Graduate Teaching Assistants Can Affect Undergraduate STEM Retention Rates: A Need For Graduate Teaching Professional Development

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Abstract

The first two years of college are the most crucial for retention, and less than 40% of entering college students actually completes a STEM degree. Graduate teaching assistants (GTAs) play a vital role in biology departments across most universities by teaching the majority of introductory laboratories and discussion sections. Though GTAs are not directly attributed to attrition rates of undergraduate science majors, attrition rates can be linked with lab climate which is influenced by GTAs. However, most GTA teaching at universities and colleges is done without any formal training and this could have a serious effect on STEM retention rates. This research examines the effects of a biology pedagogy course on GTA teaching confidence and teaching concept awareness. Based on pre-assessment surveys, GTAs walk into their first day being confident in their teaching abilities; however, they had minimal knowledge of basic teaching concepts. GTAs felt slightly more than "I have heard of this" but much less than "I know this" across all teaching concepts. There was a significant increase in both teaching confidence and teaching concept awareness, across all parameters. However most importantly, GTAs moved from an "I've heard of this" to an "I know this very well" teaching mentality. Importantly, this means that most GTAs are teaching with an "I've heard of this" teaching mentality in the majority of introductory laboratories and discussion sections where no teaching professional development exists. If poorly taught introductory courses contribute to the significant loss of STEM majors and GTAs teach with an "I've heard of this" teaching mentality it is no wonder that GTAs could have a serious effect on undergraduate STEM retention. If STEM retention rates are to improve not only must we look to the current faculty, we must also train our graduate teaching assistants.

STEM Retention vs. GTAs

Less than 40% of entering college students actually completes a STEM degree, and the first two years of college are the most crucial for retention (PCAST 2012). Seymour and Hewitt (1997) suggest that based on their introductory course experiences students often decide if they with major in or leave science. Labov (2004) concluded that poorly taught introductory courses could contribute to the significant loss of STEM majors. As a result, there is a large push to transform undergraduate STEM education (AAAS 2012; PCAST 2012; HHMI 2013). Many of these groups recommend faculty use evidenced-based teaching methods to transform their courses and laboratories. Yet during the years crucial for retention, graduate teaching assistants (GTAs) potentially spend more direct contact time with undergraduates than professors (Baumgartner 2007). Graduate TAs play a vital role in biology departments across most universities by teaching the majority of introductory laboratories and discussion sections (Travers 1989; Rushin et al. 1997; Luft et al. 2004; Sundberg et al. 2005; O'Neal et al. 2007). Though GTAs are not directly attributed to attrition rates of undergraduate science majors, attrition rates can be linked with lab climate which is influenced by GTAs (O'Neal et al. 2007). However, most GTA teaching at universities and colleges is done without any formal training (DeHaan 2005; Sundberg et al. 2005; Tanner and Allen 2006). Rushin et al. (1997) identified that most of the biology graduate schools surveyed do not require any formal training to be a GTA (75 out of 135 schools), followed by pre-service workshop (required or strongly recommended; 34 of 135), seminar in college teaching (21 of 135), and finally formal college teaching course required for all GTAs (13 of 135).

Teaching Concept Awareness Vs. Teaching Confidence

This research utilizes a mixed method pre- and post-assessment (online survey) assignment, IRB# 503231, to assess the *Biological Pedagogy* course's effectiveness on the GTA's: **1)** teaching concept awareness and **2)** teaching confidence. Here are the results for four semesters, n = 43:

Teaching Concept Awareness

For each of the following items students were asked to answer the question, I have knowledge of the following teaching concepts (Answer choices are presented on a continuum between 1 and 5: 1) I have never heard of this, 2) I have heard of this, 3) I know this, 4) I know this very well, and 5) I know this so well I could teach someone else):

1. Student Motivation Techniques
2. Classroom Management Techniques
3. Reflective Teaching
4. Learning Styles
5. Questioning Strategies
6. Teaching Methods
7. Student Assessment
8. Accommodating Students with Disabilities
9. Expected Learning Outcomes
10. Teaching Philosophy Statements & Teaching Portfolios

