Reflections on Teaching and Mentoring

Dr. Diane L Peters, Kettering University

Dr. Diane Peters, P.E. is an assistant professor of mechanical engineering at Kettering University.

Reflections on Teaching and Mentoring

Abstract

Graduate students at various universities may have the opportunity to participate in a variety of outreach activities which may include teaching or mentoring others. These experiences are generally considered to be beneficial for both the graduate student who is participating in the activity and the population that is being taught or mentored. As they assist others, the graduate student has the opportunity to develop his or her skills as a teacher and a mentor, which are critical skills for someone who wishes to pursue an academic career.

Several years ago, the author of this paper participated in a university-sponsored outreach activity as a graduate student at the University of Michigan, in which she spent several hours each week for an entire academic year at a local high school that served a community with a large population of underrepresented minorities. In this program, graduate students partnered with high school teachers, and were a regular presence in one or more of their classes. In the course of the program, they were expected to assist the teacher with science-related and engineering-related activities, help small groups of students who were having difficulties in the class, and serve as role models to the high school students. As part of this program, each graduate student was encouraged to start a blog, and to regularly post updates to their own blog or to a group blog.

In this paper, the author will use the techniques of auto-ethnography to analyze the content of her blog, in order to determine what effect these experiences had on her development as a teacher and a mentor. This analysis will be influenced by the passage of time and by later experiences, since the author has since graduated, worked as an adjunct faculty member and in an industrial position, and subsequently began a tenure-track faculty position. The results of this analysis will be of interest to graduate students who have the opportunity to participate in similar outreach programs, as they can consciously work to gain the insights that will help them in later stages of their careers, and to those designing such programs, as they will be able to use this information to explain the value of similar programs to all of those involved in them.

Introduction

The research material for this study is a blog maintained by the author-researcher while she participated in a university-sponsored outreach program at the University of Michigan. In this outreach program, graduate students in STEM fields spent two days per week at a high school in a nearby community, Ypsilanti, Michigan, embedded in science and/or math classes. While the University of Michigan and Ypsilanti High School were geographically close, they were in quite different types of communities. The university was located in the economically advantaged area of Ann Arbor, while the high school was in a predominantly minority community that was less affluent. One of the objectives of the program was to provide students at Ypsilanti High School with role models, in an effort to encourage them to pursue higher education, particularly at the University of Michigan. The graduate students selected for the program were, in many cases, interested in pursuing academic careers, and one of the benefits the program offered to them was

the opportunity to gain new experience and perspectives that would be helpful for these aspirations.

The author-researcher in this study participated in this program in the academic year immediately preceding her candidacy in a doctoral program. She had previous experience in education, having worked as an adjunct faculty member at a community college, and had participated in a variety of outreach activities through professional societies such as the Society of Women Engineers (SWE) during the portion of her professional career preceding graduate study. After participating in this program, she discontinued posting in the blog and did not revisit the material for several years; in the interim, she completed her doctorate, spent a year as a post-doctoral researcher while teaching as an adjunct at a regional comprehensive university, worked in industry for a time, and then accepted an academic position.

Background

Graduate students in engineering have a variety of motivations for pursuing their education. While some are focused primarily on research and plan to continue that focus in industry or academia, others have a strong interest in teaching, and plan to pursue an educational career at a teaching-focused institution. Some universities, in their efforts to promote outreach and expand the population of future engineering students, recruit these graduate students into outreach programs. Examples of some of these programs have included the K-12/University partnership at the University of Colorado at Boulder[1] and the partnership program between the University of Michigan and the Ypsilanti Public School District.[2] In these and similar programs, graduate students in engineering are placed in classrooms with pre-college students, in an effort to increase their knowledge and interest in STEM subjects.

