AC 2007-1056: TRAINING OF TEACHING ASSISTANTS ON TECHNOLOGY DRIVEN LESSON DEVELOPMENT

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Abstract

The Graduate Teaching with Technology Certificate (GTTC) course is a 28 contact hour training program for graduate student teaching assistants intending to become faculty members. The program combines technology with pedagogy to better enable participants to design instruction and integrate technology to enhance student learning. After being introduced to a number of technology tools currently used for instruction, participants develop a one-hour online lesson utilizing any or all of the tools. Peer and instructor feedback is utilized to help guide participants towards developing a lesson that is both technologically and pedagogically sound. A sample lesson developed by an engineering graduate student is provided in the appendix to demonstrate the content creation resulting from the course. The effectiveness of the program was measured using a series of feedback and evaluation forms provided to the participants throughout the program.

I. Introduction

Graduates with Ph.D. degrees in engineering need to know how to teach and develop educational content in pedagogically sound ways in order to be competitive in academia. Wankat [1] states, "We must ensure that future professors have an appropriate dose of pedagogical knowledge and skill." Most engineering Ph.D. graduates are not being able to satisfy the requirement for pedagogical experiences due to the lack of teaching opportunities, mentoring and engineering oriented graduate teaching assistant training programs [2,3].

In recent years, technology has added a new level of complexity to the education of graduate students pursuing careers in academia. In the work by Rutz *et al.* [4], the authors "Explore how to use instructional technologies to optimize the learning process," and conclude that instructional technology is a powerful student engagement tool but one that is often too costly due to time and resource requirements needed to develop the content.

II. Graduate Teacher with Technology Certificate Overview

The Graduate Teacher with Technology Certificate (GT^2C) program is a university-wide training-mentoring program for graduate students enrolled at Purdue University. Requirements for acceptance into the GT^2C course include: (1) Be an instructor of a class or be sponsored by a faculty member; (2) Be a degree seeking graduate student with preference being given to Ph. D. students; (3) Commitment to attend all weekly sessions. The GT^2C program is offered through a joint partnership between Purdue's Center for Instructional Excellence (CIE) and Information Technology at Purdue (ITaP). The course meets for 7 weeks, twice a week for two hours, for a total of 28 contact hours of training and mentoring. A complete schedule is presented in Appendix 1. Enrollment is limited each semester to 16 graduate students with CIE and ITaP committing 1-2 instructors each for conducting the program. The program was offered for the first time in the Fall of 2004 and has been offered every semester since.

The program exposes graduate students to the process of developing pedagogical and technologically sound content for a student's chosen topic. Once the topic is approved by the instructors, students work individually on developing a one-hour lesson plan that utilizes the instructional design process by defining the goals and objectives of the lesson, the planning and development of the lesson itself, and the assessment methods that will be used to measure student performance. Figure 1 depicts the step-by-step components of the lesson planning process that a student must address.