Table 1

Question #	1	2	3	4	5	6	7	8	9	10
Pre Avg.	1.93	2.16	2.09	2.53	2.14	2.26	2.53	2.63	2.88	2.02
Post Avg.	3.84	4.16	4.51	4.49	4.33	4.30	4.37	4.16	4.41	4.02

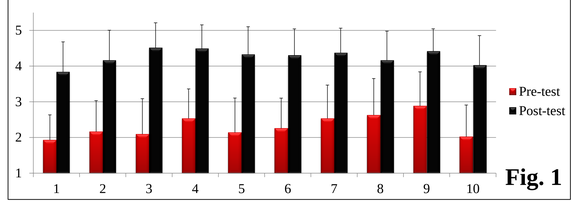

Fig. 1

Teaching Confidence

For each of the following items students were asked to answer the question, I feel confident and competent to (Answer choices are presented on a continuum between 1 and 7 with 1 being no confidence, 4 being moderate confidence, and 7 being complete confidence):

1. Specify the learning goals that I expect my students to attain.
2. Actively engage my students in the learning activities that are included in the teaching plan/syllabus.
3. Create a positive classroom climate for learning.
4. Promote student participation in my classes.
5. Prepare the teaching materials I will use.
6. Maintain high academic expectations.
7. Appropriately grade my students' exams/assignments.
8. Train my students as active learners, which is to say knowledge builders rather than information receivers.
9. Provide support/encouragement to students who are having difficulty learning or for those who have a learning disability.
10. Calmly handle any problems that may arise in the classroom.
11. Develop my teaching skills using various means (attend TLPDC sessions, sign up for teaching courses, read about teaching, etc.).
12. Encourage my students to ask questions during class.
13. Make students aware that I have a personal investment in them and in their learning.
14. Be flexible in my teaching even if I must alter my plans.
15. Make students aware of the relevance of what they are learning.

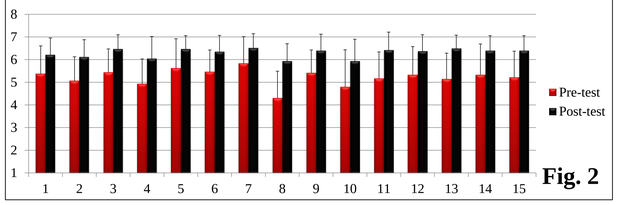

Fig. 2

Results

Over four semesters, 43 GTAs took the teaching course. Pre-course assessment results revealed that GTAs are confident in their teaching abilities, where across all questions most GTAs feel more (5.23 out of 7) than moderately confident in their teaching abilities (Fig. 2). Graduate TAs reported an average of 5.44 out of 7 that they were confident they could create a positive classroom climate (Fig. 2). However, GTAs felt slightly more than "I have heard of this" (2.32 out of 5, Fig. 1), but much less than "I know this" across all teaching concepts (Table 1). Specifically in areas of student motivation techniques GTAs reported an average of 1.93 out of 5 and in classroom management techniques an average of 2.16 out of 5 (Fig. 1). In comparing pre- and post-course assessment results, a significant difference was determined in all teaching confidence and concept awareness categories. Post-course assessment results revealed that GTAs confidence rose from 5.23 to 6.30 across all confidence questions (Fig.2), and from 2.32 to 4.26 across all concept awareness questions (Fig.1).

