revised taxonomy. These items are then followed by a series of questions that address the performance levels of factual and conceptual knowledge.

Figure 3. Screen shot of online e-Assessment survey

The performance and confidence levels are then determined and recorded on the PL/CL diagram (Figure 4) and interpreted.
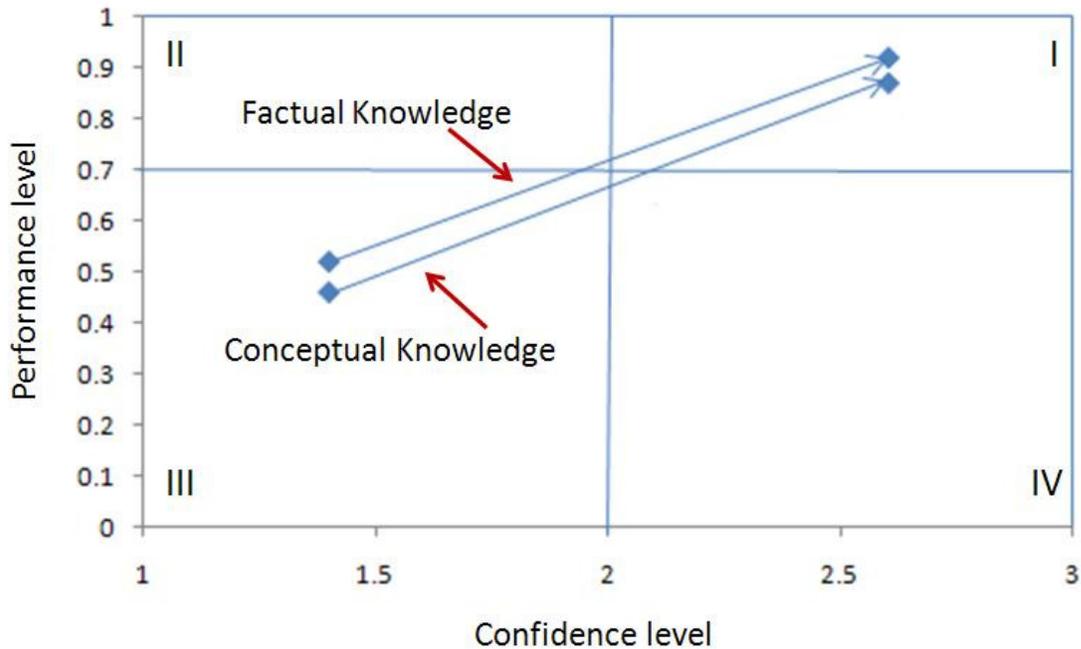
Figure 4. PL/CL diagram showing knowledge level changes

As indicated in Figure 4, the overall factual and conceptual knowledge level of students increased, moving from quadrant III to quadrant I. Hence, as previously defined, learning has occurred in these two knowledge areas. Furthermore, the progress of individual students may be tracked on the PL/CL diagram and activities for improving learning prescribed (Table 3).

Quadrant	Improvement Activities
I	Further refinement of existing skills
II	Peer tutoring of other students to increase confidence and improve other skills
III	Refocus on strategic and conditional skills
IV	Re-evaluation of entry level skills, strengthen pre-requisites

Table 3. Improvement activities

As implemented here, the model has achieved the previously stated characteristics required of an effective eAssessment tool by being integrable within the existing course structure, generating quantitative, measurable results, and providing timely feedback.

FUTURE WORK

A further test of the model as described here is planned by the authors wherein the effect of online peer tutoring is investigated as a pedagogical strategy to raise student knowledge levels. As part of this research, the scope of the model will be extended into developing and measuring the higher order thinking skills required for the acquisition of conceptual and procedural knowledge.

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