

**AC 2009-606: APPLICATION OF THE EXCEED TEACHING MODEL TO
IMPROVE GRADUATE TEACHING IN ENVIRONMENTAL ENGINEERING
COURSES**

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Application of the ExCEED Teaching Model to Improve Graduate
Teaching in Environmental Engineering Courses

Abstract

Many universities employ graduate teaching assistants to help reduce faculty teaching loads. However, the graduate teaching assistants may receive little to no training on teaching effectiveness. Some universities may have programs to mentor graduate students in effective teaching strategies; however, the programs may not be able to help all graduate students due to limited capacity and funding. A faculty advisor may be assigned to oversee the graduate teaching assistant's class, but interactions between the faculty and the teaching assistant may be limited and the student may receive little or no feedback on teaching effectiveness. In times when state legislatures want more accountability in the classroom, providing training for graduate students to improve their teaching effectiveness is imperative.

A special topics course was offered to masters and PhD students teaching lecture classes and lab classes at Texas Tech University. The purpose of the course was to introduce and teach teaching assistants the ExCEED teaching model and assess teaching performances. Topics of the ExCEED model were presented at weekly class meetings. TAs were observed at the beginning and end of the semester to assess each TAs' understanding and successful application of the ExCEED model. Additional feedback on TA teaching effectiveness was assessed through mid-semester evaluations and end-of-the-semester evaluations. Lastly, the TAs assessed their own understanding of the ExCEED model and its benefits at the beginning and ending of the course. Overall, the TA effectiveness in the classroom improved through the application of the ExCEED model in environmental and civil engineering courses.

Introduction

To reduce faculty teaching loads, more and more universities are employing teaching assistants (TAs) or adjunct professors to teach classes. TAs may receive little to no training on teaching effectiveness leaving the TAs to imitate and emulate instructors they have had during their educational experiences. Unfortunately, this may not be the most effective approach to teaching and may impact teaching effectiveness in the classroom.

Some universities have programs to mentor graduate TAs but the programs may not be available to all TAs due to capacity and funding. A graduate TA may be assigned a faculty mentor. However, informal mentoring is not always successful as other aspects of a faculty member's job may take priority, resulting in little to no mentoring to the TA. Therefore, a more formal mentoring structure is needed.

In the last couple of years at Texas Tech University, TAs have been employed to cover undergraduate lecture courses in addition to the laboratory classes typically taught by TAs, due to the departure of faculty and the hiring of new faculty with reduced teaching loads. To help the

TAs, the author of this article taught a special topics course during the spring 2008 semester based on the ExCEED teaching model. The purpose of the course was to introduce and expose TAs to the ExCEED teaching model and assess teaching effectiveness. Topics of the ExCEED model were presented at weekly class meetings. TAs were observed at the beginning and ending of the semester to assess each TAs' understanding and successful application of the ExCEED model. Additionally, feedback on TAs teaching effectiveness was assessed through mid-semester evaluations and end-of-the-semester evaluations. Lastly, the TAs assessed their own understanding of the ExCEED model and its benefits at the beginning and ending of the course.

Background on the ExCEED Model

The ExCEED (Excellence in Civil Engineering Education) Model evolved from training developed and administered by the U.S. Military Academy to train rotating military faculty. In 1999, the first ExCEED workshop² was held and has been held each summer since. The ExCEED model contains the following components: (1) structured organization which includes learning objectives, inclusion of appropriate to subject matter, and a presentation addresses different learning styles; (2) engaging presentation which includes unambiguous written and verbal communication, student-instructor interaction, and incorporation of physical model systems and demonstrations; (3) enthusiastic presentation; (4) positive relationship between instructor and students; (5) assessment of learning through classroom and out-of-classroom assessment; and (6) inclusion of technology in appropriate ways to improve student learning. The ExCEED model considers Lowman's 2-D Model of College Teaching⁶, which states that teaching effectiveness is a function of intellectual excitement and interpersonal rapport with the students. Examples of intellectual excitement include excitement, clarity and stimulating whereas interpersonal rapport includes showing interest in the student as individuals as well as their learning. Additionally, the ExCEED model uses learning objectives to provide organization to the lesson. The learning objectives should cover all of Bloom's taxonomies^{3,1}. For more about the ExCEED model, please review the following references^{2,4,5,7,8}.

Course Content

The special topics course consisted of a one-hour traditional classroom instruction combined with two observed classes. The course was structured so that information was presented to the students with time for comments and discussion. The two-way flow of information between the class participants and the instructor allowed for a richer learning experience as each person has ideas from their classroom experience, either as an instructor or a student, of effective and non-effective teaching. The content for the courses was based on the American Society of Civil Engineers (ASCE) ExCEED teaching workshop outline and contents.

The lessons covered during the special topics course include:

- Lesson 1. Why teaching is important, Lowman’s 2-D model, Planning a class
- Lesson 2. Speaking and writing
- Lesson 3. Objectives
- Lesson 4. Questioning
- Lesson 5. Learning styles
- Lesson 6. Build rapport
- Lesson 7. Nonverbal communication
- Lesson 8. Classroom assessment
- Lesson 9. Teaching with technology
- Lesson 10. Testing/syllabi

To assess student understanding of the course, the reviewer (the author of this article) visited each TAs course twice during the semester. The first observed class was within the first month of school and the last visit was within the last month of school. The ExCEED teaching assessment worksheet was used during the lesson assessment; strengths and areas of improvement were noted for each observed lesson. Within two days after the observed class, the reviewer and TA discussed the strengths and areas of improvement for the class and selected three areas of improvement for the next visit. The reviewer attempted to match the areas of improvement to the lesson covered during the special topics course.

