AC 2009-1052: JUST-IN-TIME TEACHING (JITT) IN CIVIL ENGINEERING TECHNOLOGY

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Just-in-Time Teaching (JITT) in Civil Engineering Technology

Abstract

Just-in-Time Teaching (JiTT) is a pedagogical system comprised of two elements: classroom activities that promote active learning and World Wide Web (WWW) resources that are used to enhance the classroom component. This teaching and learning strategy combines use of the WWW with a collaborative learning environment to improve student learning of and attitudes toward various content areas. It is a technique used to enhance the interactivity of a lecture period by creating a feedback loop between the instructor and the student. With this approach, after completing assigned readings, the students take online quizzes that summarize these readings. The lecture period is used to clarify misconceptions revealed in the students' responses to the online quizzes, as well as to present new material. As a result, classroom activities become more efficient and more closely tuned to the students' needs. The essential element is feedback between the web-based and classroom activities.

While JiTT system is commonly used in the physics educational community, there has been little evidence of its use in the engineering classroom. This paper describes the JiTT approach incorporated in Structural Analysis, a required junior-level course in the civil engineering technology curriculum at Georgia Southern University. Presented in paper are the concepts and plans for developing a set of asynchronous web modules that are designed to provide an effective way for a student to review, discover misconceptions, and augment understanding of structural analysis to a more realistic level. Each module will contain a set of learning outcomes related to a particular objective of the course. A set of problems will be provided that will direct the student to a particular section of a module if an error is detected. Several examples of such problems are included in the paper. The students may not be provided with a specific answer, but they must discover their problem from the material presented. It has been shown that the process of just-in-time self-discovery maximizes retention of information. The effectiveness of the modules will be assessed during fall of 2009, and the assessment data together with plans to improve and extend the future efforts in this area will be reported at a subsequent conference.

Introduction

Just-in-Time Teaching (JiTT) is a pedagogical system comprised of two elements: classroom activities that promote active learning and World Wide Web (WWW) resources that are used to enhance the classroom component. This teaching and learning strategy combines use of the WWW with a collaborative learning environment to improve student learning of and attitudes toward various content areas.

The JiTT system is based on web-based preparatory assignments (typically quizzes) that are due a few hours before class. The students complete these assignments at their own pace, and submit them electronically.

In the period between the submission deadline and the class period, faculty adjusts and organizes the classroom lesson in response to the students' submission of "Just-in-time" online quizzes. Thus a feedback loop between the classroom and the Web is established. These online quizzes serve as "warm-up" exercises which encourage students to keep up in the textbook, and are designed to challenge students' preconceptions about the topic. The feedback cycle occurs at least twice each week, encouraging students to stay current.

During the lecture, the instructor uses relevant excerpts from the online quizzes, weaving them into the presentations as appropriate. Instead of passively listening to a lecture, students participate in a guided discussion that begins with their own preliminary understanding of the material.

While JiTT system is commonly used in the physics educational community[1], there has been little evidence of its use in the engineering classroom[2-8] especially in the area of structural analysis. In this paper, a computer-aided tool developed by the author is presented, the objective being to help students identify their strengths and weaknesses in comprehending the basic concepts of structural analysis, and rectify their mistakes through online quizzes out of the classroom.

Several modules have been created for various key topics, and several more are under preparation. The development process and details of the modules are discussed next.

Modules Development Process

The topics covered with the modules are as listed below.

º Stability and determinacy of structures
º Support reactions of statically determinate structures (compound beams and frames)
º Shear and moment diagrams of compound beams and frames under different transverse loadings
º Deflection of statically determinate beams by Conjugate Beam method
º Deflection of statically determinate beams and frames by Virtual Work method
º Moving loads and influence lines for beams and trusses for
 - Support reactions
 -Shear at a point' panel shear
 - Moment at a point
 - Maximum shear at a given location
 - Maximum moment at a given location
 - Absolute maximum shear in a girder
 - Absolute maximum moment in a girder
º Approximate methods of analysis for statically indeterminate structures:
 - Portal method
 - Cantilever method
º Slope deflection method of analysis for statically indeterminate structures:
 - Continuous beams

- Frames without side sway
- Frames with side sway

º Matrix method of structural analysis

Each topic is covered with one module, and each module contains several exercises. The software used to develop these modules is called *Respondus.* It is a Windows-based authoring tool that makes it easy to create and manage exams for Blackboard, WebCT, ANGEL, eCollege and other learning systems. *Respondus* is a powerful application for creating and managing exams that can be printed to paper or published directly to WebCT Vista used at this institution.

