TEACHING GRADUATE TEACHING ASSISTANTS (GTAS) HOW TO TEACH

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Abstract: *From 1992 to 1998, an **Engineering Concepts** course was taught to first year students at the University of Virginia (UVa). In that time, enrollments increased from 250 students to over 500 each fall. As the course grew, we employed a team of graduate teaching assistants (GTAs) to provide individual and small group learning experiences. Over 50 students served as GTAs during the life of the course. They varied greatly in communication skills and teaching effectiveness. From 1994 to 1998, we compiled data on all aspects of this course - including ratings for individual faculty and GTAs.*

What makes a successful GTA? Why do some students fail to perform well? In this paper, we reflect on our experiences with these graduate students and their contributions to this course. We also report the results of surveys of their students. There were some surprises; faculty members cannot always predict who will do well and who will fail as teachers. The issues raised by the undergraduate students in evaluating their GTAs are not always what we expect.

INTRODUCTION

Engineering Concepts was a unique course at the University of Virginia's School of Engineering and Applied Science. It was the only course in which graduate teaching assistants (GTAs) were actually allowed to teach. The course had three components: lectures, labs, and workshops. In Lecture, over 300 students gathered in a large auditorium to listen to their professors. In Lab, groups of 116 students participated in scripted lessons while each worked at a computer. Workshops provided the opportunity for our students to experience a small class in which they could receive some degree of personal attention. Every year, sixteen workshops were offered, each taught by a GTA to a group of around 30 students.

Engineering Concepts had two distinct missions. One was to introduce engineering problem solving and some fundamental concepts (units, statistics, matrices, representing technical information, circuits, material balances, material properties,…). The other was to introduce the computing skills necessary for modern engineering and applied science (Internet use, spreadsheets, computer aided design, and elementary programming).

This course was required of most first year Engineering students. We also enrolled some transfer students from other schools and some students from the College of Arts and Sciences who hoped to enroll in Engineering. For most years of this study, there were over 470 students each year in this class. The students were a diverse group - especially in terms of background and motivation. Some had extensive computer skills; most had some experience with spreadsheets and word processing, but no programming or computer aided design.

GTAs are assigned to this course by their departments. Thus, we might have students from any of our 13 graduate departments. Typically, the Departments use this course, and others in the core, to fund incoming graduate students. We have minimal control over who is assigned to us. We have asked a few students to repeat as GTAs, but this is not typical. Most are picked up on research contracts, and are no longer available for teaching. We have had several advanced graduate students assigned to us, often because their advisor recommended that they gain some teaching experience in preparation for seeking an academic job.

Our graduate enrollments include ever-greater numbers of foreign students. Many score well on tests of English proficiency, but often have trouble communicating in classroom situations. As we will see, first year students are relatively unforgiving if they cannot understand their instructor, or if their GTA is not fluent enough to easily understand and respond to questions in class.

Typically, the graduate students assigned to this course do not have the level of computer skills we expect of all UVa undergraduates. Indeed, some lack fundamental engineering knowledge. They represent many different undergraduate schools and diverse fields of engineering and applied science. Thus we must often teach these graduate students the course material – sometimes in a just-in-time mode.

Course Logistics

Our GTAs filled several roles in this course: each taught at least one workshop session and assisted in our computer labs. Thus they experienced teaching in two distinct environments The GTAs were expected to attend all lectures, participate in several labs each week, conduct one or two workshops, and hold regular office hours. They also monitored and graded tests. Workshops provided the opportunity for students to ask questions in a small group setting. Homework and tests were returned and discussed in workshops, and occasionally, quizzes were given.

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We held a weekly staff meeting for all GTAs and the faculty. At this meeting, we discussed what would be covered in the next week's lectures and labs, as well as problems and questions from the previous week. These meetings were sometimes devoted to tutorials on the software we were about to introduce. Early in the semester, we discussed several issues that GTAs must be aware of: the UVa Honor system, diversity issues, questions of sexual harassment and UVa's policy on relationships, and various other problems that arise in teaching.

