2006-1353: JITT IN AN ENGINEERING TECHNOLOGY CLASS

Nancy Denton, Purdue University
> NANCY L. DENTON, P.E. CVS 3 Nancy L. Denton is a Professor of Mechanical Engineering Technology at Purdue University and associate department head. She teaches courses in basic mechanics, controls, and machinery diagnostics. She has held a number of positions within ASEE. She is also active in the Vibration Institute, serving on its certification examination committee and corresponding ISO standards group.

Heather Cooper, Purdue University
> HEATHER L. COOPER, P.E. Heather L. Cooper is an Assistant Professor of Mechanical Engineering Technology at Purdue University. She teaches courses in thermal science and machinery diagnostics, with applied research interests in alternative energy education. She has seven years of product engineering experience at General Motors Corporation, and is a member of ASEE, SAE, and ASME, now serving as the ECCD Program Chair.

JiTT in an Engineering Technology Class

Abstract

Just in Time Teaching (JiTT) is an instructional approach developed initially to engage nontraditional and non-major students in their introductory physics courses. Some level of control of the learning process shifts to the students. The approach promotes interaction between students and faculty, and facilitates a number of desirable learner traits. Typically, JiTT emphasizes preparation before class, communication skills, and conceptual understanding. Support for JiTT is widespread by instructors of concept-based courses in the sciences, and the literature indicates very positive student response. Adopters of JiTT within the engineering education community are very few, however, with no engineering technology instructors registered as JiTT practitioners as of June 2004[1,2].

The authors chose to implement JiTT practices in a heavily applications-oriented upper division elective mechanical engineering technology (MET) course, beginning in Fall 2005. Their JiTT implementation and subsequent assessment of student learning are detailed in this paper. Anticipated areas of improvement were student preparation for class, class participation, and number of students successfully meeting course learning objectives. Assessment and evaluation of the results of the JiTT implementation include ongoing tracking of student learning objective success rates, a survey of student views of JiTT, and faculty reflections.

Background

The recent rapid advances in web accessibility, coupled with the identification of active learning as a key to student understanding, provide the framework for a new instructional approach called Just in Time Teaching (JiTT). Beginning in the mid 1990's, physics educators were searching for a teaching technique to motivate and hold the interest of two disparate but equally challenging groups of introductory physics students; nontraditional part-time students in multi-hour evening class sessions at IUPUI's commuter campus and Air Force Academy cadets focused wholeheartedly on their future military careers. Their solution was to follow and adapt Toyota's Just in Time production model to the classroom, resulting in JiTT.[3] JiTT involves maintaining frequent student/faculty communication to deliver small amounts of material for nearly immediate use[4]. In the case of JiTT, the material being delivered is "packets" of course content, and the primary communication mechanism is electronic, typically based upon course management software such as WebCT[TM] or Blackboard[TM]. The fundamental premise of the JiTT approach to course delivery is that class instruction should be based on student need and involvement, with frequent student-instructor interaction. Through well-planned pre-class assignments, the instructor gauges student learning need and modifies each class appropriately to address student inputs and feedback.

From its introduction in physics, the JiTT approach has spread throughout many disciplines such as the sciences and liberal arts[2]. JiTT appears to be most commonly practiced in fields where conceptual understanding and/or formulation of viewpoint based upon that understanding form the core course objectives. Adoption in more application-focused engineering and technology

courses appears to be much more limited. Documentation of its application in engineering courses indicates that JiTT can be effective when students are expected to both learn concepts and put the concepts into practice[5]. Published literature did not reveal adoption of JiTT for any engineering technology courses before 2005, but its success in engineering courses led the authors to believe implementation of JiTT in a mechanical engineering technology (MET) course could benefit student learning.