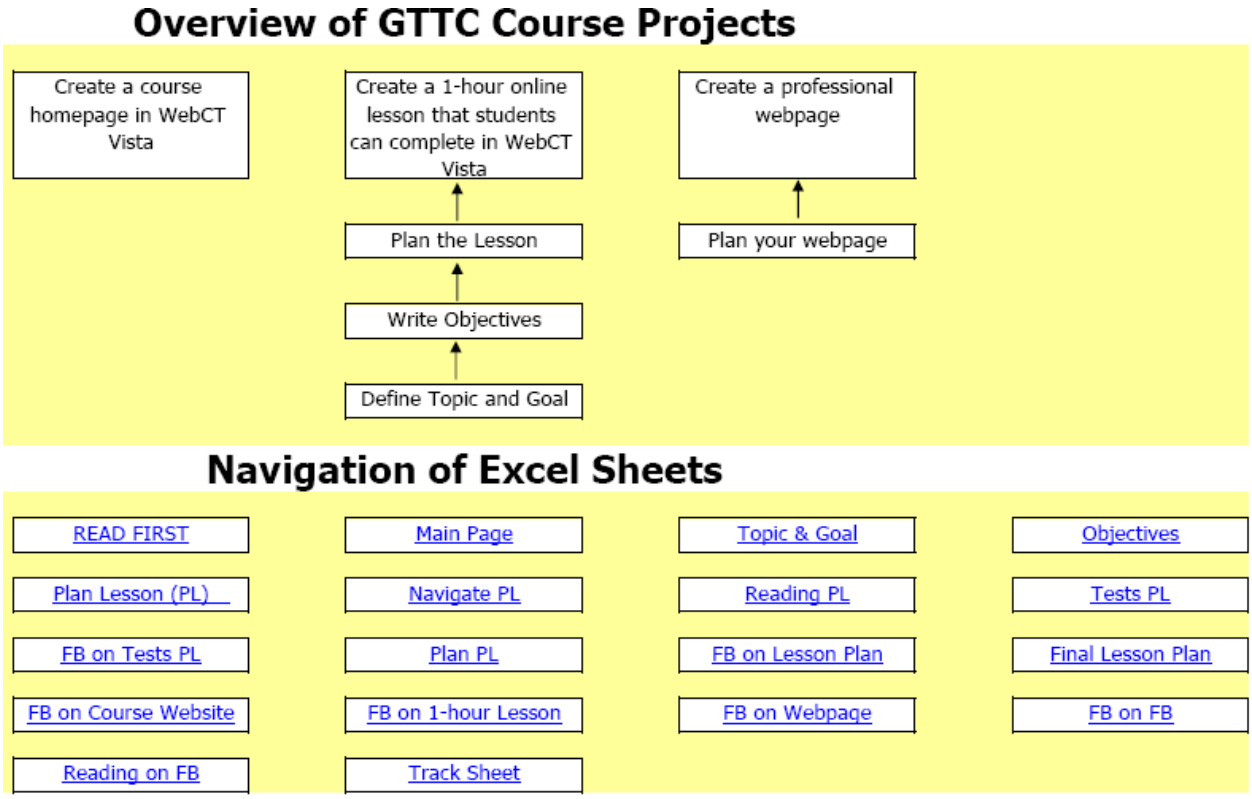

Figure 1. Overview and requirements of the GT^{2}C Program

Both an instructor and a peer provide the student with feedback on the lesson plan and the resulting lesson. The instructors play a mentoring role during the instructional process whereas the graduate student peer plays the role of a student taking the one-hour lesson. In order to follow student progress and to aid in the mapping of the different components of the instructional design process an excel document is used as the lesson plan for the one-hour online lesson.

Final Lesson Plan

Topic/Goal/Objectives			
Topic	Goal	Objective A	Objective B
Integrated Pest Management (IPM) in Crop Production	Identify key elements of an integrated pest management program. Understand importance of IPM on farm profitability. Apply some of the methodologies of IPM to an existing crop production program.	After covering IPM during labweek, students will list key elements of an IPM program and discuss importance of IPM to farm profitability, correctly completing at least 80% of the quiz questions.	Given specific parameters and information involving a crop production pest problem, students will correctly answer worksheet questions (receiving at least 7 out of 10 possible points) using their knowledge of IPM methodologies to "manage" the problem within class constraints of an IPM program.
Introduction to Lesson			
Strategy to Gain Attention	Strategy to Establish Purpose	Strategy to Stimulate Interest	Strategy to Preview Lesson
Encourage inquiry	Listing of expectations	Present value of lessons to students	Listing, although presenting a graphic organizer could convey ideas as well.
Body of Lesson			
Relevant Prior Knowledge	Strategy to Recall Prior Knowledge	Practice for Objective A	Practice for Objective B
Basic knowledge of biology, entomology, plant biology, agriculture.	Review briefly, rather unstructured.	Practice for Objective A: Pose questions to students as they work through content in WebCT learning module using assessment tools in WebCT.	Practice for Objective B: Work through different production problems (determining economic thresholds, and offering control strategies and options related to specific examples)
Main Points of Information	Strategy to Provide Information	Feedback Strategy for Practice for Obejctive A	Feedback Strategy for Practice for Objective B
1. Components of an IPM program 2. Methods of an IPM program 3. Different pests to manage 4. _____	Elaborate	Feedback for Practice for Objective A: Many multiple answer and fill in blanks. Explanations for incorrect and correct answers will be given after questions completed	Feedback for Practice for Objective B:Let students know if the threshold they found or calculated is correct, and common mistakes that might have arrived in other answers. List answers for possible control methods and alternative ideas they probably did not use.
Conclusion of Lesson			
Strategy to Review Lesson		Assessment for Objective A	Assessment for Objective B
Review Key points then Test		Assessment for Objective A: Open ended questions	Assessment for Objective B: Open ended questions and minor calculations.