Data Sources and Collection

Teaching Evaluations. Table 1 summarizes the teaching experience, rank and the TA participation in the special topics course. Environmental Engineering Laboratory, CE 3171, is a required lab associated with Environmental Engineering, CE 3309. Both courses are required for all civil engineering students whereas CE 3309 is required for all environmental engineering students. CE 3354, Engineering Hydrology, is a required course for all civil engineering and environmental engineering students. Groundwater Hydrology, CE 4363, is an elective course for civil engineering students and a required course for environmental engineering students.

Table 1. Rank, Teaching Experience and Participation in Special Topics Course by TA

TA	Rank	Teaching Experience as of Spring 2008	In Special Topics Course
A	PhD student	Never taught before	Yes
B	MSCE student	Never taught before	Yes
C	PhD student	Yes; one semester CE 3171	Yes
D	PhD student	Yes; two semesters CE 3171	Yes
E	Post-Doc	Yes; three semesters of CE 3171	No
F	PhD student	Yes; previously taught CE 3171 and CE 3354	No

Teaching evaluation data was collected for 6 teaching assistants. The teaching evaluation scores were collected from the Data Warehouse managed by Institutional Research and Data Management Warehouse, which is located on the TTU webpage. The teaching evaluations are performed at the end of each semester and the students enrolled in the course assigned numerical values to 16 evaluation questions. The highest achievable value is a 5; lowest value is 1. The questions asked on the teaching evaluation form are:

1. Overall this instructor was effective
2. The instructor was available for consultation during office hours or by appointment
3. The instructor stimulated student learning
4. The instructor treated all students fairly
5. The instructor treated all students with respect
6. The instructor welcomed and encouraged questions and comments
7. The instructor presented the information clearly
8. The instructor emphasized the major points and concepts
9. The instructor went beyond presenting the information in the text
10. The instructor demonstrated knowledge of the subject
11. Overall the course was a valuable learning experience
12. The assignments were relevant and useful
13. Course materials were relevant and useful
14. Expectations were clearly stated either verbally or in the syllabus
15. The testing and evaluation procedures were fair
16. The workload was appropriate for the hours of credit

To assess TA teaching effectiveness, the results of the teaching evaluations are parsed to into categories based on Lowman's 2-D Model. The questions that specifically address the components of the Lowman's 2-D Model that address intellectual excitement are instructor effectiveness (1); simulating student learning (3); presented the information clearly (7); emphasized major points and concepts (8); and demonstrated knowledge of the subject (10). The questions that address interpersonal rapport are available for office hours (2); treating students fairly (4); treated students with respect (5); welcoming comments and questions (6); assignment relevant and useful (12); expectations clearly stated (14); testing and evaluations fair (15); and appropriate workload (16).

TA Questionnaire. In addition to TA student teaching evaluations, the TAs completed a questionnaire in the special topics course. The questionnaire was administered at the beginning of the course to assess the students' knowledge of the ExCEED model and at the end of the course to ascertain how students' knowledge of the ExCEED model changed. The questions asked were:

1. I think my teaching scores will improve by implementing the ExCEED teaching model
2. The ExCEED model is too complex to implement
3. Implementing the ExCEED model will be time intensive
4. I want to be an exemplar teacher

5. Implementing the ExCEED model will help me be a more confident instructor
6. Learning objectives are not helpful to include in my lessons
7. Asking students questions in class alienates them
8. I am interested in improving my teaching skills
9. Implementing the ExCEED model will improve the structure and clarity of my lessons
10. I believe teaching is a learned skill

Results and Discussion

Student Evaluation Results. Table 2 contains the average evaluation score and standard deviation for all 16 questions, the number of students completing the evaluation, and the course taught.

Table 2. Average Evaluation Score and Standard Deviation for all 16 Questions, Number of Responses and Course Number

TA ID	Spring 2008			Fall 2007			Spring 2007		
	Average Score (SD)	Response Number	Course	Average Score (SD)	Response Number	Course	Average Score (SD)	Response Number	Course
A	4.34 (0.56)	20	CE3171	NA	NA	NA	NA	NA	NA
B	4.32 (0.31)	12	CE3171	NA	NA	NA	NA	NA	NA
C	4.55 (0.13)	12	CE4363	4.49 (0.25)	13	CE3171	NA	NA	NA
D	3.93 (0.31)	42	CE3309	4.62 (0.13)	13	CE3171	4.49 (0.25)	18	CE3171
E	3.34 (0.61)	12	CE3171	3.41 (0.66)	15	CE3171	3.70 (0.27)	31	CE3171
F	4.45 (0.15)	40	CE3354	NA	NA	NA	3.26 (0.31)	37	CE3354

The components of the ExCEED model include structured organization; engaging presentation; enthusiasm; positive rapport with the student; frequent assessment and appropriate use of technology. The student evaluations at TTU address many components of the ExCEED model and the questions have been further divided into two categories based on Lowman's 2-D Model, interpersonal rapport and intellectual merit, for ease of discussion. Specifically, the responses to questions 1, 3, 7, 8, 10 and 13 assessed intellectual merit, whereas the responses questions 2, 4, 5, 6, 12, 14, 15, and 16 assessed interpersonal rapport.

Intellectual Merit. Figure 1 compares the teaching evaluations for three TAs teaching CE 3171 during the Spring 2008 semester. To minimize variations in the information presented in the different sections of CE 3171, the TAs were required to develop a nearly identical syllabus for each section. The testing procedures were similar, course work requirements were similar and the assignments were similar. Although the TAs work from similar board notes, the TAs were encouraged to personalize the material they present. For example, all TAs were expected to ask questions but the questions were not scripted in the lesson notes.