Conclusion & Discussion

Over the course of the four semesters of this study, between the GTAs and their GTA mentors, the GTAs had the potential to affect up to 13,464 undergraduate students (Table 2). With most GTA teaching at universities and colleges is done without any formal training (DeHaan 2005; Sundberg et al. 2005; Tanner and Allen 2006), the number of undergraduates receiving an education from GTAs (or professors) without any formal teaching professional development is incredible. Without the *Biological Pedagogy* course, unless achieved under the GTAs own initiatives, these GTAs would have taught these 13 thousand undergraduates with little understanding about teaching. GTAs might have walked into their first day being confident in their teaching abilities (Fig. 2); however, they had minimal knowledge of basic teaching concepts (Fig. 1). For example on the pre-assessment survey, with regards to Accommodating Students with Disabilities, GTAs responded on average 2.63, in between "I've heard of this" and "I know this" (Fig. 1). However, when asked their confidence in "Provide support/encouragement to students who are having difficulty learning or for those who have a learning disability" GTAs responded on average 5.42, more than moderately confident (Fig. 2). This indicates a disparity between teaching confidence and an understanding about the theory behind teaching.

If undergraduate student leave STEM majors because of poorly taught introductory courses and there is a teaching gap in GTAs (Seymour and Hewitt 1997; Labov 2004), STEM attrition could be attributed to a lack of teaching professional development. Though GTAs have not been directly attributed to attrition rates of undergraduate science majors, attrition rates can be linked with lab climate which is influenced by GTAs (O'Neal et al. 2007). GTAs are teaching with an "I've heard of this" teaching mentality in many areas that are core concepts of classroom climate. In order to help our GTAs in the classroom it is imperative that they receive some form of teaching professional development. If STEM retention rates are to improve not only must we look to the lecture, focus must also give to train our graduate teaching assistants early in their graduate programs.

GTA Impact Numbers

Table 2

	# of GTAs	# of Mentors	Total # of Impacted GTAs	Classes Taught Per Semester	Students per class	# of Semesters Per Year	Total # Students Impacted Each Academic Year	Years of Affect	Total # Students Impacted By Project
Spring 2012	12	7	19	3	24	2	2736	2	5,472
Fall 2012	18	8	26	3	24	2	3744	1.5	5,616
Spring 2013	6	5	11	3	24	2	1584	1	1,584
Fall 2013	7	4	11	3	24	2	1584	0.5	792
									13,464

References

American Association for the Advancement of Science (AAAS). 2011. Vision and Change in Undergraduate Biology Education, Washington, DC.

Baumgartner, E. 2007. A professional development teaching course for science graduate students. Journal of College Science Teaching. National Science Teachers Association. 21 Oct. 2011.

DeHaan, R. 2005. The impending revolution in undergraduate science education. Journal of Science Education and Technology 14:253-269.

Labov, J.B. 2004. From the National Academies: The challenges and opportunities for improving undergraduate science education through introductory courses. Cell Biology Education 3:212-214.

Luft, J.A., J.P. Kurdziel, G.H. Roehrig, and J. Turner. 2004. Growing a garden without water: Graduate teaching assistants in science laboratories at a doctoral/research university. Journal of Research in Science Teaching 41:211-233.

O'Neal, C., M. Wright, C. Cook, T. Perorazio, and J. Purkiss. 2007. The impact of teaching assistants on student retention in the sciences: Lessons for TA training. Journal of College Science Teaching 36:24-29.

President's Council of Advisors on Science and Technology (PCAST). 2012. Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.

Rushin J.W., J.D. Saix, A. Lumsden, D.P. Streubel, G. Summers, and C. Bernson 1997. Graduate teaching assistant training: a basis for improvement of college biology teaching and faculty development? Am Biol Teach, 59:86-90.

Seymour, E. and N.M. Hewitt. 1997. Talking About Leaving: Why Undergraduates Leave the Sciences. Westview Press. Boulder, CO.

Sundburg, M.D., J.E. Armstrong, and W.E. Wischusen. 2005. A reappraisal of the status of introductory biology laboratory education in U.S. colleges and universities. American Biology Teacher 67:525-529.

Tanner, K. and D. Allen. 2006. Approaches to biology teaching and learning: On integrating pedagogical training into the graduate experiences of future science faculty. Life Sciences Education 5:1-6.

Travers, P.L. 1989. Better training for teaching assistants. College Teaching 37:147-149.

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