In addition to their benefits to the K-12 students, these programs may benefit the graduate students who participate in them. Graduate students may gain experience in teaching and mentoring, including the opportunity to develop materials that they present in the classroom.[1,2] In addition to the satisfaction of making a difference in students' lives, participating in outreach programs has been shown to improve collegiate teaching.[3] As graduate students design activities and implement them in the classroom, they gain experience in lesson planning, learn the importance of pre-and post-activity assessments, and discover what types of pedagogy are most effective for the material they wish to present.[3]

Methods

Research Material

As part of the program, each of the graduate students was instructed to maintain a publically accessible blog. The particular blog in question was maintained from the fall of 2007 through the end of the academic year in spring of 2008, and was exclusively used to document experiences in this program. During the full time period covered, the author-researcher worked with two teachers at the high school, and was involved with an advanced algebra class for one and a physics class for the other. Typically, two posts per week were generated, outside of scheduled school breaks. There was, at the time, no intention to use the blog's material for research; it was maintained primarily because it was an expectation of the program. However, as it progressed,

the author-researcher did find it useful for reflection. The blog is publically available, and can be accessed at http://ypsdta-dlpeters.blogspot.com/.

Analysis Methods

The contents of the blog were analyzed using the technique of autoethnography, which has been used in several engineering education studies in recent years.[4,5,6] While some researchers question the value and validity of autoethnography[7], others feel that it can be useful in understanding many issues in the social sciences, although some of those who use the technique have called for "the development of appropriate evaluative criteria for such work."[8] Autoethnography, rather than attempting to remove the researcher's personal experience from the process of research, integrates it as a key element in understanding cultural experience.[9,10] There are several different approaches to ethnography in general, and to autoethnography in particular. Autoethnography has three main elements, which may be emphasized in varying degrees: the self, the sociological or cultural aspect, and the application of the research process.[11,12] The emphasis on these three elements depends on the individual researcher, and his or her purpose in conducting the work.[12,13] Furthermore, the form of the data may vary; in some cases, the study is based on written material such as reflective journals or other personal records. In other cases, memory of the experiences is the data.[12] Even in those cases where written records exist, memory comes into play in the course of the analysis.

This analysis approaches the material from a reflexive ethnographic point of view, focusing on how the researcher changes as a result of doing the work in question.[9] As stated, the data under analysis is in the form of a written record, a blog that was preserved unchanged and not looked at in the interval between the experiences and the analysis. Personal memory did influence the analysis of this written record; however, it has unquestionably faded somewhat over time, and was not relied upon as a primary source of data. An inductive approach was taken in order to allow themes to emerge from the material,[14] rather than using a pre-determined framework for analysis.

Findings

Analysis of the material showed that the blog consisted of both descriptive material, in which the author-researcher discussed things that had happened in the classroom, and reflections, in which she discussed her impressions and interpretations of things that had occurred. Often, a single blog entry included both elements, although some were weighted more heavily towards one type than another. Overall, there was a roughly even split between descriptive and reflective material. In considering both the descriptive and reflective material, three categories emerged from the data: Connections with Students, Practical Applications of Class Material, and Observations about Students.

Connections with Students

In several of the blog posts, the author-researcher specifically mentioned ways that she had connected with students in both the advanced algebra and physics classes on a personal level, particularly by discussing the frustrations and challenges in her own life and schoolwork. In one post, she stated that

> The students in both classes have gotten to know me fairly well by now, and they're more comfortable just talking. I had mentioned to them, several times, the need to do a "sanity check" and gave an example of how it had helped me to catch an error that could have haunted me down the road in my own work. I had to re-do a fairly big bunch of derivations, but at least I knew where the algebra started going wrong. One of the algebra students said that sounded frustrating, and asked how I kept wanting to do it. It was a serious question, so I told him the truth; that I did occasionally have days when I DIDN'T want to. Everyone has days when nothing goes right and it would be easy to just quit trying.

On another occasion, she discussed the need to keep trying to work even when tired. Many of the students were often functioning on little sleep for various reasons, such as extracurricular activities, the need to earn money at a part-time job, or a requirement to leave their home extremely early to accommodate bus transfers or parents' work schedules. Naturally, they were unenthusiastic about school because of fatigue, and often would rather have napped through class.

> Some of them say that they're tired. I always sympathize with that, because I'm often tired, too. I've gone in to YHS sometimes when I've had only four hours' sleep, and if I wasn't so busy, I could have easily fallen asleep. Once some of them found out how often I'm up half the night, they knew that I understand what it's like to be tired. When I try to get them to work through something, they'll usually at least make an effort, even if they were up half the night themselves.