From the scores, TAs A and B score higher in areas relating to intellectual merit than TA E, who has taught this class several times. TAs A and B were both enrolled in the special topics course

whereas TA E did not take the special topics course. With the exception of ‘demonstrates knowledge’ TAs A and B outperform TA E by approximately 1 point. TA E was expected to have an equal if not higher score on ‘demonstrates knowledge’ because TA E is a post-doctoral. The data, as shown in Figure 1, suggests that TA E does not effectively demonstrate properties of intellectual merit, which may be a consequence of limited understanding of the importance of intellectual merit on teaching effectiveness. TA E received mid 3’s on effectiveness, stimulates learning, presented information clearly, emphasized major concepts and presented relevant material. In observing TA E’s courses, handwriting, board notes and use of color were consistently noted as areas needing improvement. TA E chooses not to work on board presentation and clarity. Although TA E has been mentored in the ExCEED model, he has not expressed desire to improve his teaching and minimally addressed the areas of improvement identified during classroom evaluations. In comparing these results, the special topics course improved TA teaching effectiveness, especially for individuals interested in teaching.

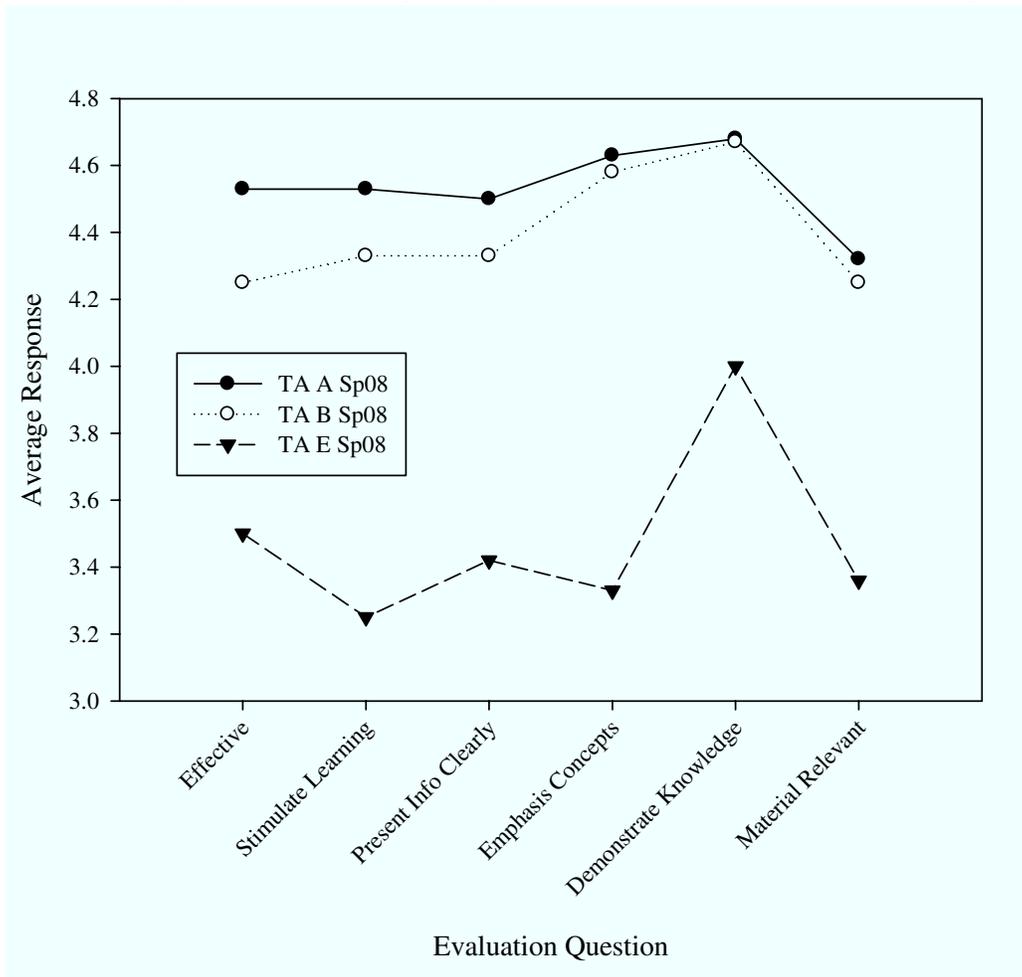


Figure 1. CE 3171 Spring 2008 Teaching Assistant Evaluations Pertaining to Intellectual Excitement

Figure 2 compares the teaching evaluations for three PhD students teaching undergraduate civil engineering courses during the Spring 2008 semester. All TAs have previous teaching experience. TAs C and D previously taught CE 3171. TA F previously taught CE 3171 and CE 3354, which is the same course taught during the spring semester. Overall, TAs C and F score approximately 0.5 points higher than TA D on questions related to intellectual merit. TA C outperforms TA F in all areas except 'demonstrates knowledge'. TA F had taught CE 3354 previously whereas TA C had not taught CE 4363 before. Previous experience teaching the course may affect the TA C's score on this question. The results show that improvements in teaching effectiveness and intellectual excitement can be improved with experience (TA E) or with the course (TA C).

One reason that TA D's score is lower than TA C and F was due to 'presenting information clearly,' which TA D admits he did not do and may be a consequence of teaching this course for the first time. Another explanation for the lower scores is the course the TA taught. CE 3309 is the least popular course in the civil engineering curriculum. As a general rule, students do not want to take this course. The author of this paper is the regular instructor of CE 3309 and usually receives low marks (approximately 4) on teaching evaluation question 11 (valuable learning experience). Although environmental engineering students are required to take the course, they are typically outnumbered 15 to 1 and their presence would not significantly impact the student evaluation value.

