

Professional Obligations in Mathematics Courses for Teachers

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This theoretical contribution draws on earlier work by Herbst and Chazan (2012; also Chazan et al., 2016) in which they describe the position of a mathematics teacher in an educational institution as accountable to stakeholders who issue four types of professional obligations. We propose an application and adaptation of that framework intended to address the case of instructors who teach undergraduate mathematics courses to future teachers. Considerations of not only the academic but also the professional ends of these courses are key in our application of the theory of obligations.

Keywords: instruction, professional obligations, professional preparation, undergraduate mathematics courses, mathematics courses for teachers

Understanding the work of teaching undergraduate mathematics courses for prospective elementary and secondary teachers is of interest to the RUME community (e.g., Hauk et al., 2017; Lai et al., 2019; Martin, et al., 2020; Yan et al., 2020). Separately, the professional obligations framework (Herbst & Chazan, 2012) has been found useful for RUME researchers to examine the decisions undergraduate mathematics instructors make (e.g., Bennett, 2022; Shultz, 2022; Shultz et al., 2022). In this theoretical contribution we offer an application and adaptation of the professional obligation framework to account for specific demands on the position of instructors of mathematics courses for teachers.

Improvement of Mathematics Courses for Teachers

Recommendations for improvement in the mathematical preparation of teachers, have posited that mathematics courses for teachers should include what researchers have called mathematical knowledge for teaching (e.g., AMTE, 2017; CBMS, 2012) for two reasons. First, research in mathematics education has documented how the mathematics needed for teaching includes types of knowledge that have not been commonly covered in university mathematics courses, even in those dedicated to teachers (Ball et al., 2001). Second, research in mathematics education has also documented that mathematical knowledge for teaching (MKT) can make a difference in the mathematical quality of instruction and in students' achievement (Hill et al., 2005; 2008). Given the prevalence of university-based teacher preparation in the number of entrants to the profession (Ronfeldt et al., 2014), it seems that if university mathematics courses for teachers could increase the MKT of new teachers (see Laursen et al., 2016), the improvement of mathematics courses for teachers could serve to improve the systemic capacity for mathematics teaching in K-12.

But because mathematics courses for teachers have been taught for decades (Ferrini-Mundy & Findell, 2010; Kilpatrick, 2019; Murray & Star, 2013), improvements in these courses need to

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consider and contend with extant curriculum, instruction, and assessment practices of those courses, all of which are anchored in institutional practices. Accounts of how individual instructors relate to such recommendations and how much they know about pedagogical content knowledge and the knowledge needed to teach teachers are valuable (Lai, 2019; Superfine & Li, 2014), but to make sense of how improvement could go, we also need accounts of the system in need of improvement (Bryk et al., 2015).

Some accounts of the system take the perspective of observers – for example noting the flow of people into K-12 teaching coming from university teacher education programs versus alternative certification (e.g., Ronfeldt et al., 2014) or charting the changes in MKT observed in courses of mathematics for teachers (Laursen et al. 2016; Pape et al., 2015). These observer accounts may help reformers understand what effects changes in university instruction may have in K12 instructional capacity. But that information by itself is unlikely to address some of the tensions instructors in these courses have to manage, which relate not only to their own knowledge and experiences (Lai, 2019) but also to the environments in which they work and the demands those environments place on them (Herbst et al., 2018). It is therefore important to understand the position and the roles of instructors of those courses. This involves not only understanding individuals in terms of what they are disposed to do but also the sets of systemic relationships and intact practices in which they are involved and that likely enable them to be so disposed (Bourdieu, 1990). To advance in this direction, the theoretical claim we make is that the professional obligations framework (Herbst & Chazan, 2012) can be used to describe how instructors of mathematics courses for teachers orient to their work.