Some of her opportunities to connect with students came when discussing their future plans and aspirations, rather than current challenges. In the physics class, she was assisting them with a bridge-building project, and was able to talk with students as she helped them glue toothpicks together.

> Having a project like this also makes it easy to walk around and talk to the students, and see how they're doing in general. One very bright, ambitious young lady is planning to visit the colleges that have admitted her, so she can figure out which one to attend. She's got quite a tour planned, including both Yale and Harvard. She's also begun to consider graduate school. I'm encouraging that.

In her reflection on the experiences in the classroom, at the end of the school year, she summarized her relationship with the students and stated that

> I was interested to see the ways that it's possible to connect with students. Sometimes, a chance comment about an experience of mine would tie in to something that they had dealt with - often when least expected.

This statement indicates that, at the time, there were other occasions that she was remembering which may or may not have been reflected in the blog. On reflection, searching through memory, the author-researcher does call to mind at least one incident that is not recorded in this blog. She had encountered one of the high school students at the grocery store, and stopped to talk to her. The student initially seemed surprised to see her there, but quickly entered into a discussion of

favorite flavors of ice cream before going on to briefly talk about her plans for the summer vacation before her last year of high school.

Practical Applications of Class Material

As an engineer with a very practical orientation, the author-researcher tends to view knowledge through a very practical lens, asking the question, "What can I do with this?" This was, therefore, an area where she felt that her contributions to the classroom were useful, and noted a number of occasions when students questioned the relevance of material they were learning. As an example, early in the term, students in the advanced algebra class were learning about matrices, and their math teacher began the lesson by discussing the uses of matrices; she was able to contribute to the discussion by mentioning an engineering example.

> [T]oday she told the students about some of the uses of matrices. Her list didn't have any good engineering examples, so I added one - robotics. Robotics is way cooler than business, at least to a lot of people (myself included), so she's asked me if I can put together a quick example of how matrices are used in robotics. I'm going to look in my notes… and put together something they can understand that will show how you can use them to work with really cool stuff.

In a later blog post, she mentioned having presented to the class about this, and also pointed to mathematics that they would be learning later in the term.

> On Friday, I gave a short presentation in the class, on how matrices are used in robotics. Those are rotation matrices, so they tied in quite well with what they're doing now. It also gave them a preview that the trigonometry they're going to learn later on will also be useful.

Later in the school year, the students in that class began working with complex numbers, and the author-researcher noticed that some of the students had difficulties with their meaning.

> One girl couldn't quite understand how a number that "isn't there" could mean anything - she asked, how could you have "i" apples? Her math skills are good, but she seems to need to tie everything to physical objects... Since I use them a lot - they're ubiquitous in controls work - I offered to put together a brief presentation for the class.

After putting together this presentation and giving it, she posted that

> I gave a short presentation on the uses for imaginary numbers. They're really not that hard to work with, given a little bit of practice, but conceptually they seem a bit remote from ordinary experience. Some of the students seem to be very "concrete" thinkers, and couldn't quite grasp the meaning of imaginary numbers last week when they were learning about them… In some contexts, they do have a real physical meaning, and that's what the presentation was meant to show them. I chose two examples of places where imaginaries have real uses – electronic circuits, and control systems… Obviously, in just a short time, I couldn't go into any depth, but the goal was to let them know that these things do have uses and even physical meaning.

On another occasion, she presented on the topic of logarithms and their uses, and tied this to their experiences. She noted that they seemed to enjoy the presentation, although she also noted that it might be because it replaced their standard assignment, and perhaps the change was what they liked.

> I gave the presentation I'd prepared on logarithms. I tried to keep their attention by asking questions - when talking about decibels of sound, I asked them how many have iPods (most). And, when talking about pH, I asked how many of them are taking chemistry… [T]hey seem to like it when I give little presentations, especially since the short worksheet I put together to go with it takes the place of their normal warm-up assignment. And, since some of the questions are conceptual, there are no right or wrong answers to worry about.