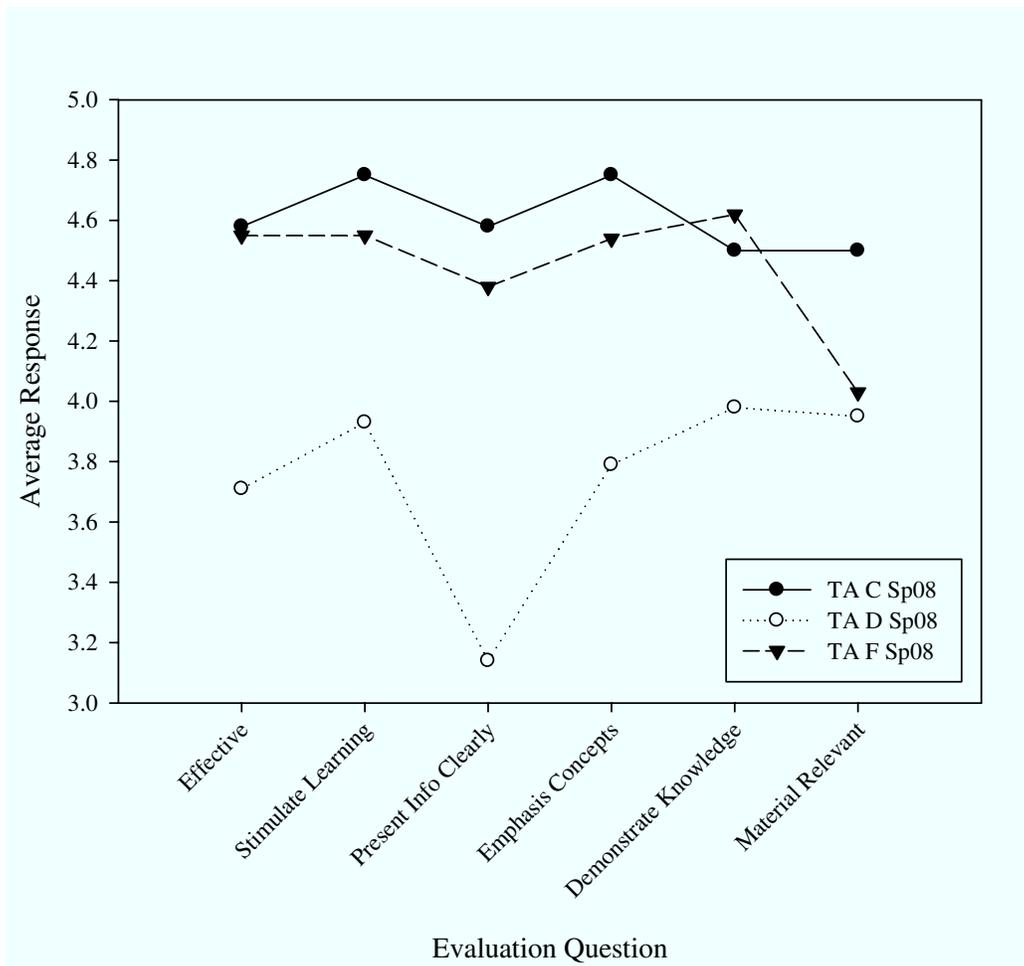


Figure 2. Spring 2008 Teaching Assistant Evaluations for Three Different 3 Hour Undergraduate Courses Pertaining to Intellectual Excitement

Figure 3 compares the teaching evaluations for the Fall 2007 and Spring 2008 semesters for TAs C and D, who completed the special topics class and TA E, who was not enrolled in the special topics class. In regards to questions monitoring intellectual excitement, TA C teaching evaluations improved during Spring 2008 semester. TA F teaching evaluations improved slightly but remained 0.5 to 1.0 points lower than TA C. TA D response values decreased and the reasons for the lower teaching evaluation score was discussed previously.