The Professional Obligations of Mathematics Teaching

Chazan et al. (2016) describe the work of a teacher in terms of an institutional position—defined in relation to institutional stakeholders—and the various roles the teacher plays in the activities the institution expects them to engage. Mathematics instruction (narrowly defined as helping students learn a course of study) is a particularly important activity in which the teacher plays a role, but not the only such activity (e.g., mentoring youth is another such activity). The stakeholders Chazan et al. (2016) identify include (a) the Client—individual students and their advocates are stakeholders inasmuch as they are expected to benefit from schooling; (b) Knowledge—the accumulated knowledge and knowledge-producing practices of humankind, personified in scientific communities of knowledge producers, are stakeholders inasmuch as knowledge is to be disseminated and preserved through schooling; (c) Society—represented by community leaders, sponsors, and authority figures—is a stakeholder, putting at stake shared values, customs, needs, and goals of a society, community, or nation inasmuch as those stakes are to be interpreted, disseminated, and preserved for a new generation through schooling; and (d) Organization—the administrative, economic, and legal aspects of an organization are stakeholders inasmuch as school institutions need to abide by them. While these stakeholders are stakeholders of schooling and thus make room for instruction as well as other activities, they serve to specify the position of a teacher inside an educational institution, providing sources of justification for decisions that an individual teacher might make in the activities they engage in—particularly, in instruction. Chazan et al. (2016) identify these sources of justification as professional obligations, and they name them (a) the individual obligation (to students as individuals); (b) the disciplinary obligation (to the knowledge disciplines that are sources of the content of instruction); (c) the interpersonal obligation (to the society in which the class of students are to integrate themselves); and (d) the institutional obligation (to the various

institutions that serve as environments for the activities in which the teacher plays a role). Those stakeholders structure the institutional space in which (mathematics) instruction takes place and individuals hired into teaching positions are socialized into roles in various activities in which it becomes natural for them to feel obliged in the ways that the four obligations describe. The obligations neither erase individual responsibility nor prevent individual agency; rather, they identify resources and constraints available to individuals to publicly warrant actions and decisions.

Those warrants for actions and decisions may be especially useful in the activity of mathematics instruction, especially as our field concerns itself with instructional improvement. Because instructors' agency needs to be co-opted in order to make some such improvements, it is important for improvement efforts not only to acknowledge the expectations teachers work under but also to identify resources that may support their participation in institutional argumentation around changes in practices. If instructional improvement requires instructors to act in ways that deviate from the expectations they or their students have coming into class, justifications may be needed. The professional obligations can help provide such justifications. Further, if recommendations for instructional improvement may seem to push teachers beyond what feels viable to them, the professional obligations may help practitioners negotiate those recommendations.

Because practical rationality and the obligations framework describe the position in which instructors are and the role they are expected to play in instruction (and because they are not a theory of action for improvement along a particular direction), they can identify sources of justification that instructors might use to argue both for and against change in any direction. As such, this framework can help researchers understand reactions against reform and it can help frame institutional discussions about improvement that acknowledge where different parties are coming from. However, practical rationality was originally developed to examine the position and the instructional role of mathematics teachers in academic contexts (that is, in the study of mathematics, be that in K-12 schooling or in mathematics courses for mathematics majors). The application of the framework to the mathematics instruction of professionals, who will use mathematics to do professional work requires some adaptation.

Expanding the Theory of Practical Rationality to Account for the Experiences of Instructors of Mathematics Courses for Teachers

We contend that in order to understand the position and the instructional role of those who teach mathematics courses for teachers, it is worth describing the instructional practice in which they are involved as contested by a tension between two different instances of the instructional triangle (Cohen et al., 2003): Each instructor of undergraduate mathematics courses for teachers is in a position from which they can be disposed to see the course they teach as both an undergraduate mathematics course and as a mathematics teacher preparation course.

Much work in mathematics education that attends to the work of teaching implements this attention by looking at the individual who does the teaching—for example, in terms of their beliefs and knowledge. In the case of mathematics courses for teachers, an important distinction among instructors runs along issues of academic preparation and professional identity: Individual instructors may have doctoral degrees in mathematics or in mathematics education, and, in some cases, they may not have doctorates; their professional identity may include having been teachers or not, doing mathematical research, doing mathematics education research, doing both kinds of research, or doing no research. Those contingencies may impact the way in which they take up their position (e.g., hired to teach mathematics courses for teachers vs. hired for other reasons

and assigned to teach such courses). While we do not deny the importance of attending to those sources of individual differences, understanding how they matter in the way individuals play their role in instruction and how they recognize the various obligations is beyond the scope of this paper. In proposing an adaptation of the obligations framework from the theory of practical rationality, we are deliberately bracketing out those sources of individual differences to describe the set of resources and constraints that support the position in which all instructors of mathematics courses for teachers are hypothesized to be and arguing that it is more complex than that of instructors of mathematics courses for academic and scholarly preparation (e.g., mathematics courses for mathematics majors). We sketch this adaptation below and indicate what further research could be done to gather evidence of how these obligations operate.

