Learning to think, talk, and act like an instructor: A framework for novice tertiary instructor teaching preparation programs

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In this report I present a framework to characterize novice tertiary instructor teaching preparation programs. This framework was developed through case study analyses of four graduate student teaching assistant professional development (GTA PD) programs at institutions identified as having more successful calculus programs compared to other institutions. The components of the framework are the structure of the program, the departmental and institutional culture and context that the program is situated within, and the types of knowledge and practices emphasized in the program. In this report I characterize one of the programs involved in the development of the framework as an example of how it is used. In addition to characterizing existing programs, this framework can be used to evaluate programs and aid in the development of new novice tertiary instructor teaching preparation programs.

Keywords: Graduate student teaching assistant, professional development, pedagogies of practice, mathematical knowledge for teaching, framework

Theoretically driven research centered on teaching preparation of graduate students (and other novice tertiary mathematics instructors) pales in comparison to the literature related to professional development of K-12 mathematics teachers. While there are aspects of K-12 professional development (PD) programs that can be highly relevant and informative to the tertiary level, there are also many ways in which tertiary level teaching preparation should be examined as its own field. In this report, I introduce a theoretical framework that draws on K-12 PD literature and responds to the particular needs at the tertiary level, and use this framework to characterize one graduate student teaching preparation program as an example of its use.

The National Science Board (NSB) uses the term professional development to refer both to teacher preparations (i.e. the teaching of pre-service teachers, prospective teachers, and teacher candidates) and to the development of practicing teachers (i.e. in-service teachers and practicing teachers) (National Science Board, 2012). Novice tertiary instructors, especially graduate students, have commonalities with both categories of teachers: the training they receive for these roles is typically the first training to teach they will have received, however often they receive a large portion of this training while they are teaching. For many practicing tertiary instructors, any professional development related to teaching they may have received as graduate students or post-docs is likely to be their only formal training as mathematics *educators*, rather than as mathematics *researchers*, and can help enculturate graduate students into academia (Austin, 2002). Thus, the literature on professional development programs designed both for pre-service and in-service teachers at the K-12 level is relevant to tertiary teaching preparation. While there is extensive research into the professional development of teachers at the K-12 level, there is substantially less literature focusing on tertiary instructor teaching preparation, especially that is theoretically driven. A large portion of the studies focused on tertiary instructor teaching preparation report on the success of existing programs or needs (often unmet) of novice instructors (e.g. Hauk et al., 2009; Kung & Speer, 2009; Speer, Gutmann, & Murphy, 2005).

However, the body of research that connects aspects of these programs to identify commonalities and key features to consider when creating a new program is lacking.

Ten years ago, Speer and her colleagues initiated the conversation among mathematics education researchers interested in novice tertiary instructor teaching preparation, calling attention to what we could learn from K-12 PD, and identified a number of research directions to pursue (Speer, Gutmann, & Murphy, 2005). Many of these directions have been pursued directly by Speer and others since this call, and as a result there are more productive models of novice tertiary instructor teaching preparation programs in existence. In this paper, I develop a theoretically driven model that connects such productive programs. This framework may be used to better understand (and make improvements to) existing programs as well as to influence the development of a new program geared at preparing GTAs and other novice tertiary instructors.

Methods

As part of a large, national study focused on identifying elements present in successful calculus programs *Characteristics of Successful Programs in College Calculus (CSPCC)* (MAA, 2013), I studied the graduate student teaching preparation programs at four institutions with successful calculus programs where graduate students and post docs were involved in the teaching of calculus. Through analyses of survey data, the project team identified institutions that were more successful than comparable institutions, where success was viewed as a combination of retaining students' positive dispositions towards mathematics, retaining students' intentions to take Calculus II, and having a reasonable pass rate. We then conducted case studies (Stake, 1995) at these institutions to learn what they were doing in calculus that may be contributing to students' success, and how this success could be translated to other institutions. Robust novice instructor teaching preparation programs were one such element, and were then studied in depth in the national sample and at the case study institutions.

As part of the MAA study, an abundance of data was collected surrounding four PhD-granting institution's GTA PD programs. This included the collection of all documents related to the GTA PD, observations of the training when possible, observations of instructor meetings, observations of graduate students teaching and leading recitation section, and interviews with graduate students, administrators, PD facilitators, and students.