She noted, late in the school year when they began learning trigonometry, that students seemed to be interested in how they could use the math they were learning, although there was no indication of whether this was due to her influence or their own inclination.

> [T]hey wanted to know what this stuff is good for. One use, naturally, is in physics, with vectors. I also mentioned that you can use it anytime you're looking at angles - for example, if you want to know if you can get a piece of furniture through a doorway and perhaps around a corner.

At the end of the academic year, she summarized her experiences with these "real-world application" presentations, saying

> [I]t was great to see that the students really liked to see practical applications of what they learned, since that was something that we… are capable of bringing to the classroom.

It is interesting to note that, while she was working with both physics and algebra classes, all of the focus on practical applications that she explicitly mentioned bringing into the classroom was focused on the algebra students. She did work with physics students on projects with practical applications, such as building bridges out of toothpicks and measuring accelerations on amusement park rides, but did not discuss it in the same terms or at such length, possibly because physics seems much more concrete than mathematics, or because the physics teacher was already doing some of this.

Observations about Students

Over the course of the academic year, the author-researcher made many observations about student behaviors, attitudes, and skills. These observations were taken equally from the advanced algebra and physics classes, and often concerned study skills that they needed to develop, or their need to develop greater confidence in their own abilities. In discussing students' confidence, she stated that

> I was helping some of them work problems in class, and I noticed something interesting. Many of them really do have the right idea, and can do the problems if you ask them what each step is, but they seem to lack confidence. That may be something that practice would remedy. It's a big problem, though, since I can see it holding many of them back. They're

> given an equation to solve, and they know what to do, but they don't feel confident that they're doing it right.

While they often know what to do, whether they realize it or not, there are other occasions where she reported that they need to learn study skills. On one occasion, she specifically mentioned note-taking skills.

> One thing that hurts some of them is that they don't take notes. Some do, of course, but there are a few students who never write anything down. I'm not sure if it's because they don't see the point, or if they never learned how to take good notes, but it's definitely something they need to work on, especially since a lot of them intend to go to college.

Another skill that is mentioned several times is time management; in one typical comment, she posted that

> Some of them work very well, but others need to learn how to use time wisely - it's a skill that will serve them well throughout their lives.

Critical thinking skills were also a key area in which they could improve. When they were going through a physics lab on projectile motion, she observed that

> One thing that I see is that some of them instantly start putting things into equations without ever asking themselves, "Is this equation applicable?" As an example, they have an equation for the range in terms of initial velocity and angle - but it only applies if the projectile is launched from the same height where it lands, which isn't always the case at all, and certainly wasn't in the lab. I tried to explain that you always have to consider what your circumstances are, and when a certain equation is valid, and I hope that came across. Generalizing what they've learned to new problems can be a challenge for some of them, though it's a critical skill that they would find useful in other areas.

In addition to comments on what they needed to improve, the author-researcher noted several positive developments. In the physics class, she commented on one particular student who had learned many of the skills she had discussed elsewhere, saying that

> There's one young man who's been doing a tremendous job - he's obviously been working hard, since he's pulled up his grade from the "OK/good" range to "great". He's doing all the stuff that he's been told he should to succeed - taking notes, at least trying problems even if he doesn't understand them, paying attention in class - and it's paying off. I'm really happy to see it.

Also in the physics class, when the bridge-testing was going on, she commented on the students' attitudes, saying, "They seemed to be having fun, even those who hadn't been too enthusiastic in the beginning."

Discussion

In the author-researcher's evaluation of her experiences in the program, her experiences were valuable in forming her identity as an engineering educator. While graduate students participating in this program were told that one of the benefits to them would be exposure to different forms of pedagogy, she did not find that pedagogy was one of the things that was most valuable to her. It is possible that this was due to other opportunities to learn pedagogy, such as seminars held by the university's teaching center. The descriptive material in the blog did describe how she developed various experiences for the students, such as the presentations on mathematical topics that were mentioned, the bridge-building exercise in the physics class, and an introduction to optimization for the advanced algebra students. While this practice at developing teaching material was undoubtedly valuable, she did not reflect noticeably on the experience of developing this material; the reflections were exclusively student-oriented. Upon looking back at these reflections and the emergent themes, she does see value in these reflections as applied to her current teaching.