Figure 2. Sample GT^{2}C Lesson Plan and Feedback

The technology tools used in the course include: (1) WebCT Vista®; (2) Macromedia Dreamweaver®; (3) Adobe Acrobat®; (4) Macromedia Breeze® and (5) Macromedia Fireworks®. Students are already assumed to be familiar with the basics of the Microsoft Office Suite and therefore are already capable of using PowerPoint, Word, and Excel. Students in the course are required to build a course webpage to be housed in WebCT Vista®, a personal/professional homepage using Macromedia Dreamweaver®, and a one-hour online lesson. The other technology tools are recommended but not required as students can choose to use Powerpoint® or Macromedia Breeze® for lesson development, Adobe Acrobat or Microsoft Word® for documents and create optional images using Macromedia Fireworks if they feel images can enhance their lesson. Figure 2 shows a sample summary of a completed lesson plan. As the lesson plan document is completed by the graduate student during the different stages of the instructional design process, it is shared with the pre-assigned instructor-mentor and a pre-assigned peer for feedback on improvements and to address any limitations the current plan and lesson might have.

Once all components of the lesson plan have been approved by the assigned instructor-mentor, the graduate teaching assistant develops the one hour online lesson using any available

technology. The completed one hour lesson is then shared with the assigned peer and instructor for feedback on quality of the lesson and its accuracy on properly addressing all the components of the instructional design process according to the lesson plan. After successful completion of all the program requirements, the graduate teaching assistant is given a certificate with the expectation that the one-hour lesson developed will be incorporated into the class the graduate teaching assistant is or will be teaching.

III. Results and Discussion

A. Surveys

At the beginning and end of the course, participants in the GT^{2}C program were asked to rate their competency regarding the different technologies introduced in the course as well as their knowledge about the instructional design process. The results show that the course met student's and instructor's expectations of improving a participant's competency and knowledge of the material (Table 1).

Table 1. Pre and Post Technology and Pedagogy Competency Survey Results

		Macromedia Fireworks	Macromedia Dreamweaver	WebCT Vista	Adobe Acrobat	Instructional Design	Writing Objectives	Pedagogy
Average	Pre	1.88	2.13	2.88	3.75	2.31	3.44	1.88
	Post	3.50	4.06	4.31	4.13	4.38	4.75	4.19
Median	Pre	2.00	2.00	3.00	4.00	2.00	4.00	2.00
	Post	3.00	4.00	4.00	4.00	4.00	5.00	4.00

A comprehensive survey, GT^{2}C Follow-up survey, was administered to all participants of the Fall 2004, Spring and Fall 2005 semesters to identify the usefulness of the program and its transferability to teaching needs experienced by the graduate students. The response rate was 55% (22 out of 40 participants completed the survey), with all but one student working on completing a doctoral program and with 18 out of 22 students having taught at least one or more classes. The majority of participants found the GT^{2}C program to be useful (45.45%) or very useful (31.82%) and most of the participants considered that the course helped them improve their teaching abilities (54.55%) or helped them a lot (27.27%), and that the transferability of the technology helped (50.00%) or helped a lot (27.27%) to develop sound pedagogy (Figure 3).

