

# Learning to Teach: Graduate Assistants' Expedition into Teaching Teachers

## Öğretmeyi öğrenmek: Araştırma görevlilerinin öğretmen adaylarına öğretmeyi öğrenme serüvenleri

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### Özet

Son zamanlarda eğitim camiası araştırma görevlilerinin lisans öğrencilerinin öğrenmelerinde oynadıkları rolün farkına varmıştır. Ancak, araştırma görevlilerinin öğretim becerilerinin geliştirilmesi boyutu doktora programlarında ihmal edilmiştir. Bu nitel çalışmada, Durumlu Öğrenme Kuramı perspektifi kullanılarak araştırma görevlilerinin öğretmen adaylarına öğretim yapmayı öğrenme kesifleri incelenmiştir. Ortaöğretim Fen ve Matematik Alanları Bölümünde doktora yapmakta olan 12 araştırma görevlisi çalışmaya katılmıştır. Veriler yarı-yapılandırılmış görüşmeler ile toplanmıştır. Katılımcıların öğretim yapmayı öğrenmelerine yardımcı olan bağlam, kişi ve araçları belirlemek için toplanan veriler daha önceden belirlenmiş kavramlar kullanılarak (*deductive*) analiz edilmiştir. Sonuçlar araştırma görevlilerinin öğretmeyi öğrenme deneyimlerinin doktora programları ve çalışma ortamları ile yakından ilişkili olduğunu ortaya koymuştur. Deneyimli araştırma görevlileri yeni başlayanlar için model oluşturmaktadır. Danışmanların bu noktada desteği eksik bulunmuştur. Doktora ve lisans derslerini veren öğretim üyeleri ve deneyimli araştırma görevlileri yeni araştırma görevlilerinin öğretim yapma deneyimlerini desteklemiştir. Tezler, kitaplar ve makaleler katılımcılara öğretim ile ilgili güzel örnekler sunmaktadır. Ayrıca deneyimli araştırma görevlileri kaynaklar ve yöntemler ile ilgili zengin bir listeye sahip iken göreve yeni başlayanlar deneyimli araştırma görevlilerinin uyguladıkları yöntemleri taklit etme eğilimindedirler. Bu çalışma araştırma görevlilerinin üniversite seviyesinde öğretim yapabilmeleri için deneyimli öğretmen eğitimcilerinin rehberliğine ek olarak formal bir eğitime ihtiyaçları olduğu noktasının altını çizmektedir.

**Anahtar sözcükler:** Araştırma görevlileri, doktora eğitimi, öğretmen eğitimi ve durumlu öğrenme kuramı.

### Abstract

Recently, the educational community has realized the vital role of graduate assistants (GAs) in the learning of undergraduate students; however, developing teaching expertise is often an overlooked component of graduate programs. In this qualitative case study, we used Situated Learning Theory to examine GAs' "expedition" of learning to teach teacher candidates. Twelve GAs studying for a PhD in the science and mathematics department for secondary education participated in the study. Data was collected by semi-structured interviews. A deductive approach was utilized to analyze data to get GAs' common views of the context, people, and tools that helped them learn to teach. Results showed that GAs' experience for learning to teach was associated with both their PhD program and work environment. Experienced GAs were role model for beginner GAs. The support of advisors' on learning to teach was found to be insufficient. Instructors in the PhD and undergraduate programs, as well as other experienced GAs, supported the experience of new GAs for learning to teach. Theses, books, and articles also provided examples of good teaching. Experienced GAs had a richer list of sources and strategies of how to use them as a source for learning to teach whereas novice GAs have a tendency to imitate experienced ones. This work further highlights the need for formal education for learning to teach in graduate programs, as well as mentoring by experienced teacher educators.

**Key words:** Doctoral education, graduate teaching assistants, teacher education, and situated learning.

**G**raduate assistants (GAs) are responsible for large portion of teaching especially at research-based universities (Austin, 2002). However, GAs have many

responsibilities in addition to teaching (e.g., conducting research) (Gardner and Jones, 2011). While doctoral programs prioritize developing GAs' research skills, preparation for

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teaching is often lacking (Utecht and Tullous, 2009). Many GAs receive little or no training on teaching (Fairbrother, 2012; Hardré and Burriss, 2012), leaving them with concerns about classroom management, instructional strategy use, and assessment (Choet et al., 2011). Recent calls have emphasized a need for training for GAs, given the key role they play in promoting quality undergraduate education (Hardré and Burriss, 2012).

While an extensive body of research has focused on the preparation of teachers at the pre-service and in-service levels, there is little known about current practices and effective means for supporting GAs in learning to teach (Gardner and Jones, 2011). This is particularly surprising given the role that GAs play in pre-service teacher education programs and preparing others to become teachers.

### Purpose of the Study

In this study, we examine the experiences of GAs enrolled in a science education doctoral program at a large university in Turkey. While there are some descriptions of the preparation of GAs for teaching in PhD programs in the US (Luft et al., 2004) and the UK (Burgess and Mayes, 2007; Gunn, 2007), in Turkey, as in many other developing countries, GAs' training for teaching is overlooked and thus GAs are asked to "sink or swim" as instructors.

We are interested in understanding how GAs working in a college of education, in the absence of formal training, learn to teach pre-service teachers. In particular, we examine the contexts, people, and tools that they draw upon to develop their pedagogy. The results of this study will address the current insufficiency of literature in this area and have implications for the design of doctoral programs as well as the incorporation of GAs as instructors in teacher education. The research questions guiding the study were: *In the absence of formal training*,

- Which contexts have helped GAs learn how to teach to pre-service teachers?
- Who has helped GAs learn how to teach to pre-service teachers?
- Which tools have helped GAs learn how to teach to pre-service teachers?