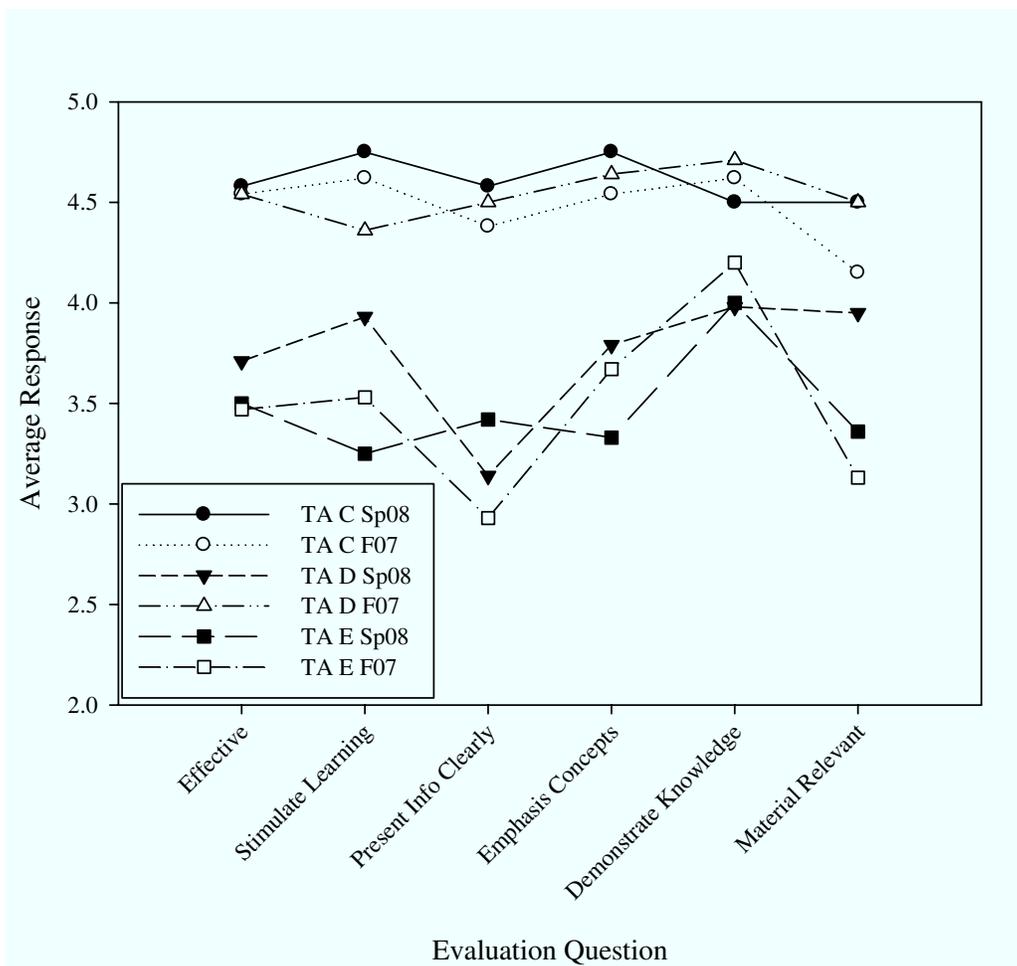


Figure 3. Teaching Evaluation Comparison for Teaching Assistants before and after course Pertaining to Intellectual Excitement

Interpersonal Rapport. The other component of Lowman's 2D Model is interpersonal rapport, which is the relationship between the instructor and the student. Figure 4 compares the teaching evaluations for the three TAs teaching CE 3171 during the Spring 2008 semester for assessment questions related to interpersonal rapport. Overall, the trends for the three TAs were similar; however, TAs A and B outperformed TA F by a 0.5 to 1.0 points. All three students performed well on available for consultation, fair, respectful, encouraged questions and stated expectations. Additionally, all TAs experienced a drop in their score for questions related to tests and evaluations fair, appropriate work load and relevant assignments. The drop in evaluation score was not surprising as many students comment the workload is high for a one-hour lab.

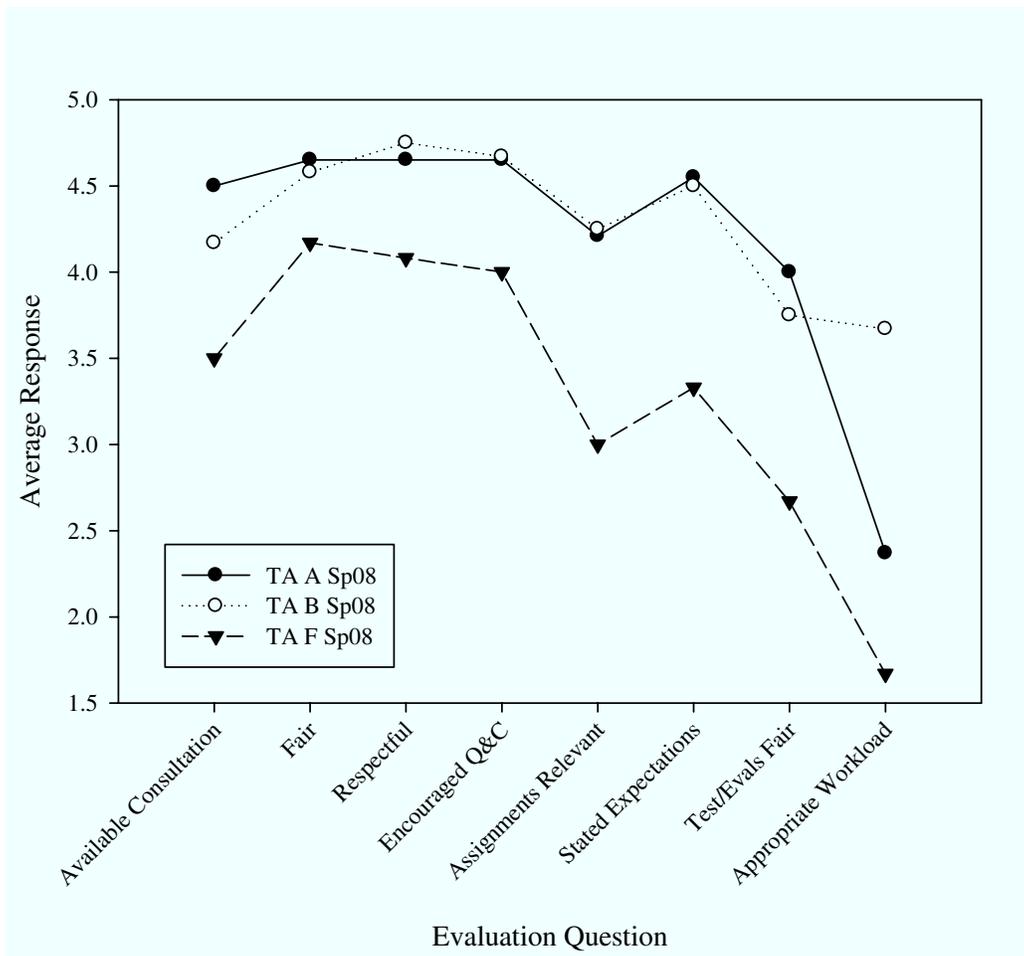


Figure 4. CE 3171 Spring 2008 Teaching Assistant Evaluations Pertaining to Interpersonal Rapport

Overall, TA C outperformed TA F in areas pertaining to interpersonal rapport with the exception of available for consultation and test/evaluation fair (Figure 5). In all questions pertaining to interpersonal rapport, TA C scored between 4.7 and 4.4. TA D scored approximately 0.5 pts lower in all questions. The results suggest that teaching experience (TA E) did not have as great of an impact on personal rapport as compared to the knowledge gained during the special topics course (TA C and D).