Previous research into student motivation has found that one of the key factors that motivates students in engineering is having instructors who care about them,[15,16] and this is borne out by her experiences in the program. She saw that students who felt that she connected with them on a personal level were more willing to work. These connections were forged not through any kind of a formula or application of a technique, but through chance remarks and sharing common experiences. Despite the fact that the author and the high school students came from very different socio-economic backgrounds, shared experiences such as fatigue under a high workload forged a connection. On reflection, she finds this to be true in the college classroom as well; students react positively to a professor who is willing to share her authentic self and share some of her own challenges. Naturally, some discretion should be used, but students react well to the knowledge that their professors are balancing a challenging workload, just as they need to balance their courseload. Students understand the pressure of deadlines, since they experience them on a regular basis themselves, and can identify with a professor's need to meet deadlines for things like grade submission, conference papers, and grant proposals.

Her experience also suggests that providing context for knowledge is important. This, too, is borne out by a great deal of research for all levels of education, from elementary school through college.[17,18] However, the question of what examples should be used is an important one; examples that are relevant to one person may not resonate with someone else, particularly when people are from different backgrounds and have different experiences. For one group of students, an example using an iPod may be very relevant and motivating, while another group of students may think of the iPod as something that their older siblings had once. This experience underscored the importance of knowing the cultural context from which examples should be taken, in order to make them as effective as possible. These can be taken from current events; October of 2013, for example, she presented students with a problem in which they needed to calculate the gravitational acceleration at a point 39 km above the earth's surface, the height from which Felix Baumgartner had just made his record-breaking jump from the stratosphere. Such examples, of course, should be regularly updated as they can easily become dated, and lose their initial impact.

The final point is, perhaps, even more important. Graduate students are typically very intelligent, with well-developed study skills, and may not remember how they went about developing those skills. Often, those who participate in outreach programs like this are among the best of a university's graduate students. Some may find themselves thinking that everyone is like them, and that good study skills are somehow innate, rather than something that can be taught and that needs to be learned. They may also think that everyone loves to learn, since they are immersed in a community where that is true of many people. However, a graduate student who chooses to pursue an academic career will be teaching students from varying backgrounds; depending on the institution at which he or she teaches, these students will have varying degrees of preparation for college work, different levels of motivation, and may not yet be proficient in key study skills. Even highly intelligent students may not have fully developed study skills; in fact, some highly intelligent students may be less likely to develop their study skills than average students, since they may be able to succeed in high school without these skills. An awareness of where students may be, and what skills they may lack, is extremely important. As an instructor, the author finds that she needs to be conscious that many things that are obvious and innate to her are, in fact, learned skills. This does not mean that college professors should excuse students who do not have good study skills, but that they should be aware of the fact that these are learned skills. Given this awareness, the author has been able to advise students more effectively; if a student does not yet possess effective study skills, they can be referred to tutors or to relevant university offices that assist students with these skills.

One of the interesting features of these themes is what does not appear. As previously stated, the high school involved in this program had a high percentage of minority students, and was in a less affluent community than the partner university. However, reflections on racial or socioeconomic issues did not appear in the blog at all. This could be due to the author-researcher's efforts to see people as individuals, and to avoid any type of stereotyping. However, it could also reflect a certain degree of unconscious self-censorship. The blog is public, and the author was aware that anyone with an internet connection could read it; in fact, the directors of the outreach program were known to be reading it. The awareness that the blog was a representation of the program to the world, and of the author-researcher to those running the program, could have influenced the types of reflections she was willing to express, particularly in regard to sensitive issues.

Conclusion

Graduate students typically have many demands on their time, and need to carefully choose which activities are worth their time and attention. Even if these students enjoy outreach activities, they may not be able to justify the time commitment unless there is some other benefit that they receive, beyond personal satisfaction. In many cases, the benefit that they would seek is in better equipping them for academic careers. In some universities, graduate students participating in outreach programs are exposed to different pedagogical techniques. While this may be quite valuable, the author-researcher in this paper found that the most useful elements of participation in this program were in practicing her ability to interact with students of varying backgrounds and a different culture than the university in which she was immersed as a graduate student. Awareness of these potential benefits can guide similar outreach programs in recruiting graduate students, and the students can benefit by consciously reflecting on these types of issues.