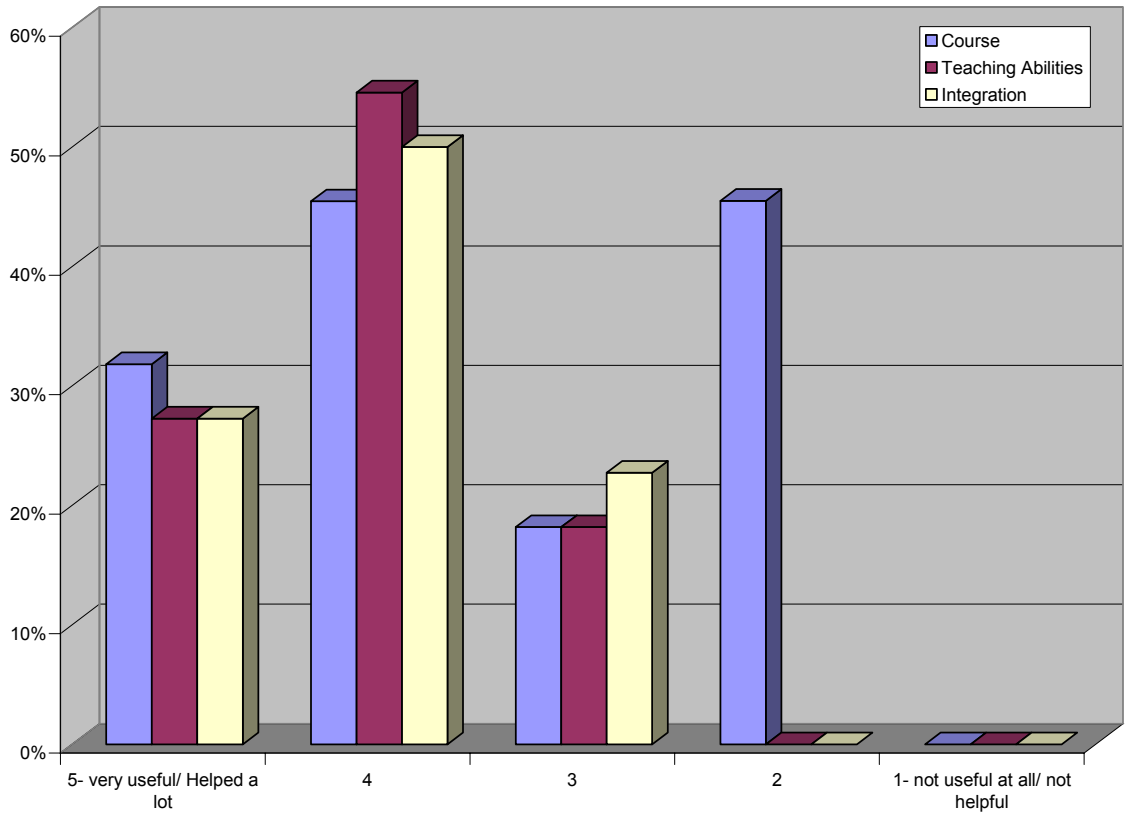

Figure 3. GT^{2}C Follow up survey results

Transferability of content learned during the course was further examined to identify pedagogical techniques and technology tools incorporated into classes taught or being taught. Most students incorporated parts of the designing lesson and writing goals and objectives content of the instructional design component. Technology did not fare as well and most students have not incorporated most of the technology taught with the exception of WebCT Vista® and Adobe Acrobat® (Figure 4).

