DEVELOPING ASSESSMENT ITEMS USING WEBCT

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Introduction

In the field of mathematics education, concerns about curricula, instructional practices, and levels of student achievement led to the publication of standards for curriculum and evaluation, teaching, and assessment by the NCTM (1989,1991,1995,2000). This effort has extended to the colleges and universities. At the center of the reform movement are the standards of content, pedagogy, and assessment. This new system includes increased emphasis on the importance of student assessment and an interest in integrating processes of teaching, learning, and assessment. The push for the standards and for tests aligned with those standards has placed assessment in a prominent position in the instructional process.

Assessment

The development of a WebCT based Precalculus course by the authors gave an important place to assessment of students learning and understanding. The goal is to move towards a greater conceptual understanding. Guiding assumptions for these changes contrast "instruction focused on learning to name concepts and follow specific procedures" with higher order thinking which is non-algorithmic and complex.

Traditional assessment items emphasized computing a numerical result, or simplifying an algebraic expression. Often the alternatives in multiple choice and matching questions were simply numbers or algebraic expressions reflecting this emphasis. To move beyond the previous emphasis on computation, questions were designed in these formats with varied lists of alternatives. Which consist of parts of various diagrams or graphs, parts of a proof, and justifications of steps of a proof.

Blooms Taxonomy – a framework for developing online assessment items

Bloom's taxonomy was used as a framework for developing online assessment questions and assessing students' understanding. The framework consists of six categories and is based on the notion of hierarchy of thought processes. The levels are: Memorization, Comprehension, Application, Analysis, Synthesis, and Evaluation. The assessment plan includes the development of multiple choice, matching, short answer, and essay types of questions and is based on utilizing the WebCT program.

Course Content

The content standards developed and used as a guideline in the teaching of a standard precalculus course are organized into eight groups: (**CS1**) Quantitative Reasoning; (**CS2**) Abstract and Algebraic Functions; (**CS3**) Defining the Trigonometric Functions; (**CS4**) Use of the Trigonometric Functions; (**CS5**) Mathematical Proofs; (**CS6**) Analytic Geometry; (**CS7**) Vectors; (**CS8**) Applications. These standards move beyond simple computations to understanding and relating concepts.

Question Type

We want to emphasize that our goal is to use each type of question to assess the higher level of thinking.

Multiple-choice questions. This type takes the form of a short question or implied question followed by four/five optional answers. This type of questions is used for the following types of tasks: Calculation, Graphical representation, Algebraic manipulation and Mathematical modeling.

Matching questions. This type is used in matching unknowns to items from the list of answers, in matching the answers to unknowns, and in matching the steps constituting a proof of a trigonometric identity to their correct order.

Short answer. This type is used the least and is mainly for short and simple tasks.

Essay questions. This item fosters interactivity and develops observational and writing skills.

Description/Examples of the Question Design

Selecting a Question and Choosing a Format: Before opening WebCT to enter question elements, one needs to decide on the question content, relation to the course, and format. This process is illustrated for the topics of graphs of functions of the form $y = k + A \sin(Bx + C)$ and $y = k + A \cos(Bx + C)$ as found in a typical precalculus course. Most precalculus texts would cover these topics in a section where the terms *amplitude*, *period*, and *phase shift* are defined and illustrated. These concepts are related to features of graphs, and basic formulae are displayed in colorful displays:

$$Amplitude = |A| \qquad Period = \frac{2\pi}{B} \qquad Phase\ Shift = \frac{-C}{B}$$

At the end of this section one finds a host of exercises in one of two forms:

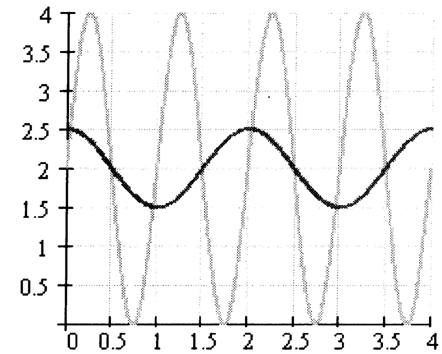
- *State the amplitude, period, and phase shift of each function and graph it over the given interval.*
- *Find an equation of the form $y = k + A \sin(Bx + C)$ or $y = k + A \cos(Bx + C)$ for each of the given graphs.*

After these questions there are usually additional exercises, involving variations and applications. When constructing test questions on this topic many instructors will use one of the above forms since they model their questions after low numbered exercises found at the end of the section. Questions presented in the first form can be answered by memorizing the basic formulae and by using a graphing calculator. As a result they do not necessarily involve a great deal of reasoning. However, the second form presents more interesting possibilities.