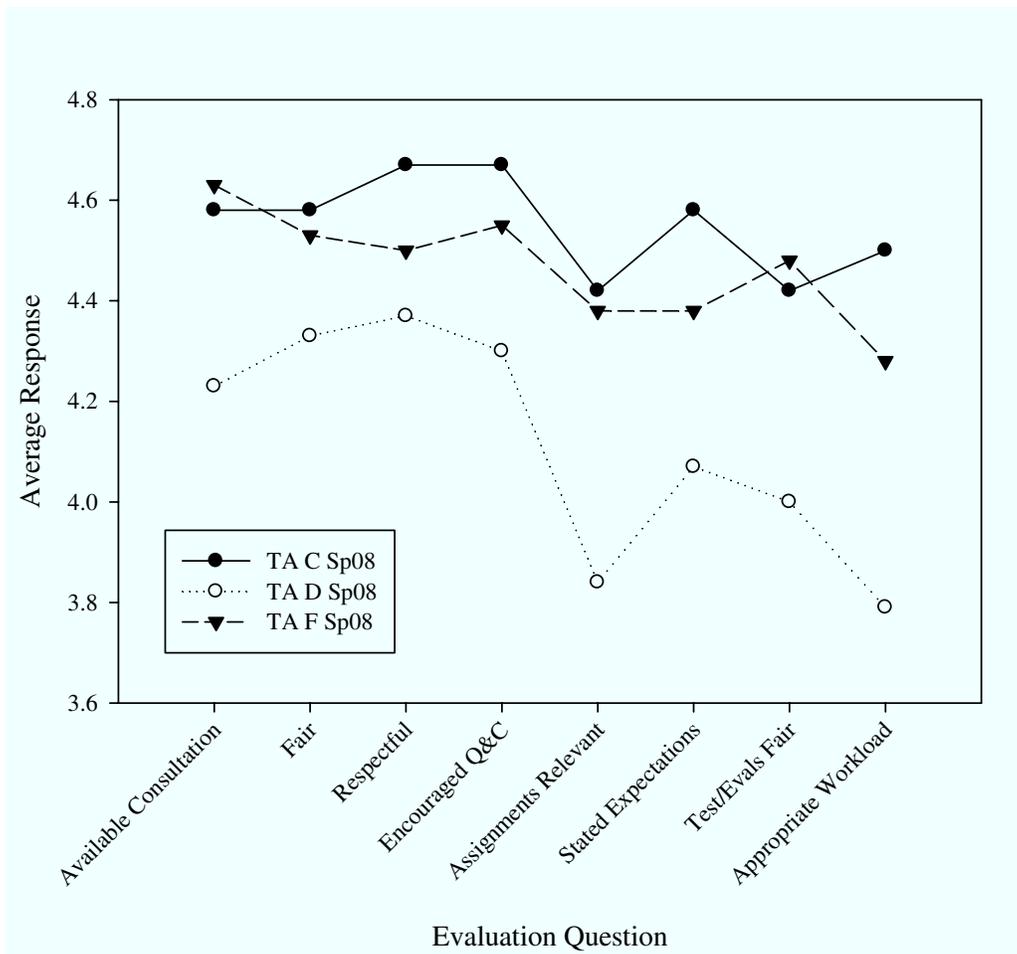


Figure 5. Spring 2008 Teaching Assistant Evaluations for Three Different 3 Hour Undergraduate Courses Pertaining to Interpersonal Rapport

Figure 6 compares the two students with previous teaching experience and enrolled in the special topics course to the student with teaching experience not enrolled in the special topics course. TA C showed marginal improvement during the semester of the special topics course, which may be a consequence of scoring high (>4.5) for the questions pertaining to interpersonal rapport. TA D had high scores (>4.5) in the evaluation questions during the Fall 2007 semester, but the scores dropped close to 4.0 during the spring semester. Both TAs C and D scored higher than TA E in both semesters on the evaluation questions related to interpersonal rapport. Recall, TAs C, D and E all taught CE 3171 during the Fall 2007 semester. Additionally, TAs C and D taught new courses the Spring 2008 semester.