At Purdue University, the upper division MET courses are typically applications-oriented. Students complete at least four MET elective courses, and all have an open-ended project requirement. The projects afford students multiple opportunities to become confident of their project management skills, integrate topics across course boundaries, work closely with departmental faculty, and demonstrate their mastery of course content. MET 317 Machine Diagnostics is a relatively popular elective course completed by approximately 50% of MET students, with 24-30 students enrolled per semester. The course includes fundamental vibration theory and applications in machinery diagnostics and maintenance practices. The class meets for two 50-minute lectures and one 110-minute laboratory session each week. Prerequisite knowledge includes dynamics, introductory physics, and calculus. Course details are posted, with full accessibility to all course components except grades and JiTT[6].

Motivation for JiTT

The authors regularly teach MET 317 Machine Diagnostics, and have identified several areas of concern through formal assessment of course learning, mentoring of student project teams, and personal observations. These concerns include minimal understanding of certain aspects of course content, varying levels of student participation in classroom activities, lack of preparation for class, and too many unexcused absences. JiTT was introduced into the course to directly address student understanding of content, involvement, and lack of preparation. The authors hoped JiTT would indirectly influence attendance by giving students a greater stake in course delivery.

Implementation of JiTT

In the Fall 2005 offering of MET 317, JiTT was introduced in the lecture portion of the course, in the first week of the semester, with the first assignment due date in the second week. The authors initially targeted one JiTT exercise per week, but eventually included JiTT assignments for 20 of the 24 class sessions throughout the semester where JiTT could have been used. (Sessions where JiTT was deemed not appropriate included those times when exams were given, guest speakers led the class, and when students presented their semester projects.) Each JiTT assignment was graded (5 points for a correct response, 4 points for an incorrect submission), and all the JiTT assignments together ultimately contributed about two percent of the final course grade.

Delivery of JiTT assignments was accomplished through WebCT Vista[TM]. Vista[TM] software affords instructors a number of secure electronic course management tools such as grade access for students, posting of assignments, and supervised chat room capabilities. Students were instructed to look for the posted assignment in Vista[TM] approximately 24 hours prior to the next

class time. The deadline for submission was one hour prior to the beginning of class. Students could submit their answers after the deadline up until the class start time to receive credit, but late submissions would not be used to shape the lecture content for that session.

Three types of assignments are defined for JiTT: (1) student assignments in preparation for the class session, (2) enrichment pages (short essays on applications of the class content), and (3) stand alone instructional material (e.g., simulations, spreadsheet exercises)[7]. For this course, assignments were all of the class preparation type and included short calculations, conceptual questions based on material already covered in class, questions designed to encourage reading ahead in the textbook, and applications-oriented web searches. A breakdown of the types of questions offered in Fall 2005 is shown in Figure 1 below. In some cases, it was difficult to distinguish between the conceptual understanding questions and those designed to encourage students to read ahead, so the best fit was used to categorize those with some overlap.
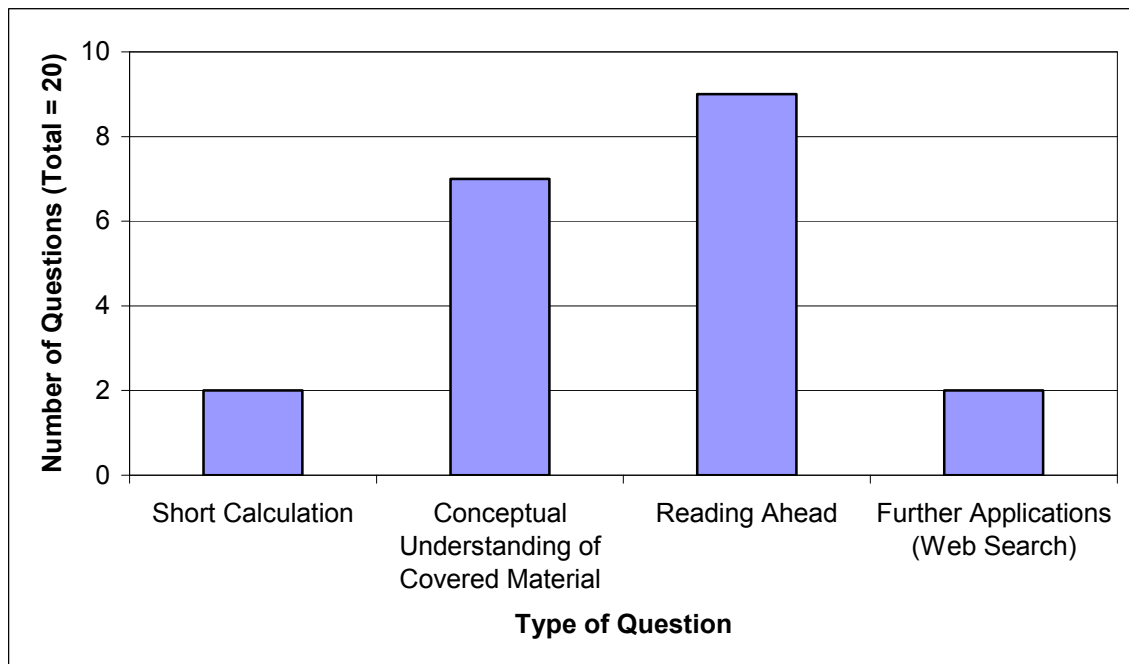