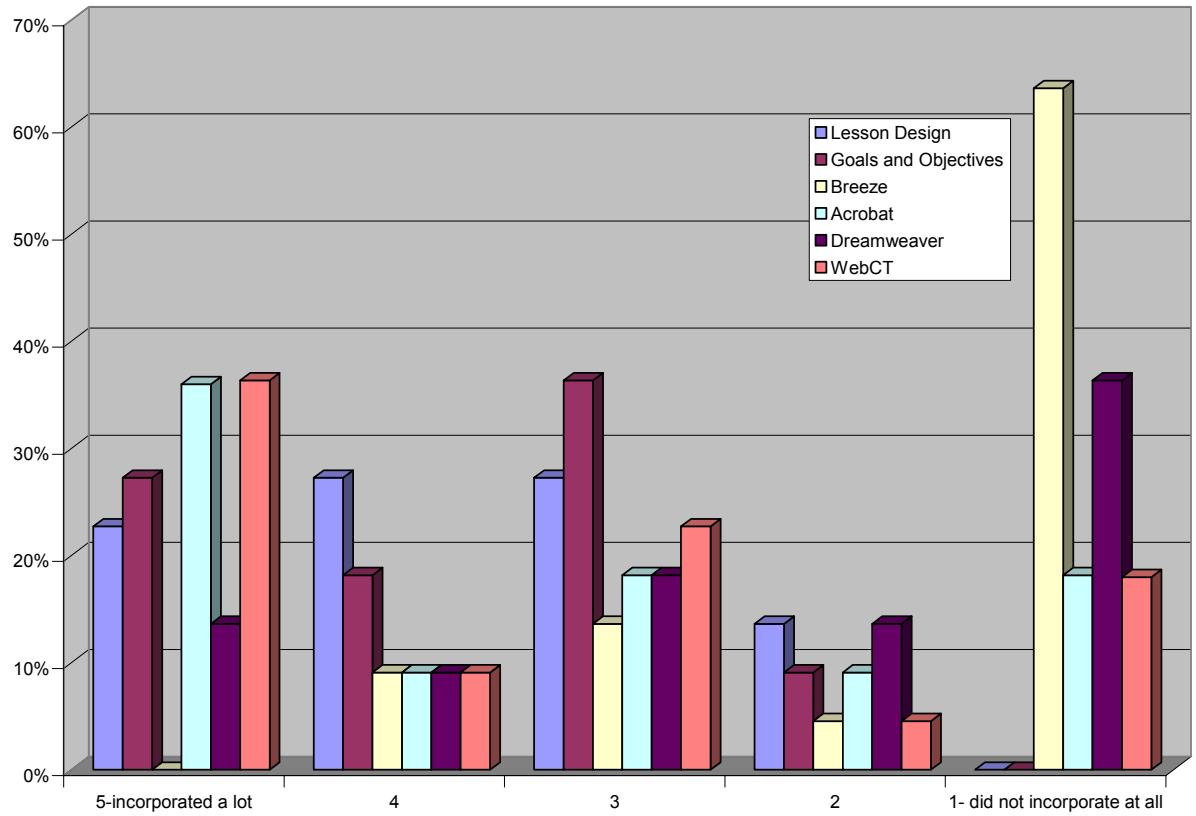

Figure 4. Pedagogy and technology incorporation into teaching

B. Student Perceptions

A student's level of competency with the different technologies introduced in the course and the lack of formal training in educational methods of teaching were the root causes of some of the most common comments provided by students. Samples of the comments given by participants regarding what they would change about the course include:

- "I would suggest that the lesson module be shorter. It is very time consuming to create these modules."
- "Shorten the time of the online lesson to maybe 30 minutes to help the students focus on one objective and the technology."
- "I would provide students with examples of an actual instructional lesson. It helps to visualize and understand the expectations better."

The time consuming nature of the program is not surprising. Norris and Palmer [5] identify the time consuming nature of these training programs as the number one concern of graduate students taking part in the Woodruff School doctoral training intern program at Georgia Institute of Technology.

When asked about what they learned from the course almost all students mentioned at least one of the technologies taught in the class, with WebCT Vista® and Dreamweaver® being the front runners. It was not surprising that students identified WebCT Vista® and Dreamweaver® as the most important aspect about the course since both technologies have immediate benefits to

students. The university uses WebCT Vista® as their course management system for all classes across campus and Dreamweaver® allows students to create their own personal homepage which most of them had not done before starting the GT^{2}C. Some of the participant's also recognized the intricate and necessary connections between the educational models and technology when developing course content. Some of the comments students provided include:

- "The most important thing I learned was how to integrate teaching principles with technology. At first, I thought we would only learn the technology available, but I absolutely loved how we discussed how to design a lesson plan and to be more attentive to student needs."
- "I now know how to be a better teacher and how to disseminate information to students so that they can learn better and also how to assess their progress."