### Literature Review

#### Teaching and its Complicated Nature

Teaching itself is a complicated task, and theoretical perspectives can help shed light on the nature and process of learning to teach. For example, Situated Learning Theory emphasizes the context and the socio-cultural nature of learning (Brown et al., 1989; Lave and Wenger, 1991). Learning is characterized as being "(a) situated in particular physical and

social contexts, (b) social in nature, and (c) distributed across the individual, other persons, and tools" (Putnam and Borko, 2000, p. 4). Grossman (1990) recognized that an apprenticeship of observation (as a student), disciplinary background, teaching experience, and teacher education programs play important roles in learning to teach. In this case, we are specifically interested in the process of *learning to teach teachers*, and how that occurs in the context of graduate programs.

Researchers have described a professional continuum for graduate students as they learn to teach teachers (Abell et al., 2009). The initial phase (observation) provides opportunities for them to see models of excellent university-level instruction. This is followed by an apprenticeship, in which GAs are engaged in readings, discussions, and syllabus design with faculty. Next, GAs co-teach with faculty and are provided feedback to support their development. This prepares GAs for being an independent instructor who is ready to plan, teach, and reflect on her/his teaching practice. Finally, serving as a mentor for novice GAs provides opportunities to further develop teaching practice. The authors stress that this represents an idealized trajectory and the manner in which GAs progress is highly influenced by the structure and design of the graduate program and the opportunities afforded them. Research on GAs' development as teachers reveal this is highly variable.

#### Research on GAs' Learning to Teach

Although GAs often have different roles, (e.g., teaching undergraduate students and conducting research) doctoral programs generally do not provide formalized training for the former (Gardner and Jones, 2011). This may be, partially, due to the fact that assessments of the quality of doctoral programs most often focus on metrics and measures related to research; for example, comprehensive exam pass rates, number of papers presented at conferences, and publications (Utecht and Tullous, 2009). Results of the survey conducted by the National Association of Graduate Professional Students (NAGPS) revealed that 55% of the 32,000 graduate students felt inadequately prepared for teaching (as cited in Utecht and Tullous, 2009).

The scarce body of research on GA preparation has focused on seminars or courses (Bond-Robinson and Rodrigues, 2006; Gunn, 2007) and training programs (Burgess and Mayes, 2007) as well as teaching internships (Hanuscin et al., 2011). Research has shown that offering courses that include assignments related to teaching, giving feedback about GAs' teaching performance, providing opportunities for watching and discussing their teaching via videotaping, and guidance and motivation have catalyzed development of GAs' teaching skills (Bond-Robinson and Rodrigues, 2006). Additionally, in a program in the UK, the researchers found that having the oppor-



tunity to observe models of effective teaching by experienced faculty and in turn receiving feedback on their own teaching enhances GAs' self-efficacy and ability to recognize their own strengths and weaknesses (Burgess and Mayes, 2007).

Despite the above, there are challenges remaining. For example, while participation in weekly seminar meetings to collaborate and discuss readings related to teaching enhances the progress of learning to teach, GAs' past experiences in their undergraduate programs remained the largest influence on their views about teaching and their role as a GA (Gunn, 2007). And, while an internship can provide opportunities for GAs to relate theory and the practice of teaching (Hanuscin et al. 2011), GAs' own knowledge for teaching particular topics can be a barrier in teaching others how to teach.

The difficulties that GAs face as teaching assistants seem to persist as they transition into faculty roles, where there may be little institutionalized support as well. Osmond and Goodnough (2011) examined a novice science teacher educator's teaching in a course that featured both online and face-to-face components. They found the interactive nature of the course design and student feedback helped the teacher understand learners' prior knowledge, identify misconceptions that they had, and diagnose the difficulties that students faced in learning new material. Similarly, in a recent study, Berry and van Driel (2013) focused on teacher educators' (TEs) teaching science method course (i.e., their emphasis while teaching secondary science teaching in the secondary method course) and how experienced TEs developed their expertise. Twelve experienced TEs both from the Netherlands and Australia had limited training for teaching, if any, at the beginning of their career. So, they drew mostly on teaching experience (i.e., as a school teacher) and experienced colleagues as source contributing their learning to teach. The authors identified different purposes, emphasis and teaching secondary method course, and attributed the differences to "the ad hoc ways in which they enter the profession, plus the apparent lack of a structure that could help them develop their practice as community" (p. 125). It is partly related to the differences among participant TEs' background. TEs who had research background benefit from the research to enrich their teaching whereas TEs who taught science in high schools drew on their past experience. In summary, the differences among the TEs regarding background and lack of initial year program for TEs are the reasons of the variance in TEs' purpose, emphasis, and teaching science teaching method course.

In summary, it's clear that while some sources of support can be found, the opportunities to develop one's pedagogy as a GA can be few and far between. The need to support doctoral students in learning to teach as part of their program is even more critical, given this problem persists into their induction period as faculty. Despite this bleak picture, however, there are cases in which support has come in the form of research; below,

we describe the use of self-study methodology to support GAs and novice teacher educators.

### Self-study and Learning to Teach

The literature provides several examples of how self-study has been used by and to support GA and novice teacher educators in learning to teach. Fairbrother (2012) stressed how a flexible role without strict boundaries about how to teach, supportive stuff, and teaching postgraduate and undergraduate courses helped her *'make the role her own'*. Additionally, intertwining her research and teaching practices in regard to teaching health inequalities (HI) contributed to her learning. Fairbrother revealed that planning, teaching, and assessing HI provided a broader perspective to her regarding the recent studies and approaches of HI literature. In another self-study of teaching in web-based and face-to-face environments, Osmond and Goodnough (2011) found that interaction with students and students' feedback about the course design helped a novice science teacher educator to learn the difficulties that learners face with, to diagnose learners' prior knowledge, and misconceptions that they had. In another example, used self-study methodology to examine on how mentored internship contributed development of graduate students' teaching (Hanuscin et al., 2011). Three GAs worked with a mentor to plan and instruct a 2-week summer institute for K-6 teachers. Key to their growth was the opportunity to discuss instructional problems they encounter with a mentor, which facilitated their ability to relate theory and practice of teaching.

Although cases like the ones above illustrate how individuals might develop their teaching practice in the absence of formal training programs that are provided at the program and/or institution level, these kinds of opportunities are idiosyncratic and may not be available to all who desire them. Questions remain about how, in the absence of formal programs, GAs learn 'on the job' to teach and how they draw on these resources and opportunities within their context. For this purpose, the framework of situated learning provides a useful tool to frame our study.