Survey of GTA performance

In 1994, we started collecting systematic data on all aspects of this course, including evaluations of the GTAs. Near the end of every semester, we administer several surveys-including the school's official course evaluation form. Our own survey is far more detailed, and asks specific questions about the individuals involved in teaching the course. At the beginning of the questionnaire, we ask the students to rate the value of lecture, lab, and workshop in helping them learn the course material. Then a series of questions probe their reactions to each of the instructors, the software used in the course, and the logistics. At the end, there is a set of questions about their particular teaching assistant, and space for comments.

We have a data set representing 5 years experience teaching and evaluating Engr160; it includes ratings of 48 GTAs teaching a total of 78 workshops from 2028 students. Data from two 1995 workshops is not currently available.

Survey Results

When individual students rated the value of the three components of this course, the computer labs were seen as most valuable (mean = 3.28), followed by workshops (mean = 3.17) and lectures (mean = 3.14). Ratings of the value of lecture and labs are moderately correlated (r = .35), but ratings of the value of workshops are uncorrelated with either lecture (r = .05) or lab (r = .14). These figures are based on 2028 students. Clearly the students varied in what they perceived to be most valuable about this course.

All GTA were rated by the students in their workshop(s) on the following attributes:

1. Preparation for class
2. Timeliness in returning homework and tests
3. Responsiveness to questions
4. Willingness to provide help
5. Availability during office hours
6. Effectiveness in helping you learn the material
7. Knowledge of the software
8. Knowledge of the engineering concepts
9. Overall Rating

These attributes were selected after discussions with students and faculty about the criteria they felt were important in evaluating teaching in this context. For each item, responses could range from 1 to 5 where 1 represents the low (poor) rating and 5 the best. Some students entered zeros or 10s in the margins for particular GTAs; we entered the zeroes, but scored the 10s as 6. The data analysis was conducted using Excel 2000 following standard statistical procedures (1, 2).

Table 1 shows the intercorrelations of all these variables based on individual cases (N=2028). The overall ratings of the GTAs were correlated with most other attributes. The weakest correlations were with timeliness in returning homework and tests and availability during office hours. The tests were graded by the GTAs, and were returned by the next workshop. Homework was graded by a team of undergraduates; thus, the promptness of its return was not controlled by the GTA. The question on office hours had a large number of missing ratings. A substantial number of students said they never tried to contact their GTA outside of class.

Table 2 shows the intercorrelations on all variables based on the means for each workshop (N=78). Here the correlations are stronger, since we have eliminated the variability within workshops. Effectiveness and overall rating are very strongly correlated (r = .96), as are responsiveness, willingness to help, preparation, and knowledge of software and of concepts. The pattern of correlations within these Tables suggests that GTAs who do any of these things well do all of them well.

In Figure 1, the mean ratings on the attributes for all instructors and workshops. There are large differences in workshop ratings as a function of the particular instructors. The ranges of most attributes are relatively large. The lines seem to connect ratings as we would expect, but with so many profiles it is difficult to see the patterns.

We selected the 10 most effective GTAs, and the 10 least effective – based on their overall ratings. Figure 2 shows the profiles for GTAs in both groups. The separation is quite striking. Those GTAs whose overall ratings are low lack most of the attributes shown by the top GTAs.

Student Comments about GTAs

We next compiled all the comments made by students about their GTAs. There were extreme differences in the words used to describe the most successful GTAs in comparison to the least successful.

Most successful GTAs: cooperative, understanding, considerate, helpful, enthusiastic, tough, dedicated, thorough, attentive, genuinely interested, kind, responsive, fair, patient, knowledgeable, well prepared, open, available, caring, awesome, wonderful, wit and humor, pleasant, on top of things, helped everyone to learn, explained things well

and made sure we all understood, if he didn't know the answer, he would find out, kept us up-to-date, review sessions for tests, gave us lots of time, expected us to ask questions; gave frequent quizzes, example problems, review sheets, e-mails.