After deciding on the general line of inquiry, the next step could be considering the relation of the topic to the goals of the course. Content standards to which the topic is related cover the use of the Trigonometric functions and Quantitative Reasoning.

Deviating from the question form found in a typical text can encourage a greater use of quantitative reasoning. Instead of immediate recognition of a question form, students need to stop and think about the question. Too often students look for a trigger phrase and proceed without even reading the entire question. Students should be encouraged to compare a problem situation to other problem situations they are familiar with, and decide which techniques are helpful and which are unnecessary. According to Schoenfeld (MAA's Source Book for College Mathematics Teaching, 1990) "*Mathematics instruction should ...develop students' ability to explore problem situations in a range of settings, at several levels of difficulty, and with a variety of methods.*" Varying question forms is an important step in this direction.

Consider the following *short-answer* question:



> *The figure shows the graphs of the functions $y = A \sin(cx) + 2$ and $y = B \cos(cx) + 2$ for certain values of the constants A, c, B, and d. What is the value of A? Write your answer as a decimal showing the digits in the units and tenths positions (such as 5.0 or –2.6).* Answer:

We have varied the typical form of this question by applying a vertical shift to the functions, and by including two graphs instead of one. Students must now distinguish between the median line of the waves and the x-axis, and between sine and cosine curves. The solution process now has more steps, and involves a greater range of mental activities.

The format of this question is easily changed to *multiple-choice*. This format eliminates the problem of students entering their answer in an expected form. The following is a variation of the multiple-choice question where there is more than one correct answer.

> *The figure shows the graph of the functions $y = A \sin(cx) + 2$ and $y = B \cos(cx) + 2$ for certain values of the constants A, c, B, and d. What are the amplitudes of these functions? Mark all possible correct answers.*
>
> □ *(i). –4.0* □ *(ii). 0.5* □ *(iii). 1.0* □ *(iv). 1.5* □ *(v). 2.0* □ *(vi) 4. 0*

There is a great deal of information in the above figure. The short answer and multiple-choice formats use only a small part of it. By changing to a *matching* format more of this information can be incorporated into the question. In the following variation of the matching format there are extra values in one of the lists.

> *The figure shows the graph of the functions $y = A \sin(cx) + 2$ and $y = B \cos(cx) + 2$ for certain values of the constants A, c, B, and d. Match these constants to their correct values.* *1. A* □ *2. c* □ *3. B* □ *4. d* □
>
> *(i) -1.0* *(ii) 0.5* *(iii) 1.0* *(iv) 1.5* *(v) $\pi/2$*
> *(vi) 2.0* *(vii) π* *(viii) 4.0* *(ix) 2π*

We can require that students reflect on their problem solving process by using an *essay* format for the question. Below we illustrate this type of question and give detailed explanation about creating it in WebCT.

Essay Type of Questions: This type of question will be illustrated from three different views: (i) from the view of a designer; (ii) from the view of a student; and (iii) from the view of an instructor. Additionally, we will relate the task posed in this quiz item to the cognitive level in Blooms taxonomy as well to the content standards for the course.

(i) **Designer's view:** Figure 1 illustrates what the quiz editor looks like when a designer creates an essay type of question.