### Theoretical Framework

According to Situated Learning theorists, individuals are part of communities that have their own rules, activities, and practices. In order to participate in them, newcomers have to learn the particular properties of the community:

Legitimate peripheral participation provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artifacts, and communities of knowledge and practice. It concerns the process by which newcomers become part a community of practice (Lave and Wenger, 1991, p. 29).



In other words, legitimate peripheral participation explicates the course of the individual's participation to community of practice. However, learning is not equal to being a member of a group. Through time and with the help of relationship between other members, newcomers' participation in the community practice increases, which helps newcomers learn (Lave and Wenger, 1991). "Communities of practice have histories and developmental cycles, and reproduce themselves in such a way that the transformation of newcomers into old-timers becomes unremarkably integral to the practice" (Lave and Wenger, 1991, p. 122). In light of this point, training GAs can be seen as a means for reproducing of the community of university instructors, namely teacher educators.

In the absence of formal training programs, however, we believe there may still be opportunities for GAs to engage in forms of legitimate peripheral participation that help them 'swim' versus 'sink' as they learn to teach at the university level. From the situated learning perspective, (a) the context in which learning occurs, (b) people who may be peers, colleagues, teachers and other people around the learners, and (c) the tools used during learning are vital components of learning process. In this study, we are concerned with how GAs learn to teach in the context of their graduate program, how this process is influenced by social interactions with others, and the tools and resources available to them that facilitate the process.

## Methodology

We employed case study methods (Patton, 2002), with GAs in a science education PhD program serving as the case (Merriam, 2009). In this context, which did not include a formal means of supporting GAs in learning to teach teachers, we examined the experiences of twelve GAs.

## Context of the Study

The study was carried out in the Secondary Science and Mathematics Education (SSME) Department of a university in Turkey. In SSME, there are two basic programs; one being the undergraduate program that trains pre-service teachers in chemistry, physics, and mathematics education fields and the other being the graduate program that trains GAs in those areas. GAs in this department will serve as a science or mathematics teacher educator upon completion of their degrees. During their graduate work, GAs are responsible for both conducting research and teaching.

Although GAs had graduated from the College of Education and were prepared to teach high school students, this is not equivalent to the task of teaching teachers. For instance, the needs of the college students are different from those of high school students. Additionally, the classes are structured differently than those in high schools. In other

words, being a faculty member is much different from being a teacher. Although there is no formal training that helps GAs learn how to teach pre-service teachers in this department, all GAs are assigned to be teaching assistants of undergraduate courses that are offered to pre-service teachers (e.g., chemistry teaching methods courses). As teaching assistants of these courses, GAs are responsible for tutoring pre-service teachers, helping faculty teach the course, grading quizzes, and teaching lab sections.

## Participants

All of the GAs in the chemistry education department were invited to participate to the study. All twelve GAs consented, resulting in a group of participants who were at the different stages within the PhD program (i.e., coursework, comprehensive exam, or dissertation) (Table 1). All 12 had graduated from the chemistry education department of the same SSME undergraduate programs.

## Data Collection

Participants were interviewed individually using a semi-structured interview protocol. Interviews took between 40-45 minutes. All interviews were audiotaped and fully transcribed for data analysis. Example questions asked during the interview include:

- How do you develop your teaching skills for teaching to pre-service teachers?
- In what contexts have you learned to teach to pre-service teachers?
- Who has helped you learn to teach to pre-service teachers? In what ways did they help you?
- What are the materials that helped you learn to teach? In what ways did they help you?

Table 1. Participants of the study

GA	Gender	Years of experience as a GA	Stage in the program
GA-1	Female (F)	4.5	Dissertation (D)
GA-2	F	4	D
GA-3	F	4.5	D
GA-4	F	1.5	Coursework (C)
GA-5	F	4.5	D
GA-6	F	1.5	C
GA-7	Male (M)	3	Comprehensive exam (CE)
GA-8	M	7	D
GA-9	F	1.5	C
GA-10	F	3.5	CE
GA-11	F	2	CE
GA-12	F	4.5	D



## Data Analysis

We used deductive analysis “where the data are analyzed according to an existing framework” (Patton, 2002, p. 453). Situated Learning served as an analytic framework (Putnam and Borko, 2000). We sought to identify social factors, contextual factors, and tools utilized by GAs in the process of learning to teach. For each of these three areas, we assembled codes to identify categories. For instance, within the area of contextual factors, we generated four categories (e.g., course work, work environment). Reengaging with the data helped us to form sub-categories (e.g., participation in undergraduate course design that is one of the sub-categories of the work environment).

Peer debriefing and member checks were used to address the trustworthiness of the research results. The first author collected and coded the data. Then, she selected two rich interview transcripts for peer debriefing. After we (i.e., the first author and two other coders) coded the two interview transcripts independently, we compared and contrasted the coding. Then, we discussed disagreements until reaching a consensus and made adjustments to the coding schema. Additionally, member checks allowed participants to react to the interpretations of the data throughout the investigation.

## Results

### Contexts for Learning to Teach Pre-service Teachers

Our first research question was concerned with identifying contexts that supported GAs as they learned to teach. In light of the data collected, the contexts that helped GAs to learn to teach include their course work; work environments; professional contexts; and other contexts (e.g., the undergraduate teacher education program from which they graduated) (■ Table 2).

### Coursework

GAs from all stages of the doctoral program mentioned the PhD courses that they took and the relevance of what they learned in coursework to their teaching. For example:

During taking PhD courses, I tried to learn about the use of instructional strategies, and research methods. In one of the courses, namely, *Test Construction in Science and Mathematics Education*, I learned how to ask effective questions. You can use those questions either in your class or in the approach that you will implement for your dissertation. It helped me to learn how to ask good questions. Moreover, there are many teaching techniques under constructivism. Although I already knew some of them, the courses helped me to understand them in a better way and use them more effectively in my classes (GA-8).