Figure 1. Fall 2005 Number of Questions by Question Type

A sample of a question that was aimed at assessing conceptual understanding of covered material is shown here for reference:

> *A pump's first natural frequency is at 17 Hz. An imbalance in the impeller causes forced vibration at a frequency of 25 Hz. The pump system has a damping factor of 1.0. Will the pump vibrate at:*
>   *(A) 17 Hz*
>   *(B) 25 Hz*
>   *(C) 17 Hz and 25 Hz*
>   *(D) It will not vibrate.*
> *Comment on how you made your decision.*

In class, the instructor asked the class to provide their answers, the instructor reviewed the correct answer, and discussed why the other answers were either incorrect or incomplete.

One of the most challenging aspects of implementing JiTT was consistent delivery of the JiTT assignments. For a typical JiTT assignment, the timeline was as follows:

8:00-9:30 AM	Day Prior	Instructor begins thinking about JiTT
9:30 AM – 3:30 PM	Day Prior	Instructor posts JiTT assignment
8:30 AM	Class Day	Student submission deadline for JiTT
8:30 – 9:15 AM	Class Day	Instructor reviews JiTT responses and modifies class content as needed
9:30 AM	Class Day	Class session begins

Posting an assignment as late as 3:30 PM on the day prior to class would not allow enough time for students to give the JiTT posting the attention it deserved. While this late posting time only occurred a few times, the inconsistency certainly contributed to the inconsistency of student participation (discussed later). Also, having the submission deadline only an hour before the class session did not give the instructors enough time to shape the day's class activities around the JiTT responses. On most days, the authors were only able to discuss student answers and briefly clarify the related material. Student interest in the instructors' comments and the related questions the students raised showed that JiTT contributed to more engaged students and improved class discussion.

Results

As shown in Figure 2, just over 50 percent of the 21 students enrolled in the course completed 90 percent or more of the JiTT assignments. Four of these eleven students completed all 20 JiTT assignments for 100 percent participation. A third of the students completed between 70 and 80 percent of the assignments. The remaining three students completed 60 percent or less of the JiTT questions. In general, participation was better during the weeks when email reminders were sent out to the students the day before a JiTT assignment was due.