I drew on qualitative research strategies (e.g, Braun & Clarke, 2006; Miles & Huberman, 1994; Stake, 1995, 2005; Yin, 2003) and employed three specific techniques for analyzing this data: pattern matching, explanation building, and cross-case syntheses. Through pattern matching I developed systematic groupings of data using inductive thematic analysis (Braun & Clarke, 2006). Inductive thematic analysis is a bottom-up approach, where the themes are data-driven, though are not developed in an "epistemological vacuum" (p. 84). Through these analytic techniques I developed the framework for novice tertiary instructor teaching preparation programs, described below. While I attended to the ways in which these institutions prepared graduate students in their roles as instructors, these programs can be informative for preparing other novice tertiary instructors, such as post-docs, lecturers, and new tenure-track faculty.

Components of framework

The central component of this framework is the *structure* of the teaching preparation program; when it occurs, for how long, who participates, what is discussed, and how. Within this structural design, different aspects of knowledge are emphasized and to varying degrees, and

participants engage in different practices to gain this knowledge and to varying levels of authenticity. This structure, with the various types of knowledge emphasized through different practices, is like the structure of a house. The design of any house is influenced and constrained by the environment (the square footage available, the zoning laws, the terrain of the land, etc.) and the designer(s) (the architect and possibly the new owners). Similarly, the structure of a teaching preparation program is influenced and constrained by the environment within which it is situated: the institution and the department.

The structure of the program is constrained, determined, and enabled by the surrounding environment. The *institutional and departmental context* and *culture* together comprise the environment within which the teaching preparation program exists. The institutional and departmental context guides the needs and capabilities of a teaching preparation program. For instance, the responsibilities of novice instructors are determined by (a) the number of graduate students, post-docs, and other novice instructors in the department in relation to the number of other faculty and in relation to the number of undergraduates served by the department, (b) the types of classrooms available (large lecture halls versus small classrooms), and other components of the context of the institution and department. The institutional and departmental culture shapes how the department responds to these needs and capabilities. For instance, whether graduate students serve as recitation leaders or course instructors will be shaped by (a) the institution and departments' views on class size, (b) their orientation toward optimal learning environments, (c) their aspirations for undergraduate instruction, and other components of the culture of the institution and department.

Within the structure of the program, different *knowledge* and *practices* are emphasized and in different ways. As part of developing as an instructor, one develops knowledge and practices surrounding instruction. Thus, the tertiary teaching preparation programs emphasize different types of knowledge and practices depending on the community and needs within than institution.

One way to characterize the types of knowledge needed to teach is the classic distinction by Shulman (1986), who differentiated between *pedagogical knowledge (PK), content knowledge (CK),* and *pedagogical content knowledge (PCK).* Pedagogical content knowledge is distinct from a blend of basic pedagogical knowledge and basic content knowledge and was introduced by Shulman in response to the wide-held belief that content knowledge alone was sufficient to teach. PCK is the particular form of content knowledge related to the aspects of content knowledge "most germane to its teachability", including ways of representing content so that it is understandable to others (Schulman, 1986, p. 9).

To characterize the practices graduate students can legitimately and peripherally engage in as they learn how to be tertiary instructors, I draw on Grossman et al.s' (2009) *pedagogies of practice.* Grossman and her colleagues (2009) identified three concepts for describing ways to teach practices in professional education: *representations of practice, decompositions of practice,* and *approximations of practice.* Representations of practice comprise different ways practice can be represented for novices. In teacher education, one may represent the practices of teaching through written case studies, Videocases, photographs of the classroom, narratives, lesson plans, technological reproductions, among many others. The authors note that "the nature of the representation determines to a large extent the visibility of certain facets of practice" (p. 2066) and thus different representations of the same practices have different affordances for the learner. Decompositions of practice break down a complex practice into its multiple parts, which has affordances as well as limitations. By decomposing a practice, it may remove the practice from the actual context within which it is situated (for an elaboration on this point see Putnam &

Borko, 2000) however it also enables the novice to focus on specific aspects of a practice without the complications of the actual context. Approximations of practice are activities that allow novices to engage in legitimate practices of a community in a peripheral way, meaning that they are "more or less proximal to the practices of a profession." These approximations may take the learner directly to the practice, as is done during student-teaching, or bring the practice to the learner through various representations, such as video or role-playing.