Each module supplies a diagnostic correction mechanism that identifies common student errors and provide specific feedback based on the type of mistake encountered. The examples in each module attempt to improve comprehension of a concept by leading students through a series of questions demonstrating how complex solutions are created by integrating individual small steps. In examples at the beginning, students are asked very basic questions about the material. Students then fill in blanks on the web page, select from multiple answers, or seek more in-depth help on the matter. When students answer a question, they are given instant feedback. Wrong answers lead to feedback on how the correct solution can be reached while correct answers allow students to move on to the next series of questions. The degree of difficulty increases with subsequent examples and asks students to do more steps simultaneously in order to fill in more than one blank or make more than one choice. The organization forces students to actively process the information in the example instead of just skipping ahead regardless of their consequences

In developing each online quiz, first multiple scenarios are considered; and then for each of these possible situations as many exercises are prepared as warranted by the topic addressed. Two examples are presented in this paper (see Appendix). One exercise is presented in Example 1 pertaining to the topic of stability and determinacy of a truss shown in Figure 1. The feedback information is also included in each exercise. This exercise is for the students to recognize the fundamental differences between a stable structure and an unstable structure, and also between a statically determinate structure and a statically indeterminate structure. The second difference leads to the recognition of a situation where Statics alone is not adequate for solution of the problem. Example 2 is on effects of moving loads on a beam. The concept of influence lines lies at the core of this exercise.

The author plans to develop a total of about 35 exercises covering the above topics. Thus far 10 such exercises have been completed; the remainder is expected to be done within six months.. Each exercise takes anywhere from 60 to 90 minutes from formulating the problem to actually publishing it online. The only investment in this project is the faculty time, as there is no other cost involved. The author plans to publish an updated paper (including assessment results) within a year upon completion of development of all the modules.

Student Usage

It is the intent of the author to incorporate this teaching tool in the junior-level Structural Analysis class starting fall 2009 semester. Students will have online access to these modules, and will use them as necessary.

Assessment

The author plans to assess the effects of Just-in-Time teaching on student attitudes and cognitive gains, using a range of instruments including surveys, classroom observations, and pre/post tests. The online (warm-up) quiz scores will be considered as Pre-test scores. After each topic is covered in the class in details, the students take another quiz in class, and those scores will be considered as Post-test scores. A comparison of the two sets of scores will testify to the efficacy of the online quizzes. A weighted average of the Pre-test and Post-test scores will account for 10-15% of the course grade. The modules will remain available to the students throughout the semester for them to use, if need be.

Summary

This paper is a status report on the work done by the author in application of the Just-in-Time Teaching phenomenon to Civil Engineering Technology discipline. Though not complete yet, the information presented herein would likely be beneficial to those in the academic community who have an interest in implementing this pedagogical system. Several interactive online quizzes on certain topics of Structural Analysis course have been created to facilitate student learning. Many more modules covering various other topics of the course are planned to be developed. These quizzes (also called warm-up exercises) have been created to promote an interactive student centered environment in the classroom, and also to help instructors fine tune their courses to match students' needs. *Respondus,* a Windows-based powerful authoring tool that makes it easy to create and manage exams for WebCT Vista has been used to create the modules. It is planned to use the tool in fall 2009, and report the results of its usage subsequently by which time further enhancement of the tool is likely.

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Appendix

Example 1

A simply-supported truss is shown in Figure 1. All joints are pinned. The truss is

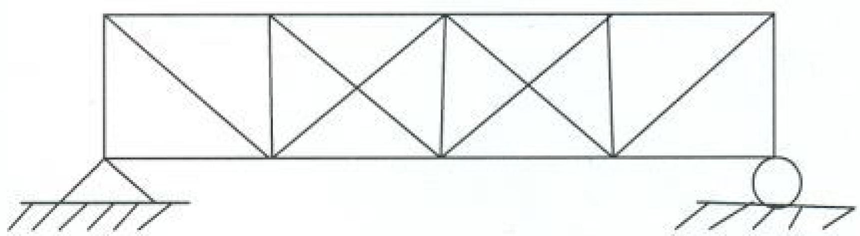

Figure 1

- a. Unstable.
- b. Stable and determinate.
- c. Stable and statically indeterminate to 1st degree.
- d. Stable and statically indeterminate to 2nd degree.
- e. Stable and statically indeterminate to 3rd degree.

Feedback

0.0% a. No. For the truss to be stable externally, it must be fully constrained by a minimum of three non-parallel, non-concurrent reaction components; and the truss has three such support reactions (two at pinned support and one at roller support), hence it is stable externally. port and one at roller support), hence it is externally stable. It is also stable internally, because the truss configuration consists of triangles only. From another viewpoint, the total number of unknowns is 22 (19 member forces and 3 support reactions), whereas the number of equilibrium equations available is 20 (= 2x number of joints of 10 = 20). The truss would be unstable if the number of unknowns is less than the number of equilibrium equations available, which is not the case here.

0.0% b. No. For the truss to be stable externally, it must be fully constrained by a minimum of three non-parallel, non-concurrent reaction components; and the truss has three such support reactions (two at pinned support and one at roller support), hence it is stable externally. port and one at roller support), hence it is externally stable. It is also stable internally, because the truss configuration consists of triangles only. The total number of unknowns is 22 (19 member forces and 3 support reactions), whereas the number of equilibrium equations available is 20 (= 2x number of joints of 10 = 20). The truss would be determinate if the number of unknowns equals the number of equilibrium equations available, which is not the case here.