Ideally, the authors would have liked to study the effects of JiTT on performance with respect to the established core learning objectives, measured in this course through scores on certain final exam questions. For the Fall 2005 semester, no obvious correlation existed between assessed exam performance and JiTT results; student performance improved on some core learning objectives and dropped on others, with no clear link to JiTT. A number of other changes in course delivery occurred in the same semester (new textbook, first team-taught offering, significantly revised lectures), so determination of any cause and effect relationship was not possible. Although correlation between JiTT results and performance cannot be made, it is interesting to note that overall course homework scores averaged 81.4 percent for those who showed 90 percent or greater participation in JiTT, and averaged 53.2 percent for all other students. It is believed this trend in homework scores is just another indication of class participation rather than any result of JiTT, though the instructors had no method for verifying this.
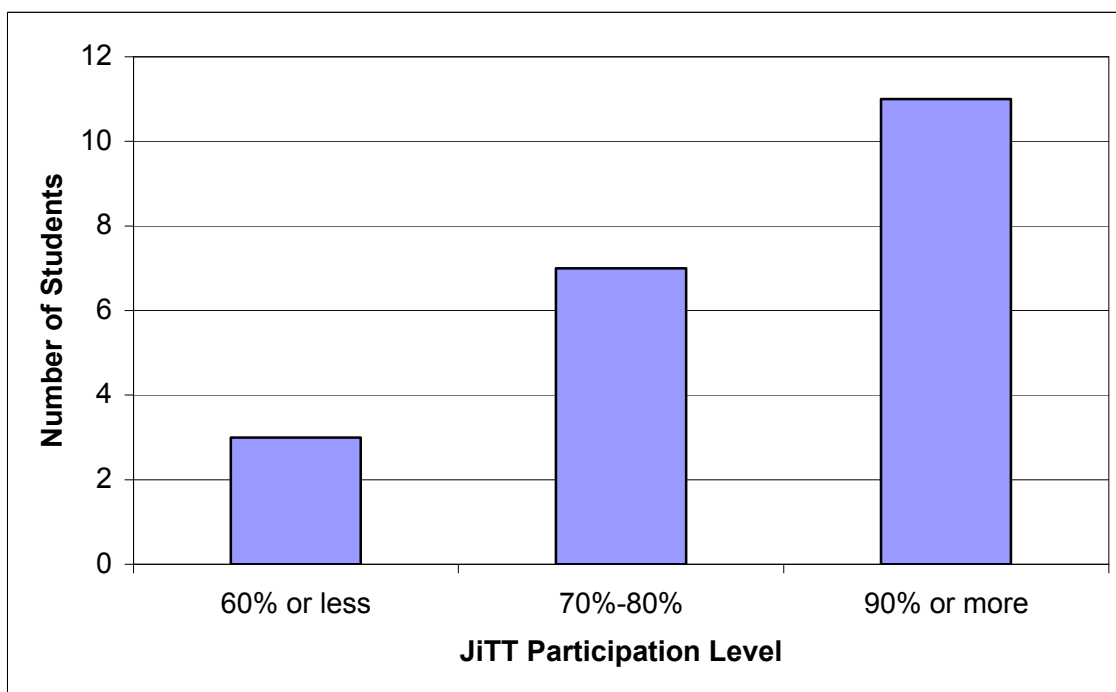
Figure 2. Fall 2005 Student Participation in JiTT

A survey was delivered at the end of the semester to determine student perceptions on the JiTT concept in MET 317. The results are shown in Table 1. Student reactions were mixed – about 40 percent agreed it added to the course, while about 40 percent disagreed. It was noted when compiling the survey results that those students who participated the most perceived it to be more useful than the occasional users. All but one student indicated they had some improvement in learning due to JiTT.

Students did provide a small amount of candid comments about JiTT as well. One student commented that JiTT was "sometimes a pain" and "easily forgotten." Two students pointed out that the questions needed to be posted earlier. On a few occasions, the authors did forget to post JiTT assignments until late in the day prior to class, so comments relating to the timing were expected.

From the perspective of the authors (faculty), both new to JiTT, the JiTT concept seemed to be a valuable approach to this type of course, but the implementation was not as effective as it could be. The biggest issue was that a comprehensive roadmap for JiTT in MET 317 was not put in place from the beginning of the course; therefore, the JiTT assignments were often somewhat of an afterthought for the faculty as they prepared their respective class sessions. Also, it was quite challenging to think up good non-theory questions in this applications-oriented course, especially for course topics that had no related calculations. For JiTT assignments involving internet searches, students demonstrated difficulty with critical reading of information they found (large sections of web pages were cut and pasted into the submission without regard for whether the sections answered the specific question asked). Students were much more careful to choose only

relevant information when they searched for answers from their textbooks and class notes. Overall, however, it did seem that JiTT improved class participation discussion in many cases. It was observed that the students who participated fully in JiTT assignments seemed more likely to be engaged during the lecture sessions.