However, each of the nine stated that they learned ‘theory only’ in PhD courses related to teaching and learning, and did not get a chance to apply what they learned. For example, GA-10 talked about the influence of PhD courses as follows:

GA-10: ... I did not take any courses related to teaching. I just learned teaching theoretically.

R: What do you mean by learning teaching theoretically?

GA-10: I took a *Learning Theories* course. We learned about how people learn. Then we planned lessons by considering those theories. However, we did not teach [the lessons]. They were just planning. Additionally, I took a *Research in Science Education* course in which we discussed the factors that influence learning, how we should teach, and which points are important during teaching. I mean we know what to do, theoretically, due to PhD courses; however, we did not have a chance to apply the knowledge or to develop teaching skills.

To obtain more detailed information, we asked which types of courses participants have taken during their PhD program. When we looked at the courses taken by the participants, we realized that they could be categorized into two parts; namely, research-based and teaching based courses.

GAs took more research-based courses due to the fact that they are required courses, (e.g., *Research methods in education, Educational Statistics, and Seminar*) for PhD students enrolled

■ Table 2. Contexts in which GAs' learning to teach were situated

Categories	Subcategories	Total # of GAs (%)	Examples of how contexts help GAs learn to teach
Course work	PhD courses taken	9 (75%)	Learning about instructional and assessment strategies
Work environment	Being a GA of undergraduate courses	7 (58%)	Developing confidence in teaching by observing others' teaching, and beginning to try different teaching methods
	Participation in undergraduate course design	8 (67%)	Understanding all aspects of course design and developing their knowledge on the subject
	Participation in projects	2 (17%)	Enriching repertoire of instructional strategies and observing teachers using project-based teaching
Professional contexts	Participation in conferences and workshops	5 (42%)	Sharing teaching experience and teaching materials with other faculties
Other contexts	Undergraduate program	3 (25%)	Experiencing concrete examples for teaching chemistry
	Prior teaching experience in a different context	1 (8%)	Transferring past teaching experience to teaching teachers



to SSME department. In terms of teaching and learning-based courses, *Test Construction, Theories of Learning, and Cognitive Development in Science and Mathematics Education* were not required courses, but were taken commonly by GAs. When prompted, GAs stated that the relevance of the course with GAs' thesis and the recommendation of other GAs were the factors motivating them to take those courses.

### Work environment

Work environment was the second context that figured prominently in GAs' experiences. Although participants noted some relevant opportunities (e.g., undergraduate courses, participating in undergraduate course design), they generally criticized the inadequacy of the teaching opportunities provided by work environment.

I think that learning it [how to teach] is not a skill that you can develop by reading. Regarding teaching at this level, the experiences that have been provided to us so far is not enough. Also, I think the other opportunities that will be offered will not be enough either. It is one of the topics that we discuss with other GAs. We criticize that what is going to happen in the future. In this context, we have not supported about teaching college students. Therefore, we [GAs] compulsorily read about how to teach. Sometimes I compare this program with others. In some of them, GAs have to co-teach some courses. I felt that those GAs are much better than us in developing their teaching skills and having dialogue with students. In this program, we do not have co-teaching opportunity (GA-4).

GAs revealed that being GAs of undergraduate courses, participating in undergraduate course design, and research projects on how to teach were helpful in learning to teach. It is interesting that, although all of the GAs are assigned to teach undergraduate courses, only experienced GAs indicated the benefit of being a GA of undergraduate courses. For instance, GA-6 talked about her experience:

When I was a GA teaching in the secondary science teaching method course, I assisted the other GA because I was also new to the department. Due to the fact that it was the first time for taking an active role in such a course, I was trying to learn... I was also in learning mode just like the students.

Other GAs mentioned the same point, that being a GA of undergraduate courses facilitated their teaching pre-service teachers. One of them (GA-1) said that at the beginning, she was nervous while teaching, and so she observed other GAs' sessions and tried to imitate their teaching style. With the experience of being a GA in undergraduate courses, she developed confidence and began to try different teaching methods.

Additionally, participation in undergraduate course design was identified by GAs as yet another work duty that benefited them in terms of learning to teach. Experienced GAs are invit-

ed to participate in the development of new courses for pre-service teachers; however, only experienced GAs who were at either comprehensive exam or dissertation stages did so. GA-7 shared his experience in designing a lab course:

GA-7: I had a chance to design a lab course. We were preparing everything related to how to teach the course and what we would do in the lab. We were deciding upon the experiments that would be best used in the course. Additionally, we were thinking on which skills should be developed, and how we could assess those skills.

R: Did you have a chance to teach it? How did it contribute to your development?

GA-7: I mean, you are preparing it and when you apply it... You are ready to teach it because you prepared it. You include the components that you want to include, and it motivates you to teach them. Second, when you teach the course, you can see the shortcomings of your design. I mean, you are more careful about them in your future design experiences. You focus on if we used the time efficiently, if we stressed the objectives that we want students to achieve. When you design it, you learn at the same time. You also learn the subject without noticing it.

Owing to this experience, GAs had a chance both to get feedback about the course design and to develop their knowledge on the subject.

Finally, GAs who had research experience cited this as a supportive experience in their learning to teach. Two of the GAs (GA-1 and GA-7) participated in research projects related to teaching:

The project is about teaching Nature of Science (NOS) to pre-service teachers. For this project, I tried to develop my own understanding in terms of NOS. We met every week and discussed which aspects of NOS we would focus on and how we would teach the aspects of NOS. All members suggested activities, and we discussed them. Then we decided to use some of them. While using them in the class, I had a chance to observe which points were going well and which problems we have. The assessment is also important for us... In the first semester, we did not use quizzes; however; this semester we decided to use them. We also use some cases to check whether they can apply their NOS knowledge to different situations discussed in the class or not.

GA-7 also participated in a project related to project-based teaching and shared experiences he had. In this project he studied the implementation of project-based teaching in science classes. Participation in the project enriched his repertoire of instructional strategies and provided a valuable experience of observing teachers using project-based teaching in their science classes. Rather than learning the strategy in theory only, the project let him see the practical aspects of teaching.