Least successful GTAs: not responsive, didn't know stuff, not enthusiastic, argumentative, hard to approach, hostile, seemed to dislike job, not aware, ill prepared, disorganized, little initiative, blunt, not very informed, language barrier, unable to communicate, slacker, no firm grasp of material, hard to understand, very informal, no planned activity, accent problem, didn't want to be there, passive, hard to hear and understand, awkward at times, nervous, didn't know anything, didn't care, has a certain confidence that interferes with his ability to teach, bad about returning papers, what took 10 minutes was spread over 50 minutes in workshop, doesn't return e-mail, not very helpful, couldn't express his ideas well.

The most successful GTAs exhibited competence, but that alone is not enough. They liked what they were doing, and cared about their students. They had a genuine interest in the welfare of their students, and put in extra effort on their behalf. They had enthusiasm, and went beyond the bare requirements of their job. They had respect for their students, and exhibited fairness, consistency, availability and helpfulness.

These highly successful GTAs have been evenly distributed over the years we taught this course. Every year there are 2 or 3 stars, and a bunch of acceptable performers. The best GTAs set a standard that the others try to achieve.

The least successful GTAs were polar opposites on many of the same dimensions. Their students felt that they didn't want to be teaching this class, but had to. For these GTAs this was only a job, and they choose to do the bare minimum. Several GTAs exhibited arrogance, hostility, and provinciality. A couple only answered hard questions, and belittled those who asked easy ones. Some told their workshop students that what they were learning in this class was unimportant, or would never be used again. The poorer GTAs showed no imagination, did only what they were told to do, and put in no extra effort. The problem of course is how much of a contrast these GTAs were from the others; their students knew how badly they were being treated and resented it.

The unsuccessful GTAs were mostly concentrated in the early years of this course. In 1994 and 1995, we had 3 problem individuals each year. Two each year were not native English speakers. Indeed, seven of the 10 students rated low in effectiveness had communication problems; first year students reported not being able to understand them. One year we had half the GTAs with less than optimal English language skills.

In 1996, we insisted on screening any foreign students prior to accepting them as GTAs for this class. That year, two foreign students were accepted - both seemed to have adequate English skills - one worked out, the other did not. From 1996 to 1998, there were three cases of students I was reluctant to employ because of their accents but who then proved to be excellent instructors. They were sensitive enough to their students to pace themselves appropriately, and to adjust their interactions patterns to their audience.

WHAT CAN WE TELL GTAS ABOUT HOW TO TEACH?

We now teach our graduate students about teaching strategies, methods, and attitudes. Among our suggestions are the following:

Know the material
Keep ahead of your students
Do all problems in advance of class
Plan your workshops, but be willing to let the plan go if circumstances warrant
Be confident in dealing with students. You are more knowledgeable, and more mature.
You don't have to know all the answers, nor deal with all the questions.
Don't rush in with the answer. Make the students think about their question. Make them do some work, before you do.
Never let a workshop out early; if they don't have questions for you, ask some of them.
Never tell your students that what they are learning has no value. Your field may not need material balances or computer programming, but most do.
Don't advocate for your discipline. Not everyone should be a (chemical, systems, aerospace) engineer.
No matter how good you are, some students won't like you. No matter how bad you are, someone will.
With effort and experience, your teaching will improve.

What else can we do to improve graduate student teaching?

After the first few years, we developed several strategies and policies designed to improve our GTAs' teaching skills and attitudes. We tried to become more involved in ensuring their success.

Selection: The most successful GTAs are those students who want to teach. When a student asks to be placed in this course, I typically jump at the chance to get them. I have accepted several "weaker students" who really wanted to teach, and each proved exceptional. They were good at assessing what their students didn't understand, and conveying the necessary knowledge in a comprehensible manner. Several advanced PhD students have been disasters,

in part because this assignment distracted from their research, but also because they were arrogant and hostile to teaching.