Table 1. Fall 2005 JiTT Student Perception Survey Results

Question	Response category with number and percent of responses				
	Every Time	*Most Times*	*Sometimes*	*Occasionally*	*Never*
1. I submitted JiTT answers _____.	5 26.3%	12 63.2%	1 5.3%	1 5.3%	0 0%
2. Participating in JiTT helped me prepare for lecture topics _____.	1 5.3%	1 5.3%	8 42.1%	7 36.8%	2 10.5%
4. JiTT motivated me for class _____.	0 0%	4 21.05%	4 21.05%	5 26.3%	6 31.6%
	Every Topic	*Most Topics*	*Some topics*	*Few topics*	*No Topics*
3. I understand the topics addressed in JiTT more than other course topics.	0 0%	2 10.5%	9 47.4%	7 36.8%	1 5.3%
	Strongly Agree	*Agree*	*Neutral*	*Disagree*	*Strongly Disagree*
5. JiTT was a useful addition to the MET 317 class.	2 10.5%	6 31.6%	4 21.05%	6 31.6%	1 5.3%

Future Plans

Much of the difficulty in implementing JiTT in the Fall 2005 semester came from lack of sufficient planning and organization on the part of the instructors. JiTT was not designed as an integral part of the course material. The JiTT assignments were not designed to target specific core learning objectives. The instructions, submission requirements, deadlines, and grading for JiTT were not clearly established from the beginning of the semester. There was not enough time between the student submission deadline and the beginning of the class session for adequate instructor preparation of the JiTT-related material.

Several changes have been made for the second semester with JiTT in MET 317:

- A question database has been developed to make implementation easier
- Posting and submission times have been shifted so that there is more time for students to work with the JiTT assignments, and more time for the faculty to adjust the class session content based on JiTT responses
- The JiTT rules have been included in Vista™ so they are available for reference throughout the semester
- Point allocations for JiTT have been adjusted: students receive 5 points if fully correct, 4.5 points if partially correct, 4 points if wrong but showing evidence of good effort, and 1 point for submission with no evidence of effort or the submission was too late to apply
- Clear instruction has been provided on seeking web-based answers so that the information the students provide is pertinent to the questions they are addressing

Conclusion

The JiTT approach was introduced into a heavily applications-oriented mechanical engineering technology course with mixed results. Students who chose to participate consistently in JiTT viewed it more positively than those who were less involved. Nearly all students perceived some increase in learning due to JiTT. Dissatisfaction appeared to be based primarily on implementation difficulties. Student feedback and faculty observations generated a number of changes that were implemented in the second attempt at JiTT.

Bibliography

1. Novak, G. (2004). JiTT Impact and Citations. Retrieved October 4, 2005, from http://webphysics.iupui.edu/jitt/impact.html
2. Patterson, E.T. (2004). JiTT Adopters. Retrieved October 4, 2005, from http://webphysics.iupui.edu/jitt/adopters.html
3. Gavrin, Watt, Marrs, & Blake. (2003). Just-in-Time Teaching (JiTT): Using the Web to Enhance Classroom Learning [CD-ROM]. *Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition*, Nashville, TN.
4. Self, Patterson, Novak, and Hamilton. (2005). Just-in-Time Teaching: Potential Uses in Mechanics Courses [CD-ROM]. *Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition*, Portland, OR.
5. Eschenbach and Cashman. (2004). Introduction to Air Resources – Just in Time! [CD-ROM]. *Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition*, Salt Lake City, UT.
6. MET 317 course website. Retrieved January 16, 2005, from http://www.tech2.purdue.edu/met/courses/met317/
7. Novak, G. (n.d.). What is Just-in-Time Teaching? Retrieved October 4, 2005, from http://webphysics.iupui.edu/jitt/what.html