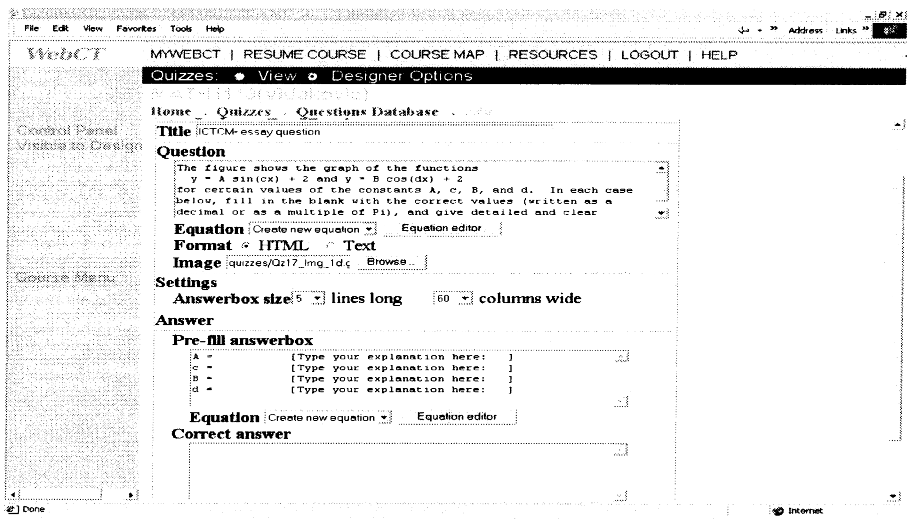


Figure 1: Essay question – designer view

For this particular quiz item the designer needed to create the graph (image) of the figure used in the task in some other application, save it either as a gif or jpg type of file and upload it in the "Image" box. The question and the answer did not require any html codes, but the equation editor could be used in typing the symbols. The instructor has an option of typing the correct answers in the "Correct answer" box and the students will be able to see them after submitting their response.

(ii) **Student's view.** Figure 2 illustrates what the question looks like when the student accesses the quiz.

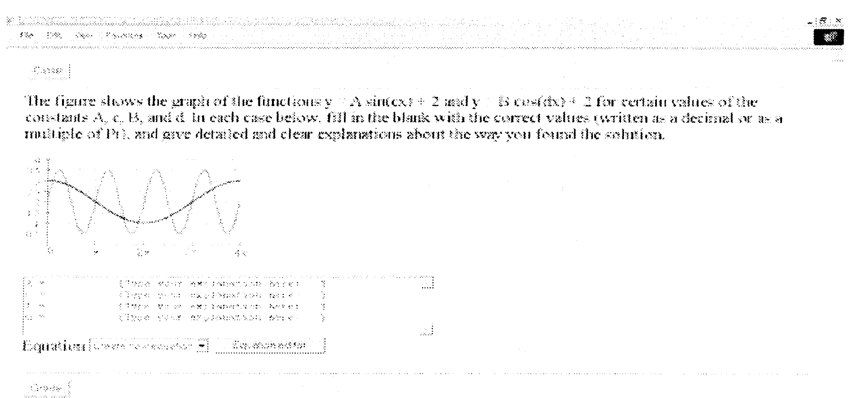


Figure 2: Essay question – student view

The student also has an option of using the equation editor when typing their answers.

(iii) **Instructor's view.** The essay type of question is not graded automatically. In order to grade them, the instructor needs to access each response individually, read it and evaluate it manually. Note that besides the grade the instructor has a choice of adding some written feedback to the student. (During the presentation, several students' responses will be illustrated).

Relationship to Blooms Taxonomy: This particular task includes Memorization (student needs to know the relevance of each constant to the graph of the given function – amplitude, period, shifts, etc.), Application (students have not seen previously the task formulated in this way), and Analysis (student needs to analyze the graphs, coordinated them with given equations, and relate the constants to the given information).

Relationship to Content Standards: This task definitely contributes towards the development of student mathematical literacy. Being required to explain and write clearly how they obtained their answer requires them to reflect, connect, and express their thoughts in a written form. The task requires students to analyze the graphs of functions and their properties and to relate them to their algebraic expressions. From the literature, it is known that this is a difficult task for students as many of them are unable to inquire information about the function from its graphical representation and to relate it to its algebraic forms. It is worth to notice that this is task is very different from the task of graphing a function whose algebraic equation is given.

Conclusion

WebCT provides an excellent environment for the development and delivery of effective assessment tools. During preparation consider variations of question forms and formats, alignment with content standards, and analysis of cognitive tasks. When properly implemented WebCT quizzes can provide practice on different but related problems, and a daily emphasis on reasoning tasks and problem solving.

References

Schoenfeld, A. (1990). MAA's Source Book for College Mathematics Teaching.

National Council of Teachers of Mathematics. Commission on Standards for School Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, Va.: The Council.

National Council of Teachers of Mathematics. Commission on Teaching Standards for School Mathematics. (1991). *Professional standards for teaching mathematics.* Reston, VA: The Council.

National Council of Teachers of Mathematics (NCTM). (1995). *Assessment standards for school mathematics.* Reston, VA: The Council.

National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics*. Reston,VA: The Council.