Motivation: We developed a set of guidelines for GTAs, and instituted a weekly staff meeting to discuss problems and approaches to teaching. We introduced the weekly staff meetings in part for their motivational value. Those GTAs who are excited about teaching stimulate and challenge the others. This meeting often set up a competitive dynamic, in which the workshop instructors tried to outdo each other in eliciting optimal performance from their students. We cannot dictate caring, or concern for students, but competition often yields similar results.

Control: We now give academic credit for being a GTA. We require all GTAs to attend the regular weekly lectures. Lab lessons are distributed enough in advance to allow the GTAs to work through them and raise questions. Each week I prepare a list of suggested workshop activities. Although the more successful GTAs don't need them, they invariably use them; and still manage to go further. The less successful GTAs at least had something to do.

Midterm evaluations: We now require each GTA to distribute a standard mid-semester workshop evaluation. These are solely for the GTA's personal use. The faculty never sees the results. But the GTAs can become aware of problems in time to take corrective action. They are encouraged to bring their problems to us – either individually or at the weekly staff meeting.

Conclusions

Of course, this paper is not only about teaching assistants, it is also about us. Generally, what makes a good or bad GTA is also what makes a good or bad professor. Perhaps some of these recommendations will be helpful to those just starting their teaching careers. These results remind us of what we should already know. Pat Cross reviewed the characteristics of a good teacher in her ERM Distinguished Lecture in 1991 (3): knowledge and preparation, concern for students, enthusiasm, availability, ability to explain clearly, stimulation of interest, and encouragement of discussion.

Much of what makes an instructor good is competence and preparation. Students quickly become aware if an instructor hasn't taken the time to prepare for class. However, a major component of student reactions and performance involve the attitudes and behaviors of the teacher. Caring about students is evident both in the classroom and out. How can we instill concern for students in our teaching assistants? Primarily by modeling it: if the faculty shows empathy and understanding for all our students, our GTAs will notice and try to imitate it.

A great deal of work has been done on the importance of student attitudes toward engineering education (4, 5), and some on faculty attitudes (6). Programs designed to teach teachers (7) should emphasize the affective as well as intellectual components of teaching excellence.

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Table 1: Intercorrelations of attribute ratings based on individual cases (N= 2028)

	prep	timely	responsive	help	available	effective	software	concepts
Preparation	1.00							
Timeliness	0.42	1.00						
Responsiveness	0.63	0.39	1.00					
Willing to help	0.52	0.34	0.70	1.00				
Availability	0.49	0.40	0.50	0.58	1.00			
Effectiveness	0.64	0.35	0.71	0.61	0.53	1.00		
Kwlg of software	0.59	0.32	0.59	0.51	0.44	0.63	1.00	
Kwlg of concepts	0.61	0.32	0.58	0.51	0.45	0.62	0.75	1.00
Overall rating	0.71	0.46	0.78	0.72	0.57	0.80	0.67	0.69

Table 2 Intercorrelations of attribute ratings based on workshop means (N= 78)

	prep	timely	responsive	help	available	effective	software	concepts
Preparation	1.00							
Timeliness	0.57	1.00						
Responsiveness	0.87	0.57	1.00					
Willing to help	0.72	0.46	0.87	1.00				
Availability	0.75	0.59	0.77	0.81	1.00			
Effectiveness	0.86	0.56	0.92	0 0.80	0.83	1.00		
Kwlg of software	0.82	0.46	0.83	0.72	0.68	0.79	1.00	
Kwlg of concepts	0.88	0.49	0.85	0.70	0.68	0.85	0.93	1.00
Overall rating	0.88	0.64	0.94	0.88	0.85	0.96	0.81	0.86