## Professional contexts

Academic professional events were a contributing context identified by experienced GAs (i.e., four of whom were at the dissertation stage and one of whom was at the comprehensive exam stage):

...We go to conferences, present our research, and interact with other researchers, which influences our teaching skills because we both present and teach in front of many people. If you have anxiety related to talking in front of people, you may overcome it. Due to the fact that we talk to other researchers during conferences, we can also benefit from other researchers' experiences. Moreover, we have a chance to participate in presentations related to development of new materials for teaching and to be aware of the progress in our area of interest, to take the materials and methods and implement them in our classes. Additionally, you can participate in workshops and seminars, which are also beneficial (GA-12).

GA-12 viewed conferences as a chance to decrease teaching anxiety, and to share teaching experience and teaching materials with other faculties teaching in different colleges.

## Other contexts

As prior, all GAs had graduated from chemistry teacher education undergraduate programs. The purpose of these programs is to educate pre-service teachers to teach chemistry at the high school level. GA-6 and GA-9, who were at the coursework stage, stated that their undergraduate programs helped them learn how to teach pre-service teachers, although the focus of the program was to teach how to teach at the high school level:

Due to the fact that I started my PhD just after my graduation and without any high school teaching experience, my main source has been my undergraduate program. I took undergraduate courses on teaching. The most helpful one was *Secondary Science Teaching Methods*. Although I took chemistry classes before, I started to learn how to teach in that course. There were concrete examples for teaching

chemistry. I learned which concepts should be stressed and possible misconceptions of the students (GA-9).

Undergraduate coursework was a valuable source of knowledge for GAs, especially when the teaching experience (i.e., K-12 teaching and teaching experience at tertiary level) is lacking. Experiencing the application of instructional strategies was vital for developing teaching chemistry and teaching how to teach pre-service teachers.

Additionally, previous teaching experiences were mentioned as a contributing factor for one of the GAs (GA-11) in learning how to teach pre-service teachers:

Actually, I learned it by doing because we do not have a course that is directly related to teaching. I took advantage of my previous experience. I taught for a long time to help poor students in an organization that focuses on that mission.

GA-11 could draw on her prior teaching experience when learning how to teach pre-service teachers. Based on her past experience, she felt she could develop a good way of communication with pre-service teachers. Although the contexts and the learners were quite different from each other, classroom management was a more general skill she could transfer into this context.

In summary, experienced GAs were more often observed to draw on the opportunities provided by their work environment (e.g., being a GA of undergraduate courses, and participation in undergraduate course design and projects) than less experienced GAs. Similarly, only experienced GAs noted that they took advantage of the benefits of professional contexts (e.g., conferences and workshops) for enriching their teaching repertoire and learning about others' teaching practice.

## People who play a role in GAs learning to teach

Our second research question was concerned with identifying people who have helped GAs in learning how to teach pre-service teachers. GAs mentioned three main groups of people who helped them learn how to teach: Academicians, peer GAs, and students (■ Table 3).

■ **Table 3.** People who have helped GAs learn how to teach pre-service teachers

Categories	Subcategories	Total # of GAs (%)	Examples of how contexts help GAs learn to teach
Academicians	Instructors of the PhD courses	4 (33%)	Learning how to integrate daily-life examples into teaching
	Faculties at the undergraduate program	4 (33%)	Enriching use of instructional strategies
	Advisor	1 (8%)	Learning about students' misconceptions
	Faculties at other institutions	1 (8%)	Sharing teaching experience and teaching materials
Peer GAs	Other Experienced GAs	12 (100%)	Observing their teaching and focusing on how they teach
Students	Undergraduate students' reactions	1 (8%)	Tailoring instruction with help of their feedback, reaction, and needs



## Academicians

Participants cited the influence of faculty from their undergraduate and PhD programs on their learning to teach. Four of the GAs, at different stages in their graduate study, thought that instructors of their PhD courses provided models of good instruction. Observing experienced instructors' teaching provided useful information regarding how to teach.

One of the instructors has all the features that an instructor should have. He always relates the questions asked during the class to the topic discussed. He was really successful at it. I realized that I should relate the topic to students' daily-life. Yet, although I know what he says, I realized that I have never thought in that way. Additionally, I learned that I should know both chemistry and pedagogy. I am neither a chemist nor a pedagogue. I should be both. (GA-4).

Similarly, faculty working in the undergraduate program from which GAs graduated also played a role in GAs' learning to teach process.

GA-7: I observed my instructors. One of the instructors from my undergraduate program, for instance, who has relationship with pre-service teachers, has good knowledge in chemistry... He formed an image of a teacher in your mind. You learn if you listen to his teaching without realizing it, his teaching techniques are so effective.

R: Which strategies does he use?

GA-7: He uses constructivist strategies. Even if he does not have enough time, he tries to stress conceptual understanding. He focuses on the reason and the process. And in laboratory, he provided the application of the topic and examples from daily-life. It was effective from these aspects.

Observing faculty members' teaching and implementation of instructional strategies were valuable sources for GAs in developing their own repertoire of instructional strategies.

Although advisors are viewed to play a critical role for graduate students, it is interesting that only one experienced GA (dissertation stage) (GA-8) stated that his advisor helped him learn to teach. This advisor shared students' possible misconceptions about chemistry and chemistry concepts. In contrast, others made statements regarding the lack of support by advisors for teaching, but expressed expectations that this kind of support was not an advisor's responsibility. GA-2 explained:

My advisor and I have never talked about how to teach. I mean, we do not talk about teaching because I feel that as if her duty is not giving advice about teaching. We talk about my dissertation and the research we conduct.

Faculty at other institutions was also identified as facilitators of GAs' learning to teach. As mentioned earlier, sharing teaching materials and experience with other faculty during conferences was valuable support for GA-12.

## Peer GAs

Other experienced GAs figured prominently as people who facilitated GAs learning to teach, by serving as role models and mentors.

GAs in the department are also my sources in learning to teach. I talk to them, for instance, it is your first semester in teaching and you do not know how to do it... When you observe their teaching, you also learn about how you should teach pre-service teachers or how you should interact with them. You learn by observing them... By using them as a role model... I benefit from their teaching experience (GA-6).