0.0% c. No. For the truss to be stable externally, it must be fully constrained by a minimum of three non-parallel, non-concurrent reaction components; and the truss has three such support reactions (two at pinned support and one at roller support), hence it is stable externally. It is also stable internally, because the truss configuration consists of triangles only. The total number of unknowns is 22 (19 member forces and 3 support reactions), whereas the number of equilibrium equations available is 20 (= 2x number of joints of 10 = 20). The truss would be statically indeterminate to 1st degree, if the number of unknowns exceeded the number of equilibrium equations available by one, which is not the case here.

100.0% d. Yes. For the truss to be stable externally, it must be fully constrained by a minimum of three non-parallel, non-concurrent reaction components; and the truss has three such support reactions (two at pinned support and one at roller support), hence it is stable externally. It is also stable internally, because the truss configuration consists of triangles only. The total number of unknowns is 22 (19 member forces and 3 support reactions), whereas the number of equilibrium equations available is 20 (= 2x number of joints of 10 = 20). The truss would be statically indeterminate to 2nd degree, if the number of unknowns exceeded the number of equilibrium equations available by two, which is the case here.

0.0% e. No. For the truss to be stable externally, it must be fully constrained by a minimum of three non-parallel, non-concurrent reaction components; and the truss has three such support reactions (two at pinned support and one at roller support), hence it is stable externally. It is also stable internally, because the truss configuration consists of triangles only. The total number of unknowns is 22 (19 member forces and 3 support reactions), whereas the number of equilibrium equations available is 20 (= 2x number of joints of 10 = 20). The truss would be statically indeterminate to 3rd degree, if the number of unknowns exceeded the number of equilibrium equations available by three, which is not the case here.

Example 2

A simply supported beam of 20 ft span has to carry a series of moving loads as shown in Figure 2.

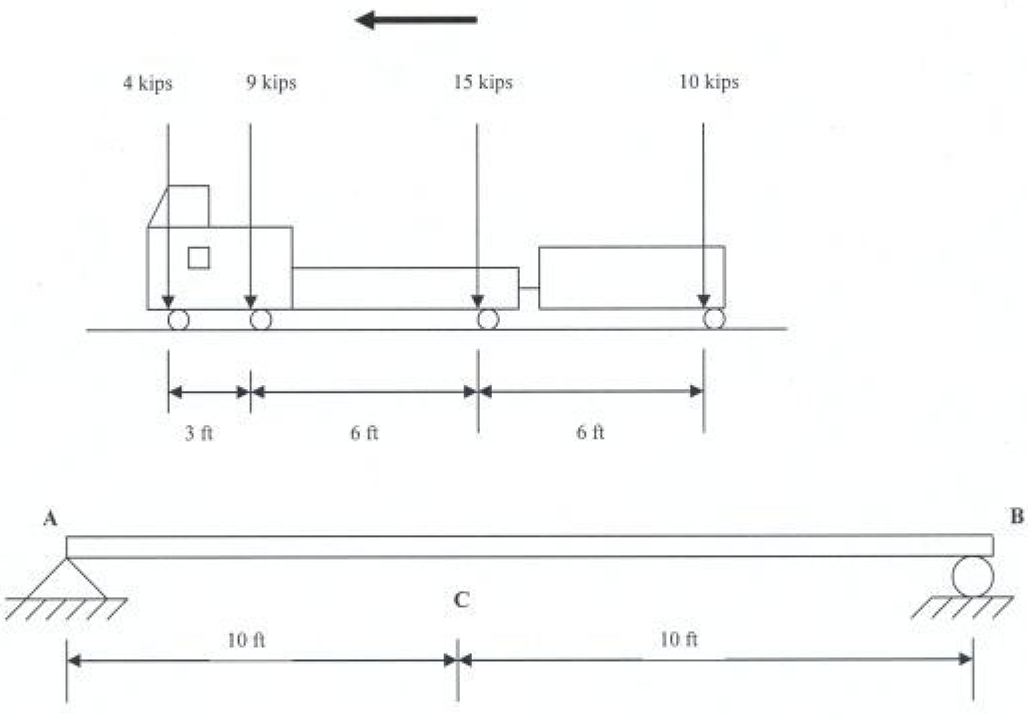

Figure 2

The maximum moment at C occurs when

- a. None of the four loads is at C.
- b. The 4-kip load is at C.
- c. The 9-kip load is at C.
- d. The 15-kip load is at C.
- e. The 10-kip load is at C.

Feedback

0.0% a. No. The maximum moment at C occurs when one of the loads is at C.

0.0% b. No. The maximum moment occurs when the largest load of 15 kips acts at C, because the sum of the products of moment influence coefficients and corresponding load magnitudes attain the maximum value for this position of the loads.

0.0% c. No. The maximum moment occurs when the largest load of 15 kips acts at C, because the sum of the products of moment influence coefficients and corresponding load magnitudes attain the maximum value for this position of the loads.

100.0% d. Yes. The maximum moment occurs when the largest load of 15 kips acts at C, because the sum of the products of moment influence coefficients and corresponding load magnitudes attain the maximum value for this position of the loads.

0.0% e. No. The maximum moment occurs when the largest load of 15 kips acts at C, because the sum of the products of moment influence coefficients and corresponding load magnitudes attain the maximum value for this position of the loads.