Teaching preparation programs provide many examples of representations, decompositions, and approximations of the practices of teaching with varying levels of authenticity. For instance, by watching Videocases, novice teachers are able to "enter" the classroom, observe student behavior and imagine how they would react as the teacher, without the actual responsibility of being in the classroom. This approximation of teaching has a low level of authenticity because real teachers do not have the opportunity to pause or rewind classroom activity in order to decide how to react or how to interpret the situation. Practice teaching is an example of an approximation of teaching with much higher authenticity. During practice teaching, novice teachers have limited responsibility in the classroom, but are able to experience it in real time and in a much more authentic way than by watching a video. Grossman and her colleagues (2009) highlight the benefits of representations, decompositions, and approximations of practice with varying levels of authenticity, which "quiet the background noise so that they can tune in to one facet of practice at a time" (p. 2083). As novices participate in the practices of a community (through approximations of practice, representations of practice, and/or decompositions of practice) they do not just develop the skills of the community, but also develop (to varying degrees) a shared knowledge base and shared dispositions. Figure 1 illustrates the relationships between them, and provides a visualize representation of the framework for novice tertiary teaching preparation.

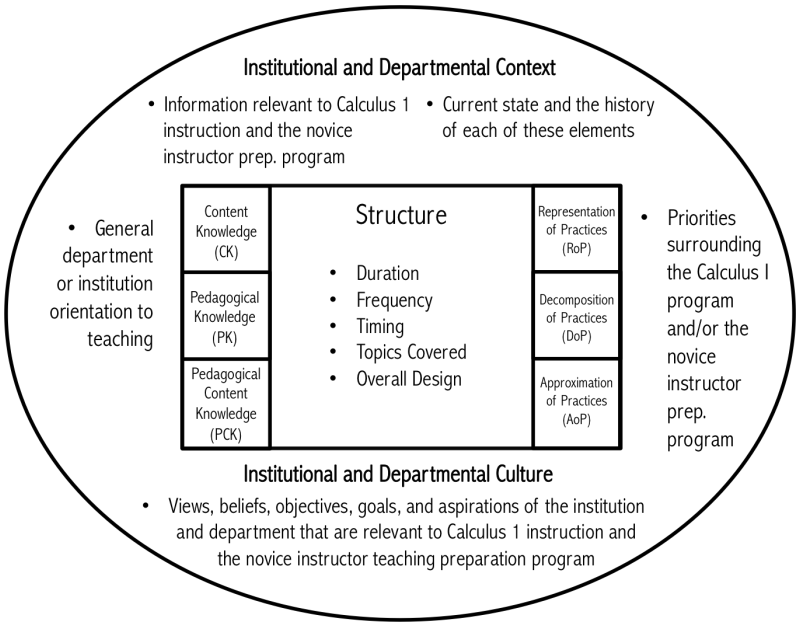

Figure 1 Framework of instructor teaching preparation programs

Different tertiary teaching preparation programs necessarily focus on different types of knowledge depending on their goals and guiding philosophies, as well as depending on the department's needs and the needs of the novice instructors. For instance, if novice instructors

typically come into their role as instructors at a specific institution with extensive teaching experience but are less confident in their mathematical knowledge, a tertiary teaching preparation programs may emphasize content knowledge related to teaching more than pedagogical knowledge. If, instead, novice instructors typically come into their role at a specific institution with very strong mathematical content knowledge but little to no experience interacting with students, than tertiary teaching preparation programs may emphasize pedagogical knowledge and pedagogical content knowledge, but not content knowledge.

Within the structure of tertiary teaching preparation programs, different types of knowledge is emphasized to different degrees of depth and novices engage in different pedagogies of practices to varying degrees of authenticity. These varying degrees of depth and authenticity are represented in the framework by darker or lighter shading of the six smaller boxes in Figure 1, where darker represents knowledge emphasized more deeply or more authentic pedagogies of practice. These emphases are guided and constrained by the institutional and departmental environment that the program is situated within, and help to provide more information about the structure of the program. The level of shading was determined through the case study analysis.