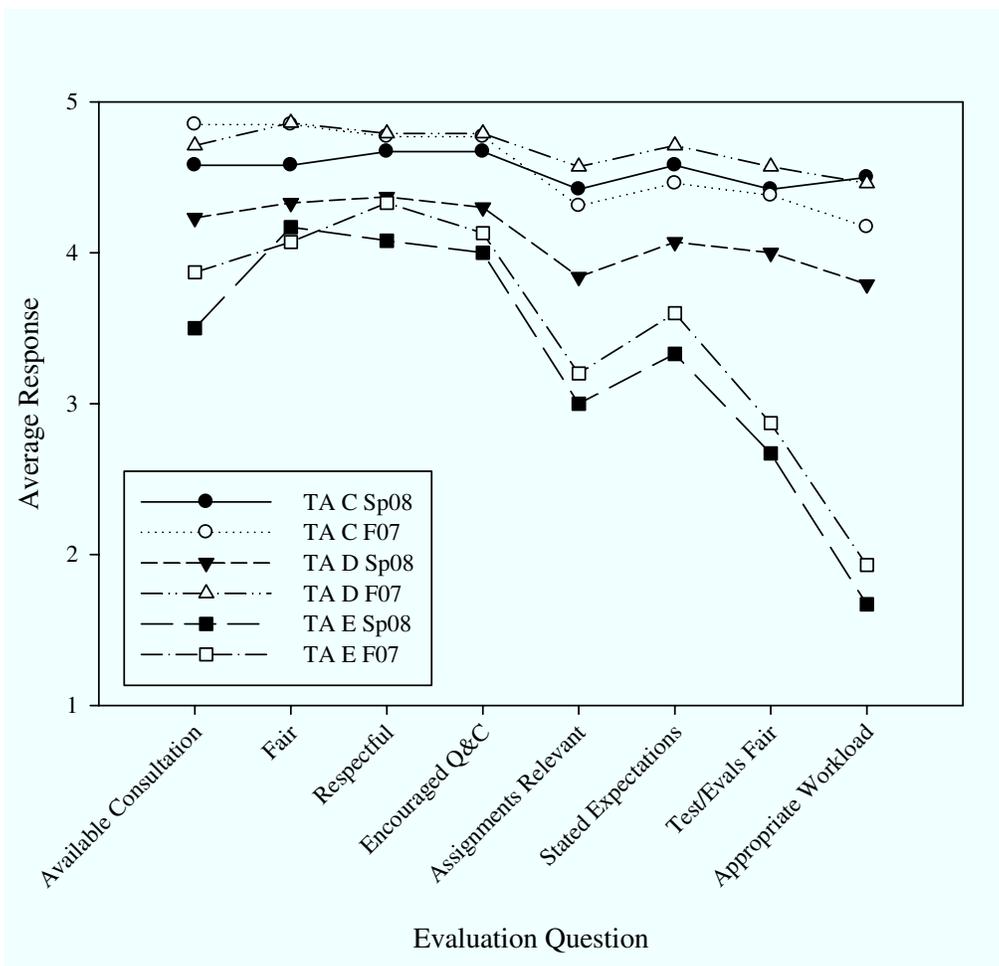


Figure 6. Teaching Evaluation Comparison for Teaching Assistants before and after course Pertaining to Interpersonal Rapport

Between the comparisons in teaching evaluation scores between TAs C, D and E, who all taught CE 3171 in the Spring semester and the improvements in teaching evaluation scores by TA C between the Spring 2008 and Fall 2007 semester, the special topics course improved TA teaching performance. The outlier to the aforementioned trend is TA D, whose teaching evaluations decreased between the Fall 2007 and Spring 2008 semesters. To further investigate this decrease in teaching evaluation performance, the teaching evaluations for TA D for the three semesters of teaching evaluations available are presented in Figure 7. During the Fall 2007 and Spring 2007 semesters, TA D taught CE 3171 and TA D taught CE 3309 the Spring 2008 semester. During the semesters TA D taught CE 3171, the teaching evaluations were similar and were greater than the semester TA D taught CE 3309.

Although TA D's evaluation responses pertaining to IE decreased by approximately 1 point (Figure 3) in the spring 2008 semester compared to Fall 2007, evaluation scores assessing IR decreased by 0.5 points. The results suggest that an instructor that strives to clearly present the

material, engage the students and exhibit other characteristics of IE will have higher IR values because the students recognize the instructors' efforts to create a valuable learning experience. This relationship is confirmed using TA E teaching evaluation data. TA E, who puts in minimal effort into the classroom attributes of IE, consistently performs lower on IR than those who emphasize IE in the classroom (TAs A, B, C and D).

TA D is scheduled to teach CE 3171 during the Spring 2009 semester and TA D's teaching evaluation scores are expected to increase from the CE 3309 values. Additionally, the Spring 2009 teaching evaluations are anticipated to be similar to values from previous semesters the TA taught CE 3171.