The Institutional Obligation on Instructors of Mathematics Courses for Teachers

The institutional environments in which one finds mathematics courses for teachers include not only the mathematics departments that offer these courses and the colleges which employ the instructors but also the teacher education programs that admit the students and require them to take these courses. At least in the United States, these tend to be separate organizations within universities. All those organizations hold the instructor accountable in some way. Some of those mechanisms of accountability may be common across organizations, unspecific to the courses, and inscribed in rules and policies (e.g., work contracts, class schedules). Mathematics departments also hold instructors accountable (e.g., expectations for office hours and syllabi). Teacher preparation programs are likely to exercise this accountability through expectations that become visible when they are violated (e.g., education advisors letting teacher education students fulfill alternative requirements when they fail mathematics courses for teachers, or students themselves feeling empowered to confront mathematics instructors on matters of content choice when they don't see its relevance for future teachers). We contend that the location of mathematics courses for teachers in institutional environments that include these various organizations makes for instructors' institutional obligation to be more complex than that of instructors of mathematics courses for mathematics majors. We suggest that research could endeavor to elicit from instructors narratives of episodes in which their instructional decisions were shaped by explicit interactions with teacher education personnel or expectations they have internalized from prior interactions with teacher education faculty or students. Research could elicit from mathematics department chairs and from teacher education coordinators the expectations their respective institutions have for these courses. What experiences do teacher education programs expect these courses to provide their students and how do they convey these expectations to mathematics instructors? Are those expectations different among mathematics courses for elementary and secondary teacher preparation? How do those expectations play out in recruiting and evaluating instructors of those courses?

One strategy that mathematics departments have employed to ensure attention to the needs of teacher education programs is to employ individuals with degrees in mathematics education or who participate in mathematics education professional communities to teach mathematics courses for teachers. Research could document the diversity of episodes in which instructors with different professional profiles are called to attend to the institutional obligation as well as how the departmental discussions on curriculum, pedagogy, and assessment in mathematics courses for teachers incorporate attention to the expectations from teacher education programs. Research might also document how teacher education program discussions incorporate and process information from instructors and students of mathematics courses for teachers (e.g., about the quality of students' mathematical work or the difficulty of courses). While it seems auspicious

that mathematics departments might employ faculty interested in and prepared for mathematics teacher education in teaching these courses, we cannot assume that a change of instructor will eliminate any need for institutional accountability on the part of these instructors. Instead, it seems important to describe how this institutional accountability is experienced by instructors with different preparation and to gather case knowledge on how instructors handle institutional influences on their instruction.

The Individual Obligation on Instructors of Mathematics Courses for Teachers

The obligations framework proposes that students, as the clients of education institutions, hold teachers accountable to serve them as individuals. The case of students in mathematics courses for teachers is similar insofar as they are undergraduate college students: Instructors are obligated to attend to them as whole persons, with cognitive, emotional, and physical needs and goals. As young adults, students are likely to be able to advocate for many of these needs themselves rather than through their parents. But for instructors of mathematics courses for teachers, the individual obligation seems more complicated. We suggest that the instructor may also need to be accountable to their students as future professionals, attending to other aspects of their individuality that the students themselves may not be as ready to advocate for. These include aspects of the professional identity of a teacher that will be important for the individual presentation of self of these novice teachers when they commence their professional life. Instructors' accountability to students as clients may compel them to see their students not only as individuals with present needs and desires but also as future professionals with future needs.

Research could elicit instructors' narratives to find out what aspects of students' future professional identity emerge in the course of instruction as compelling opportunities for instructors to make individual accommodations. Personal characteristics often part of moral character (e.g., self-control or intellectual honesty), individual beliefs (e.g., about mathematical ability), and skills (e.g., voice projection) might be included and that instructors may recognize opportunities to build students' sense of professional identity when characteristics like those emerge in the context of classroom work. Research should especially attend to how instructors negotiate with prospective teachers the need for them to learn material that might seem difficult or uninteresting to them at the moment (during college years) and whether and how instructors' recognition of an obligation to students as future professionals serves them in such negotiation.