An Example

Here I use the framework to visually represent one model of novice instructor teaching preparation programs, called the Apprenticeship Model. The Apprenticeship Model of novice instructor teaching preparation was enacted at a small university with around 5,000 undergraduate students, where fall enrollment in Calculus 1 is around 270 and class sizes are around 45. Graduate students, both Master's and Doctoral students, are involved in the teaching of Calculus I as teaching assistants, tutors, and course instructors. Post-docs are not involved in the teaching of Calculus I at this university.

The primary guiding philosophy behind the Apprenticeship model is the desire to transition graduate students into the role of instructor, both as part of their immediate role as GTAs and as their (potential) future role as undergraduate mathematics instructors. Embedded within this philosophy is the belief that people learning a new profession (who will develop a professional identity surrounding it) must participate in the practices of the profession with growing responsibility. This belief is in line with a perspective in which learning is viewed as the process of engaging a novice in the practices of the profession with legitimate but peripheral participation (Lave & Wenger, 1991). The term "peripheral" indicates that the practices novices are involved in are less central versions of the authentic practices, or are central practices with limited responsibility. As one clinical psychology professor involved in the Grossman et al. (2009) study said when describing how clinical psychologists are prepared, "if you're learning to paddle, you wouldn't practice kayaking down the rapids. You would paddle on a smooth lake to learn your strokes" (p. 2026). The main components of the Apprenticeship model are:

- A three-unit class, inspired by Lesson Study (Lewis, 2004), that takes place during the semester before the graduate student is placed as a course instructor.
- A mentor instructor for whom the mentee acts as a teaching assistant in the class they will be teaching during the semester before the graduate student is placed as a course instructor.
- Weekly course meetings once the graduate student is placed as a course instructor.
- Observations and feedback once the graduate student is placed as a course instructor.

Graduate students are required to participate in a number of teaching development activities, both prior to teaching and while they teach. All new GTAs must attend a one-day seminar led by the mathematics department, with some of this time spent doing practice teaching presentations. During the seminar faculty conduct workshops on topics including pedagogical basics, such as how to write well on the board, as well as more advanced pedagogical topics, such as how to implement cooperative learning. Additionally, all first-year GTAs are assigned a faculty mentor during the orientation session.

As shown in Figure 2, the framework representation of the Apprenticeship Model gives a clear overview of the structure and encompassing environment of the novice instructor teaching preparation program.