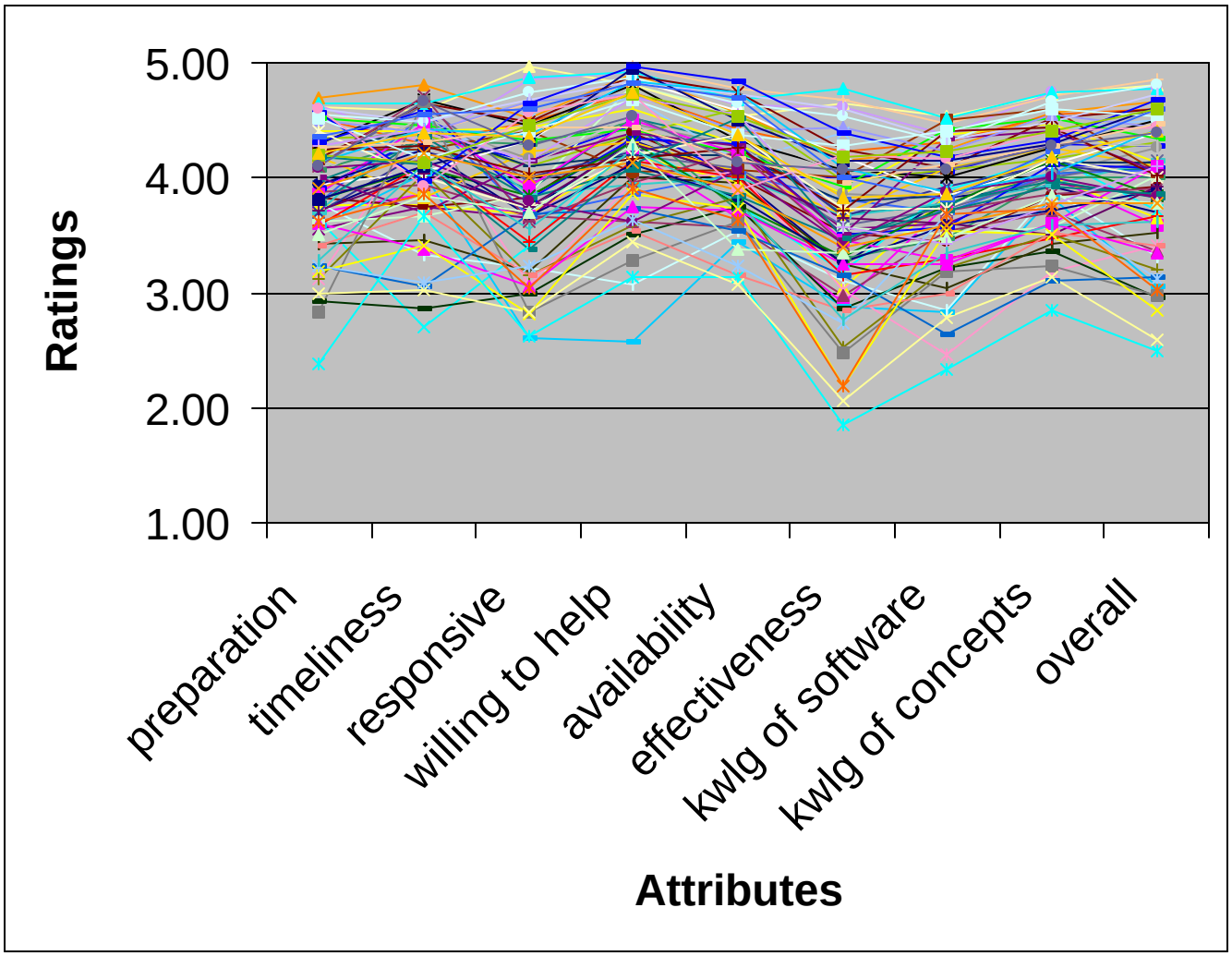

Figure 1 Attribute profiles for all GTAs and all workshops