Similarly, GA-9, who was completing coursework, stated that she used experienced GAs as role models and thought that teaching in a similar way was helpful because these GAs had already tried these methods. Although beginner GAs who were still at the coursework stage had a tendency to imitate experienced GAs' teaching, GAs who were at the comprehensive exam and dissertation stages were apt to discuss teaching strategies with other GAs.

In one of the Ph.D. courses that we took, we came together and designed the class for the next week. We were talking about how we can teach... We discussed the way of teaching (GA-10).

Thus, a difference in how GAs utilized their peers to support their learning to teach is evident among our participants. Those at the early stages of their program primarily used others as role models to imitate, while those who were more experienced relied more on peers as colleagues with whom they could plan and criticize their teaching.

## Pre-service teachers' reactions

Fellow GAs and faculty members were not the only people that supported GAs in learning to teach; GA-8 stated that he also learned from interactions with his students (pre-service teachers) and reflecting on their reactions to his teaching.

For example, you have two groups. Let's say that students in the first group had some difficulties and asked questions to you. It may be related to your teaching's shortcoming or an unexpected question. You may not put that point into your plan, but after that question, I say that it should have been mentioned or it should have been taught. Then, I then add that point to my teaching for the



other group. Therefore, in developing my teaching, pre-service teachers also have influence on me because they have very diverse perspectives related to the topics. At the beginning, I could not plan for different students; but with help, I realize that I also should include another point in my teaching.

In this manner, GA-8 used the pre-service teachers' reactions, feedback, and difficulties to modify his instruction. Teaching pre-service teachers with different characteristics also supported his teaching development regarding designing instruction for diverse learners' needs.

### Tools that assist GAs in learning to teach

This section describes the tools used by GAs' in learning to teach. Two categories of materials emerged from the data: printed materials and electronic tools (■ Table 4).

#### Printed materials

First, in terms of printed materials, books were found useful regarding developing their teaching by GAs who were at the end of Ph.D.

Generally, the books that include lots of activities attract my attention. The books especially related to my area of interest. I have focused on developing activities to teach NOS to pre-service teachers. How they teach the topic, for instance, if they do not provide much details about how to teach the activity, I am disappointed because I am trying to learn something about teaching method, how they present the activity to the students, which concepts are stressed during which step, whether the knowledge is provided directly or not, or whether pre-conceptions of the students are detected or not. I am really interested in learning what happens during the whole procedure. There are books that contribute to my teaching (GA-1).

As GAs gained experience, they were more likely to seek out information and resources on their own. They were also clear about what they were looking for (e.g., teaching activity books that give the details about the roles of learners, teacher, and what they do in each step of the activity). In contrast, GAs at the coursework stage of the program were more likely to seek out articles.

...I do not believe that it is possible to learn teaching only theoretically. I cannot solidify the effective teaching if I do not have an example. Articles are helpful in that way. When you read them, you see that they use A and B [teaching methods]. So, you can use them in your class. For me, they are concrete examples (GA-6).

Other GAs specified the same point related to the help of reading theses that provide them detailed teaching activities. GA-1, at the dissertation stage, and GA-7, at the comprehensive exam stage, mentioned the helpfulness of theses in terms of providing detailed teaching activities for them.

#### Electronic sources

Animations from the Internet were cited by two GAs at the dissertation stage (GA-3 and GA-8). They shared similar experiences with animations from the Internet.

I studied animations and learned from them. I can use them in the class. In the books, there is a theoretical part, for example, dissolution of NaCl in water. It says that when NaCl dissolves in water, ions are formed. Then, I take a beaker, water and salt to the class, which is nice; however, for the third level [of representations in chemistry] that is a particulate level, I use a flash animation and tell the dissolution of NaCl in water with help of them (GA-8).

Through these, they did not only increase their knowledge on the subject, but also gained new representations to integrate into their teaching.

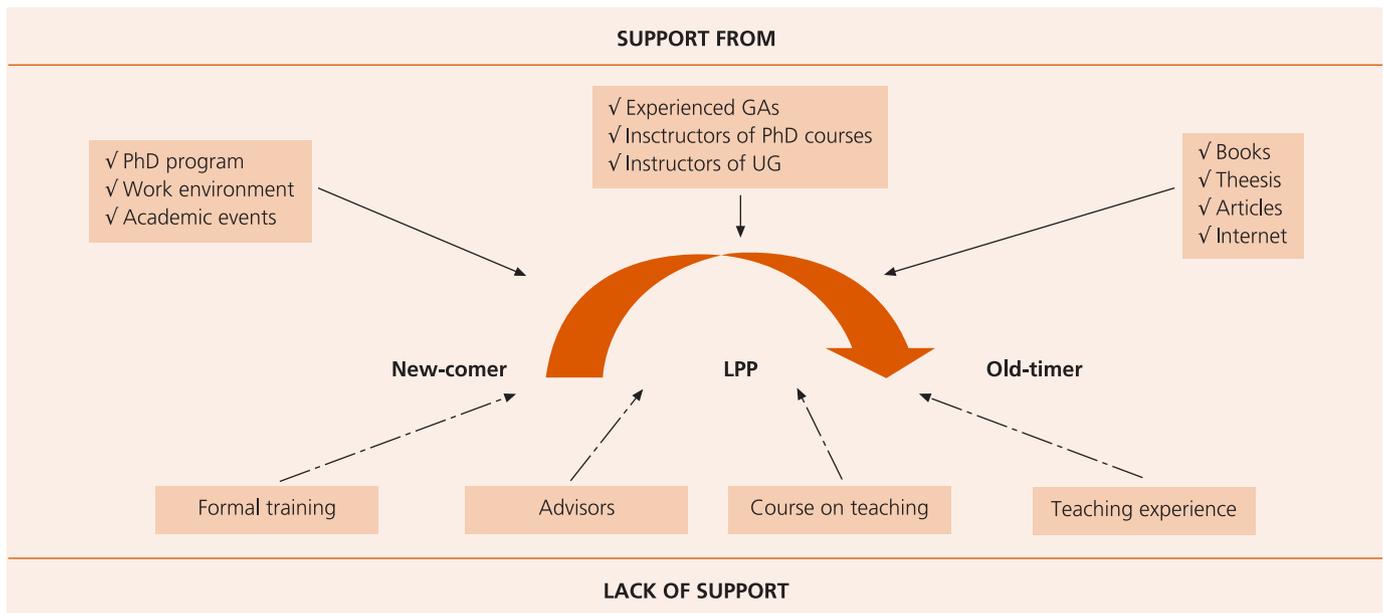
GAs' responses about the tools they found beneficial made the difference between novice and experienced GAs clearer. Only experienced GAs utilized books and the Internet for developing their teaching practice. The only tools that novice GAs used for learning to teach were articles. On the contrary, experienced GAs were aware of both the tools (e.g., animations from the Internet) that are useful and how to best use them (e.g., finding representations useful to teach abstract topics).