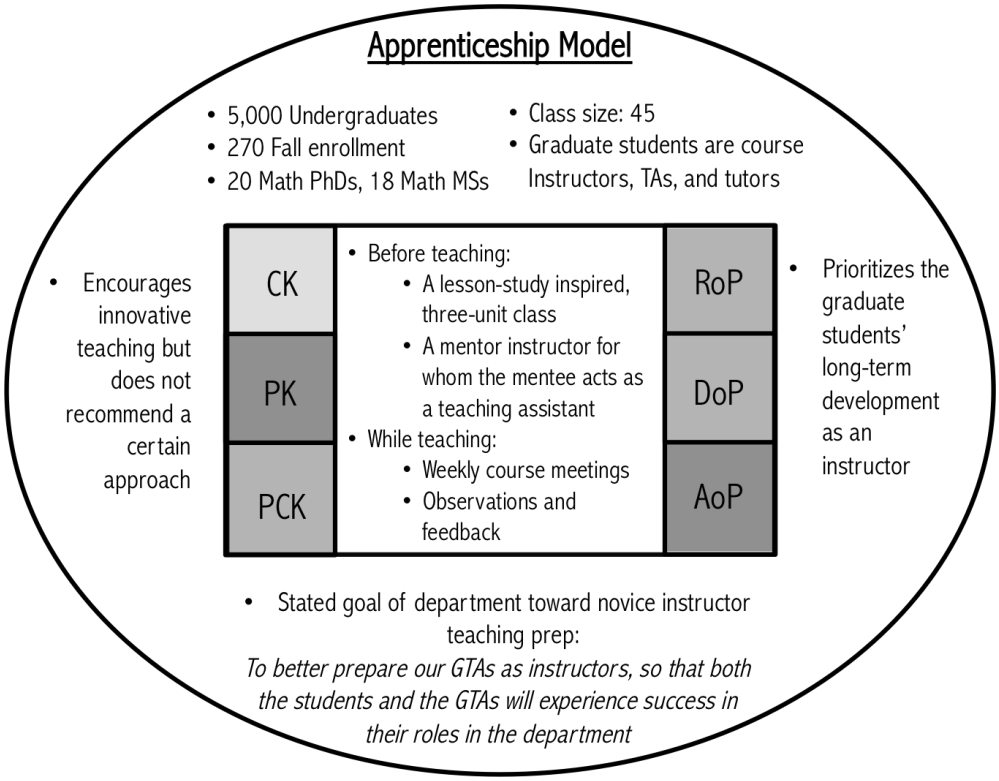

Figure 2 Apprenticeship model

The main structural components of the program are a lesson-study inspired course and mentoring that occur before the GGTA is placed as an instructor, and ongoing meetings and observations once the GTA is placed as an instructor. The shading provides a visual representation for the level of emphasis of the knowledge and the level of authenticity of the practices involved in the programs. Within this structure, pedagogical knowledge is emphasized more deeply than PCK or content knowledge, though PCK is emphasized through both the lesson-study inspired course and the mentoring. Content knowledge is potentially emphasized through the mentoring, although it is not a primary focus. During the lesson-study course, novice instructors participate in a number of pedagogies of practice to varying degrees of authenticity. Through the lesson-study-like iterations of developing, presenting, and refining lessons, graduate students engage in approximations of the practice of teaching to increasing degrees of authenticity. The practice of teaching is decomposed into planning, presenting, and refining

through the lesson-study course with medium level of authenticity. Through both the lesson-study course and the mentoring, graduate students have multiple opportunities for teaching to be represented, by other graduate students, their mentor instructor, and by reading and watching cases. This program is situated within a small department that prioritized graduate students' long-term development as instructors and encourages innovative teaching but does not require a certain pedagogical approach.

Conclusion

While the framework representation does not give the rich detail of the program on its own, it provides information useful in comparing across models, and can be used to ask and answer questions regarding the evaluation or implementation of an individual model. In the presentation of this report, I will use the framework to compare two novice tertiary programs to highlight this affordance. The framework can also be used to evaluate a program or to help with the creation or improvement of a teaching preparation program. To aid in the evaluation of a program, a mathematics department may determine that their GTAs and post docs seem to know very little about how their students may think about mathematics, their difficulties, and how to explain problems so that they will better understand them. They could use this framework to describe their current program and identify that they are not, in fact, spending time during the teaching preparation discussing PCK. To aid in the development of a program, this framework can help direct attention to important components to consider. In many mathematics departments, a more robust novice teacher preparation program is developed based on the initiative of one or two motivated individuals – the change agents. Often, these change agents are not necessarily mathematics education experts, or have good ideas about what the novice instructors need at their institution but do not know how to go about setting up a new program. The framework introduced in this report provides an organized and systematic way to think about the components of a teaching preparation program.

Many institutions are currently seeking to make improvements to their GTA training programs – in fact, in a recent survey through the *Progress through Calculus (PtC)* project (an extension of the CSPCC project), the MAA has determined that 68 graduate degree granting mathematics departments are either currently implementing changes to their GTA PD program or are discussing changes for the future. In order to implement these changes, change agents at these institutions often draw from their own experiences as graduate students or knowledge of other programs to adapt to their institutions. One additional use for this framework would be to characterize a large number of programs and provide the visual representations to institutions looking to implement changes to their program. These condensed visual representations would enable the change agents to consider many different programs and compare specific aspects across the programs easily. Through the PtC project, we have collected data from 135 graduate degree granting mathematics departments regarding their GTA PD programs. A future stage of this work will be to use the framework discussed in this paper to characterize these programs to begin to create a visual library of novice tertiary instructor teaching preparation programs that can be then adapted by institutions for GTA PD or other novice teacher preparation.

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