Overall the course was very well received by all students and most of them considered that their expectations of the course had either been met or exceeded. Some of their comments regarding the overall course included:

- "I expected the course to include more technological skills."
- "This is a wonderful course from which I learned a lot of very useful techniques in developing my course and webpage."
- "I am very satisfied with this course. I feel that I have learned a lot in a short time period. Speed of the meetings was very good and all the meetings were effective."
- "The course did meet my expectations to learn more technologies to be used in instructional design."

C. Instructor Reflections

We observed that most students enjoyed the course and found it to be very useful to their career development. Feedback from students was used extensively both from one semester to the next and during the course by the instructors in an effort to make better use of the student's time and help them successfully complete all the requirements. The time consuming nature of the course both from a student and instructor point of view was identified as the main challenge of the course. Graduate students participating in the course volunteered to be a part of it, and it was our expectation that the faculty advisor to the student would consider the added time commitment by the student; however, this was not always the case and retention was a significant problem once the assignments started to pile up and research and teaching responsibilities increased. From an instructor's point of view, the mentorship of student's posed a challenge due to difference in disciplines and other work responsibilities, as well as the tightly constrained due dates of assignments and the expectation to have next-day feedback.

IV. Conclusions

Graduating Ph.D. students pursuing a career in academia should be leading the way in the application of new technology in higher education as mentioned by Wankat [1]. The GT^{2}C training program is a technology driven instructional design course tailored to graduate students needing to enhance their knowledge and comfort level with the development of pedagogically sound and technologically designed content. Engineering students can benefit significantly from such programs as the GT^{2}C due to the lack of appropriate educational training [1, 2] found in the traditional engineering doctoral curriculum. An example of such benefits is provided in

Appendix 2, which highlights the work of a Mechanical Engineering graduate teaching assistant who developed a simulation-based lesson to help students better understand the complexities of PID controllers and the parameters affecting system performance.

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Appendix 1: Syllabus for GT^{2}C Program Fall 2006

Class Activities	Assignments Due	
	Due prior to beginning of class	**Due at end of class**
NO CLASS	• First Draft of topic & goal for lesson ➔ email to your mentor	
• Introduction to course • Complete skill pre-survey • Revise topic/goal as needed • Lesson on course homepages in WebCT Vista • Develop your course homepage		• Revised topic and goal
• Lesson on Objectives • Write your objectives • Receive & implement peer feedback for objectives • Develop your course homepage	• Final approved topic & goal for 1-hour online lesson • Reading on Objectives	• First Draft of Objectives (Incl. peer feedback) • First Draft Course homepage
• Revise objectives as needed • Receive peer feedback on course homepage • activities & assessment lesson in WebCT	• Review examples of 1-hour online lessons	• Revised objectives • Course homepage (incl. peer feedback)
• Lesson on Develop a Lesson Plan • Develop lesson plan for 1-hour online lesson • Receive & implement peer feedback on lesson plan	• Plan for Introduction to your lesson • Final approved objectives for 1-hour online lesson	• First Draft of Lesson Plan for 1-hour online lesson (Incl. peer feedback)
• Revise lesson plan as needed • Lesson on activities & assessment in WebCT Vista • Lesson on Breeze/PowerPoint	• Final approved course homepage	• Revised lesson plan
• Develop 1-hour online lesson	• Final approved lesson plan for 1-hour online lesson	
• Develop 1-hour online lesson		
• Develop 1-hour online lesson		
• Peers take the 1-hour online lesson and give feedback • Implement peer feedback on 1-hour online lesson	• 1-hour online lesson • 1-hour online lesson is available in WebCT Vista for a peer to take it	• Peer feedback on 1-hour online lesson
• Revise 1-hour online lesson as needed • Lesson on Fireworks • Lesson on Dreamweaver	• Review examples of professional webpages • Plan for professional webpage	
• Lesson on Dreamweaver • Develop professional webpage		
• Develop professional webpage	• Final approved 1-hour lesson	
• Develop professional webpage • Peer feedback on professional webpage		• First Draft of Professional webpage