### Summary

To summarize, different contexts, people, and tools helped GAs in their expedition into teaching teachers. As illustrated in

■ Table 4. Tools help GAs learn how to teach

Categories	Subcategories	Total # of GAs (%)	Examples of how contexts help GAs learn to teach
Printed materials	Books	7 (58%)	Providing example teaching activities
	Articles and thesis	7 (58%)	Providing details about how to apply the instructional strategies
Electronic sources	Animations from the internet	2 (17%)	Providing additional representations useful to teach abstract topics



■ Figure 1. Summary of results.

■ Figure 1, the types of support on which GAs drew varied according to their experience as a GA. We realized that GAs with more experience were more aware of the available contexts, people, and tools than less experienced ones. Moreover, results made us think that GAs might start their expedition with little knowledge of how to teach and how to look for useful sources to facilitate their learning. Observing more experienced GAs' practice and imitating what they do may be the only available strategies that they had at the beginning. Then, with help of the cumulative support taken from their own experience as a GA, as well as advice from experienced GAs, they started learn more practical ways on which they can draw. Experienced GAs who were almost finished with their Ph.D. had a rich list of sources (i.e., regarding context, people, or tools) and strategies of how to use them as a source for learning to teach (e.g., using pre-service teachers' feedback for re-designing his teaching or learning about how other faculties working at different colleges teach during a conference).

In ■ Figure 1, the support provided to GAs was shown in bold whereas lack of support was represented in grey color. Interestingly, there were some sources of support we expected to benefit GAs, but that they did not draw on. For instance, GAs did not take any formal training on how to teach pre-service teachers, how to assess their understanding, the pre-service teacher program, etc. Related to this point, the entire participant TAs criticized the doctoral program. Specifically, GA-10 highlighted the inadequacy of training offered.

I think that learning it [how to teach] is not a skill that you can develop by reading. Regarding teaching at this level, the experiences that have been provided to us so far is not enough. Also, I think the other opportunities that will be offered will not be enough either. It is one of the topics that we discuss with other GAs. We criticize what is going to happen in the future. In this context, we have not supported about teaching college students. Therefore, we [GAs] compulsorily read about how to teach. Sometimes I compare this program with others. In some of them, GAs have to co-teach some courses. I feel that those GAs are much better than us in developing their teaching skills and having dialogue with students. In this program, we do not have teaching practice opportunity.

Moreover, only one GA had a chance to talk his advisor about students' misconceptions in chemistry. Although the doctoral program examined in this study was a science education doctoral program, coursework on teacher education and on how to teach were missing. However, several courses that were offered (e.g., Theories of Learning and Test Construction in Science Education) were useful for GAs for learning theoretical aspects of teaching rather than practical ones.

Another missing point was practice teaching experience provided to GAs. None of the doctoral courses included teaching experience as a component of the course. Also, having teaching experience for K-12 or teaching at college level was not a requirement for applicants to the program.



I know that I have to motivate pre-service teachers, use some activities during teaching. But they are all in theory. I have not applied them yet... The program does not offer any course on teaching. Also, there is no obligation for TAs to observe faculty members' teaching. So, I do not have much chance to observe others' teaching. How I have learned about teaching is.... May be reading about how to teach. Due to lack of practice in teaching in this program, I know how to teach just in theory (GA-6).

## Discussion and Conclusion

Abell et al. (2009) claimed that “doctoral programs should function as a community of practice through which its members (faculty and students) develop a disciplinary knowledge base, skills for designing and carrying out science education research, and knowledge for teaching science teachers” (p. 80). It is this latter aspect that has been often neglected by doctoral preparation. The neglect of GAs' pedagogical preparation results in GAs' inadequate understanding of undergraduate students (Gardner and Jones, 2011). In this study, we examined the way in which *graduate teaching assistants* are initiated into a community of practice – specifically, the context, tools, and people who supported them in learning to teach teachers. We document these “expeditions” into new territory through the eyes of the GAs themselves, in the hopes of identifying available forms of legitimate peripheral participation that exist and how these might become more institutionalized in the preparation of GAs.

First, our findings highlighted the lack of courses on teaching, especially content-specific teaching methods courses for students at the Ph.D. level. Although participants took courses on learning theories and test construction, no specific course on teaching methods and teaching science teachers was offered. Thus, their coursework did not align with their needs in terms of developing them for their future (and present) roles as teacher educators. Similarly, none of the participants underwent any formal orientation or seminar before teaching courses for prospective science teachers. It is likely that the faculty themselves were not offered such courses, and thus it is not part of the institutional history of the program. Nonetheless, research illustrates the potential benefit for inclusion of these courses in doctoral programs. For example, Bond-Robinson and Rodrigues (2006) showed that a course that included projects related to teaching, watching and reflecting about video-taped cases, and providing guidance for GAs was beneficial for development of GAs' teaching skills. Such courses might also help avoid current reliance on “an ‘apprenticeship of observation’ to learn to teach teachers”; overwhelmingly the GAs in this study indicated that past experiences in their undergraduate programs influenced their

learning in terms of both context and people that helped them to learn to teach.