In fact, universities running such programs may wish to consider promoting such reflection, and integrating it into the programs. An experience in which graduate students engage in a guided reflection could help them to better draw meaning from their experiences and learn how they can use it to become better teachers and mentors to their students in the future.

References

1. DeGrazia, J. L., Sullivan, J. F., Carlson, L. E., & Carlson, D. W. (2001). A K-12/university partnership: Creating tomorrow's engineers.. *Journal of Engineering Education*, *90*(4), 557-563.

2. Andrews, J., Meadows, L., & Oguntebi, J. (2008). Engineering graduate students: Engaging today's teachers, training tomorrow's scientists and engineers, and opening new academic and career paths for K-12 students. *Proceedings of the American Society for Engineering Education Annual Conference*. Pittsburgh, PA.

3. Kotys-Schwartz, D. & Zarske, M. (2005). Graduate student personal experiences: Improving collegiate teaching through K-12 outreach. *Proceedings of the American Society for Engineering Education Annual Conference*. Portland, OR.

4. Aleong, R. J. (2012). In search of meaning and identity: An autoethnography of a graduate student navigating the field of engineering education. *Proceedings of the American Society for Engineering Education Annual Conference*. San Antonio, TX.

5. Sochacka, N., Guyotte, K. W., Walther, J., & Kellam, N. N. (2013). Faculty reflections on a STEAM-inspired interdisciplinary studio course. *Proceedings of the American Society for Engineering Education Annual Conference*. Atlanta, GA.

6. McCord, R., Hixson, C., Ingram, E. L., & McNair, L. D. (2014). Graduate student and faculty member: An exploration of career and personal decisions. *Proceedings of the American Society for Engineering Education Annual Conference*. Indianapolis, IN.

7. Delamont, S. (2007). Arguments against auto-ethnography. In *British Educational Research Association Annual Conference* (Vol. 5, p. 8).

8. Holt, N. L. (2008). Representation, legitimation, and autoethnography: An autoethnographic writing story. *International Journal of Qualitative Methods*, *2*(1), 18-28.

9. Ellis, C., Adams, T. E., & Bochner, A. P. (2011). Autoethnography: an overview. *Historical Social Research/Historische Sozialforschung*, 273-290.

10. Ngunjiri, F. W., Hernandez, K. A. C., & Chang, H. (2010). Living autoethnography: Connecting life and research. *Journal of Research Practice*, *6*(1), Article-E1.

11. Reed-Danahay, D. E. (1997). Auto/ethnography: Rewriting the Self and the Social. Berg.

12. Wall, S. (2008). Easier said than done: Writing an autoethnography. *International Journal of Qualitative Methods*, *7*(1), 38-53.

13. Wall, S. (2008). An autoethnography on learning about autoethnography. *International Journal of Qualitative Methods*, *5*(2), 146-160.

14. Patton, M. Q. (1990). *Qualitative evaluation and research methods* . SAGE Publications, inc.

15. Chen, H.L., Lattuca, L.R., & Hamilton, E.R.(2008) Conceptualizing engagement: Contributions of faculty to student engagement in engineering. *Journal of Engineering Education*, 97, 339-353.

16. Cady, E., Fortenberry, N., Drewery, M., & Bjorklunk, S. A. (2009). Validation of surveys measuring student engagement in engineering, part 2. *Proceedings of the American Society for Engineering Education Annual Conference*. Austin, TX.

17. Cantrell, P., & Robinson, M. (2002). How do 4th through 12th grade science textbooks address applications in engineering and technology?. *Bulletin of Science, Technology & Society*, *22*(1), 31-41.

18. Patterson, E. A., Campbell, P. B., Busch-Vishniac, I., & Guillaume, D. W. (2011). The effect of context on student engagement in engineering. *European Journal of Engineering Education*, *36*(3), 211-224.