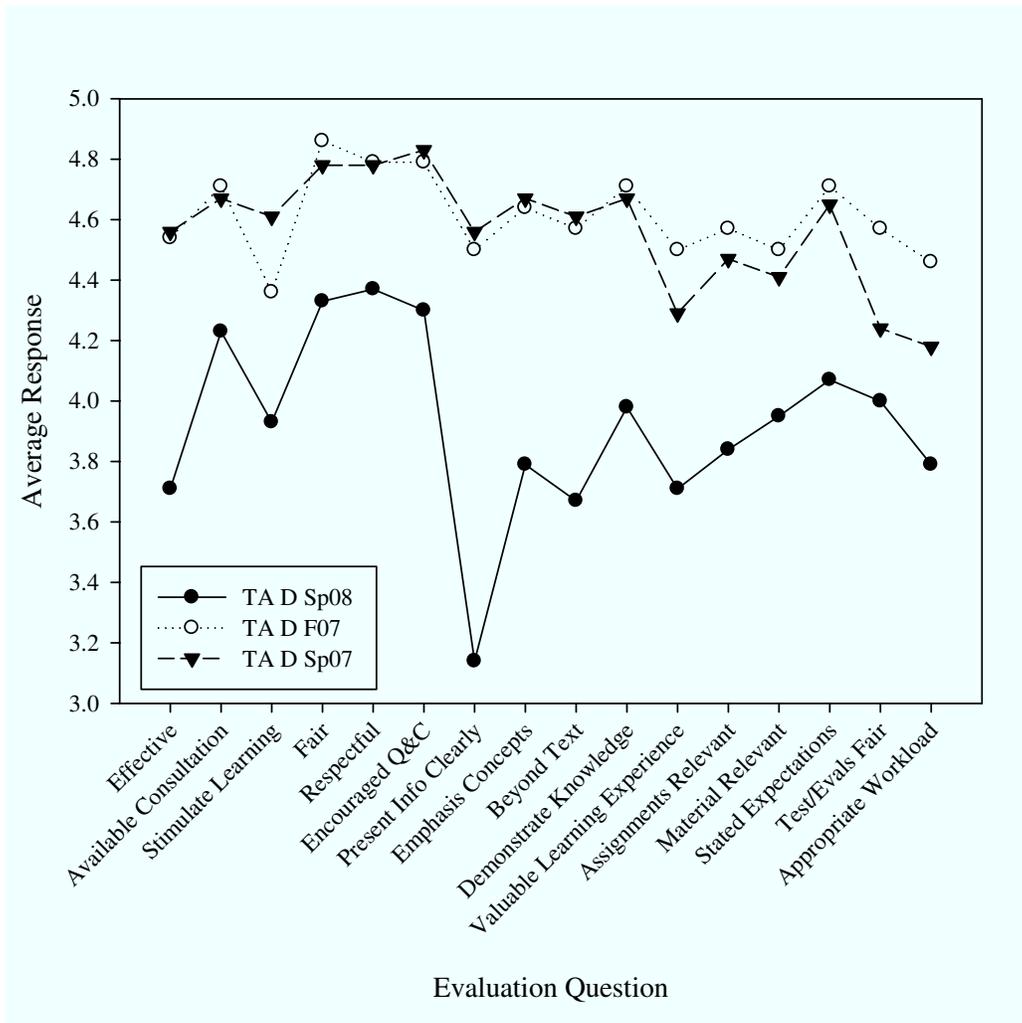


Figure 7. Comparison of TA D Teaching Evaluations for Spring 2008, Fall 2007 and Spring 2007

Classroom Observations. The classroom observations generally focused on the basics of the ExCEED model, specifically: board organization; use of color; question asking and answer techniques; garnering of enthusiasm; appropriate use of technology; orientation to subject matter;

and physical models. In general, the initial classroom observations focused on board layout, objectives and the use of color. By the end of the semester, the TAs board layout and use of color improved. The learning objectives had improved, but one area of weakness was the development of short, unambiguous learning objectives that stretched Blooms Taxonomy. Objectives, which are a component of the ExCEED model, were an area of improvement for all TAs.

Another area of improvement for all TAs was questioning. Either the TA asked few to no questions during class or they asked long, ambiguous questions. Additionally, the TAs needed to work on praising the students that answered questions during class. Questions are an integral component of engaging the students as well as assessing student learning; both are components of the ExCEED model.

TA Questionnaire. Table 3 presents the pre (before class) and post (after class) results for the special topics questionnaire. Note: one student did not complete the post questionnaire. Additionally, two TAs did not answer all of the pre questions. Due to their exposure in their classes (two environmental engineering faculty members have attended the ExCEED workshop and use the ExCEED model) and previous exposure during mentoring by the author of this article, the TAs believed the model can improve their teaching and help them be a more confident instructor. The TAs were mixed as to whether or not the model was too complex and implementation would be too time intensive. However, the post survey shows that the TAs disagreed that the ExCEED model was too complex to implement and implementing the model would be time intensive. The course did not change the TAs' attitudes towards learning objectives and the use of questions in the classroom.

Class strength comments include:

- “Helped me focus on areas I had been ignoring (objectives, questions and board notes) or short-changing”
- “Overall, I believe I am a better lecturer for the class”
- “Good class; really made me think about the way I teach and convey ideas”

Class areas of improvement include:

- “Some topics were not as useful for me (technology, learning styles) or were more difficult to apply”

Comments regarding the ExCEED model:

- “Self evaluation of IE and IR still suspect”

Table 3. Responses to ExCEED Model Assessment Questions

Questions	Pre*					Post*				
	SA	A	N	D	SD	SA	A	N	D	SD
1. I think my teaching scores will improve by implementing the ExCEED teaching model	3	1				1	2			
2. The ExCEED model is too complex to implement		1		1	1				3	
3. Implementing the ExCEED model will be time intensive		3		1					3	
4. I want to be an exemplar teacher	3	1				3				
5. Implementing the ExCEED model will help me be a more confident instructor	1	3					3			
6. Learning objectives are not helpful to include in my lessons				3	1				2	1
7. Asking students questions is class alienates them			1	1	2				2	1
8. I am interested in improving my teaching skills	4					3				
9. Implementing the ExCEED model will improve the structure and clarity of my lessons	1	3				2	1			
10. I believe teaching is a learned skill	2	1				1	2			

Note: SA=strongly agree; A=agree; N=neutral; D=disagree; and SD=strongly disagree

*Number of responses

The comments and the pre-post survey suggest that the students valued the special topics course and believe the course improved their teaching effectiveness. The written comments suggest more class time during the special topics course should cover the difference between intellectual excitement and interpersonal rapport. Additionally, the difference between intellectual excitement and interpersonal rapport should be connected to the TAs strengths and areas of improvement as well as the teaching evaluation questions. The results of teaching evaluations suggest future revisions of the special topics course should cover identifying relevant course material, determining appropriate workload, and selecting relevant assignments as all TA's had low responses for the corresponding teaching evaluation questions.

Conclusion

The results of the study suggest a course based on the ExCEED teaching model improved TA teaching effectiveness. Additionally, the TAs are more confident teachers because their lessons are structured, organized and stimulating. The course helped them identify strengths and areas of improvement, which they can continue to address in future TA experiences. Currently, the course is a special topics course and will be taught when the need arises to train new TAs. The course may become a short-course taught before school starts so that all new TAs are exposed to

the ExCEED model before entering the classroom. Additionally, this course was taught only to environmental engineering students and may be taught to the civil engineering graduate students or to TA in other engineering majors. Regardless of whether or not the class is taught, the author will visit the TAs classes to assess TA effectiveness and the application of the ExCEED model.

Desire and teaching experience may provide similar results; however, this approach requires more time and may result in ineffective learning experiences until the TA learns effective teaching strategies through trial and error. Overall, the application of the ExCEED model will improve teaching effectiveness; however, the greatest gains will be made for individuals who desire to be excellent teachers.

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