• Revise professional webpage as needed • Complete skill post-survey • Complete feedback for GT^2C survey		• Revised Professional Webpage

Appendix 2: Engineering Student Sample Work

A. Lesson Plan

Topic

Introduction to the basic tuning rules for PID controllers.

Goal

Students will learn the working principles of PID controllers and how to apply one of the most popular tuning rules.

Objective A	**Objective B**
Students will specify from memory how individually increasing one of three PID parameters will affect(increase, decrease, not change) all four major characteristics of system response. At least three should be correct.	Given the step response curve of an unknown system, students will measure system dynamic characteristics, choose one of the three types of PID controllers, and calculate by hand the necessary parameters within 10% of error for the controller using class notes and the Ziegler-Nichols tuning constants table.
Activity(ies) for Objective A	**Activity(ies) for Objective B**
Students will be given a standard second order system with three different controllers, each concentrating on one of three parameters of the PID controller. They will adjust the value of the parameter and see its effect on the response of the system, which is calculated real-time by a Java Applet embedded in the webpage.	Given a figure of the step response of an unknown 2nd order system together with a figure showing the definition of the constants used in the ZN tuning table, students will calculate controller parameters and input them in a Java Applet to see if the controller achieves the desired response. They can then tune the parameters a little bit using the knowledge they learned in Activity A.
Assessment for Objective A	**Assessment for Objective B**
Multiple choice questions. Students will choose which of the response characteristics will increase when one of the controller parameters is increased. I may try some variations, e.g., ask them to choose which of the three parameters, when increased, will cause the settling time of the system to decrease.	Since the Objective B requires the students to be able to design controllers using the Z-N constant table, student will be asked to calculate the controller parameters using the Z-N constant table, given a figure showing the step response of an un known system. To reduce error in reading the figure, measurements of the Z-N parameters will be marked in the figure, but they will not be given their usual symbols, so students need to remember how each symbol in the ZN table is measured from the response in order to use them. This will be a fill-in-blank question.

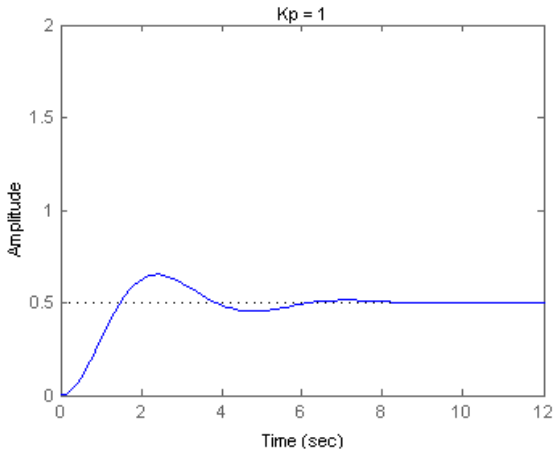
B. MATLAB ® Simulation for Kp Tuning (Instructional activity)

Tuning The Proportional Gain Kp

CL RESPONSE	RISE TIME	OVERSHOOT	SETTLING TIME	S-S ERROR
Kp	Decrease	Increase	Small Change	Decrease

Move the slider below and observe how Kp changes the system response. The controller is Kp only.

Step response of the closed-loop system



Controller Parameters:

Kp = 1

Ki = 0 (fixed)

Kd = 0 (fixed)

Remarks

The parameter Kp is mostly used to improve(reduce) rise time of the system as it increase the natural frequency of the system. It also reduces steady-state error(watch how the dotted line moves closer to 1). However it increases overshoot quite a bit.