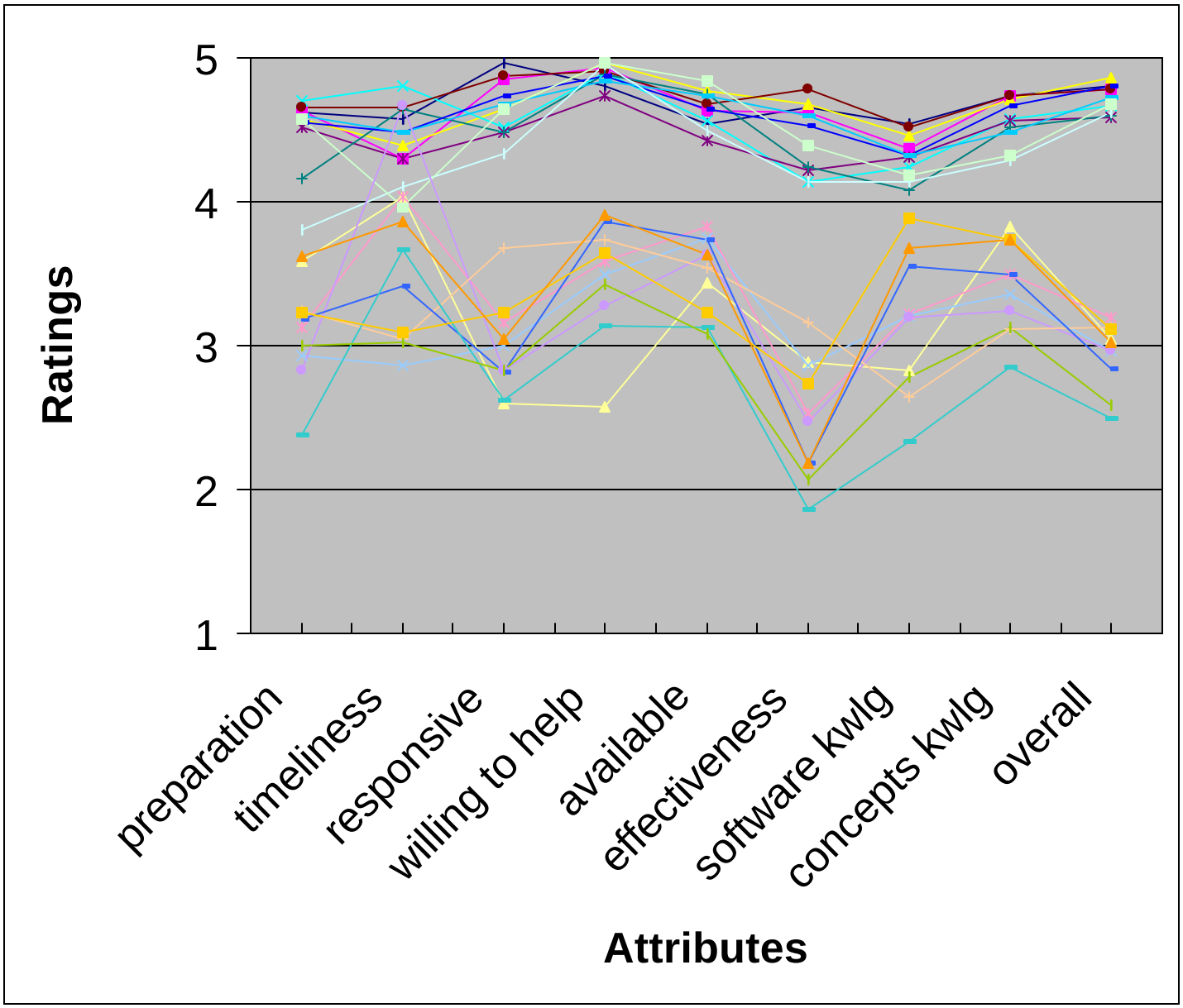

Figure 2 Attribute Profiles of GTAs with highest and lowest on overall ratings