To be part of a community and to learn its tenets, *newcomer* GAs need time with, and assistance from *old-timers* (Lave and Wenger, 1991). In this study, it was not the faculty, but the experienced GAs who appeared to function as ‘old-timers’. That is, GAs were not being initiated into a community of teacher educators, but into a community of novice teacher educators. GAs who were at the coursework stage expressed how they benefited from interactions with and support of more experienced GAs. Nonetheless, given even experienced GAs have limited teaching experience and limited pedagogical content knowledge (PCK) for teaching teachers, this remains problematic. GAs in this study indicated a lack of support for their learning to teach from the true “old timers” at their institutions - their faculty advisors. Though GAs benefited from their advisors' expertise in developing their research skills and knowledge, they did not receive equal support in relation to developing their teaching skills and knowledge.

With the scaffolding of experienced old-timers (i.e., faculty members) through collaboration and reflection, a newcomer will eventually be enculturated into the community of practice. However, our study showed that GAs were not provided this type of experience (i.e., apprenticeship, collaboration, and reflection). Rather, they were expected to be able to plan and teach at the very beginning of the doctoral program. It contradicts to the model for science teacher educators:

The experienced GA helped the newcomer to approximate best practice through continuous feedback on the syllabus. Thus, the apprentice develops PCK for teaching teachers by actively engaging in discussion with an experienced GA and by reading about, discussing, and practicing teacher education in small pieces (Abell et al., 2009, p. 88).

In contrast to the above excerpt, experienced GAs may not be equipped to provide rich feedback or suggestions to newcomers the way a veteran teacher educator may. As Gardner and Jones caution, “...if untrained peers are teaching the novice [GAs], this can compound ineffective pedagogical practice” (2011, p. 32-33).

This is not to say that progress was not made by the GAs in our study toward learning to teach teachers. As we examined the way in which contexts and tools played a role in learning to teach, we observed a shift in the nature of how GAs relied on these tools early on and later in their teaching experiences. For example, in terms of contexts, it seems that experienced GAs were better able to take advantage of their experiences being teaching assistants of undergraduate courses through participation in educational conferences and proj-



ects than newcomer GAs. Similarly, in terms of tools, results showed that more experienced GAs (i.e., GAs at comprehensive exam or dissertation stages) were able to seek out specific resources, such as books, that could help fill gaps in their knowledge for teaching. Nonetheless, it is *how* GAs use these tools that matters. “People who use tools actively rather than just acquire them, by contrast, build an increasingly rich implicit understanding of the world in which they use the tools and of the tools themselves” (Brown et al., 1989, p. 33). GAs need some basic knowledge to be able to realize the usefulness of those practices (e.g., participating in course design) and tools (e.g., books). With help of experience, and experienced GAs and instructors, newcomers are supposed to recognize the way that they can profit from the activities (Lave and Wenger, 1991).

### Implications and Recommendations

GAs are often expected to teach undergraduate students without and/or with little formal training or school experience for teaching. It is unrealistic to expect that GAs can teach effectively with little support. Luft et al. also (2004) criticized the situation: “The title of [our] article, “Growing a Garden without Water,” represents the expectations and potential of GTAs [graduate teaching assistants] in the absence of adequate support to facilitate their growth. GTAs have an essential role in universities and colleges, but without proper instructional support they may not achieve their potential” (p. 229). In order to make the garden green with water, important steps should be taken. First, we find it problematic that the primary people supporting GAs in learning to teach are other GAs who have more experience, but likely underdeveloped PCK for teaching teachers. Nonetheless, we find it promising that GAs did seek out assistance from other faculty at professional meetings and recognized the benefit of observing others teach. We believe that professional organizations can play an important role in supporting GAs through offering more structured opportunities for novice teacher educators (i.e., GAs) and experienced teacher educators to network and form mentor/mentee relationships. The most important point regarding the support provided is determining which types of experiences and when they should be offered to GAs. Regarding this point, Abell et al. (2009) suggested an “intentional sequence of learning experiences (p. 90), which means that specific opportunities for GAs who are at the different stages of the career phases should be available. For instance, observing veteran instructors’ or experienced GAs’ teaching may be useful for novice GAs. However, it should not be the only source provided to GAs. In addition to that, GAs should have a chance to read about teaching and discuss their teaching with experienced instructors. Then,

teach a course with an instructor collaboratively, and eventually plan and teach courses independently, which is also parallel to the Situated Learning Theory that highlights the importance of apprenticeship of observation and legitimate peripheral participation of novices to a community of practice (Brown et al., 1989; Lave and Wenger, 1991; Putnam and Borko, 2000).

To reinforce the influence of these opportunities provided by work environment (e.g., observing veteran faculties’ teaching), professional organizations could design workshops and short courses for GAs. This would allow GAs from multiple institutions to benefit from the expertise of faculty, broadening opportunities for important social interactions to support their learning. Because our findings revealed that it was primarily experienced GAs who participated in these types of events; we believe efforts should be made to encourage novice GAs to participate in conferences as well.

Additionally, we believe that universities could draw on GAs’ interest in observing others’ teaching by making arrangements for GAs to conduct observations of faculty in various courses. This could be accomplished through formal coursework. For example, observing others’ teaching may be a part of teaching methods course. Moreover, courses including planning and teaching experiences, and feedback on teaching performance could be provided for doctoral students as well.

Furthermore, experienced GAs and advisors should help novice GAs; therefore, both informal and formal discourse communities should be organized (Gunn, 2007). Weekly or monthly meetings with special topics (e.g., teaching techniques and assessment strategies) may provide opportunities to learn, discuss, and share knowledge and experiences among GAs at different stages of their career, which is consistent with the social aspect of learning according to Situated Learning Theory (Brown et al., 1989; Lave and Wenger, 1991). Just as mentoring support is provided to pre-service and in-service teachers (i.e., especially teachers in the induction year) (Bradbury, 2010), mentoring should be provided to GAs. Finally, although advisors play a vital and obvious role in GAs’ research, our findings illustrate that they can also play a supportive role in terms of mentoring GAs in practical aspects of learning how to teach.

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