The Interpersonal Obligation on Instructors of Mathematics Courses for Teachers

The obligations framework proposes also that society is another stakeholder of the work of teaching and the source of a professional obligation for instructors to conduct their classes in ways that steward social values and goals. Insofar as an undergraduate class includes young adults that have to interact with each other in socially productive ways and that will incorporate themselves into the social world after college, it is likely that instructors will feel compelled to steward some social values and expectations that apply to everybody (e.g., taking turns in conversation, respecting the personal space and property of others). But insofar as the undergraduates will be teachers, some of those values and expectations may concern the role that teachers play in society. A salient one is a sense that society needs teachers for its children (Beckmann, 2011) and that these teacher cadres need to represent the diversity of society (e.g., Bristol & Martin-Fernandez, 2019; Frank, 2019). This has implications for instructors with regards to the ways that their courses and the grades they assign in those courses tend to serve as a gateway not only for individual students to get their degrees but also, and especially, for society to receive its teachers. Students' interactions with instructors and their course material can also

affect students' continued interest in the profession of teaching. The interpersonal obligation suggests societal needs that should compel instructors not to alienate students from mathematics or discourage their desire to teach mathematics in K-12 contexts.

We suggest that research could better unpack how instructors encounter and respond to opportunities to attend to the interpersonal obligation. What are some ways in which instructors' obligation to recruit and form teachers that can serve society is and can be displayed? How has it been ignored?

The Disciplinary Obligation on Instructors of Mathematics Courses for Teachers

The disciplinary obligation as proposed by Herbst and Chazan (2012) alludes to mathematics instructors' obligation to represent the discipline of mathematics when they teach in classrooms. One could expect this disciplinary obligation to be present also for instructors of university mathematics classes, including mathematics courses for teachers. For example, because textbooks and lecture notes are presentations of course content rather than disciplinary communications (as journal articles are), it is expected that this didactical transposition of knowledge (Chevallard, 1991) may depart from the norm in mathematical communication (e.g., sometimes stating a proposition without providing proof or providing a definition that goes beyond necessary and sufficient conditions). Instructors might show recognition of their obligation to the discipline of mathematics if in the context of such pedagogical practices they pointed out to students that the statement could be proved even if the proof is beyond the scope of the course or that some of the stipulations of a definition are implied by others.

But in addition to an obligation to the discipline of mathematics, Knowledge as a stakeholder can be expected to hold instructors of mathematics courses for teachers accountable in other ways. The progress made by mathematics education research in the last few decades added to the fact that this scholarship has become more widely known among and practiced by college mathematics instructors (such as RUME participants), suggest that instructors might recognize a disciplinary obligation toward the knowledge generated in mathematics education research. This scholarship includes at least two types of knowledge worth noting, both contained within the notion of mathematical knowledge for teaching and illustrating the interdisciplinary nature of mathematics education research. The first is specialized knowledge of mathematics or mathematically specific knowledge needed for teachers to engage in tasks of teaching mathematics. As Ball et al. (2008) have argued and illustrated, this is purely mathematical knowledge that reveals itself as needed in the context of tasks like creating problems for students or analyzing the mathematical errors students make in problems. The second is empirical knowledge about students' understanding of mathematics and the ways in which students might respond to instructional strategies; that is, elements of pedagogical content knowledge. We distinguish these two types of knowledge because their truth status results from different types of inquiry, one more deductive, founded on mathematical reasoning, and the other inductive, founded on scientific reasoning. We suggest that research could elicit from instructors narratives of episodes in which their awareness of research on mathematics teacher knowledge has compelled them to deviate from, qualify, or add to the content they teach.

Furthermore, the professional practical knowledge of mathematics teachers, which is not warranted solely by mathematical or scientific reasoning but also informed by policy and educational politics, may contribute yet a third source of accountability to knowledge for instructors of mathematics courses for future teachers. Documents such as the Common Core Standards (National Governors Association, 2010), exercise a transdisciplinary accountability similar to that of the disciplinary mathematical knowledge or the interdisciplinary knowledge

from research in mathematics education. For example, while a mathematical concept (e.g., geometric transformations) might be well defined in different ways, a Standards document may implement a particular choice of definition to be used in K-12 settings and that choice may serve as a justification for the instructor of a geometry course for teachers to make instructional decisions (e.g., not to adopt the definition provided in the textbook, but to change it to match that of the Standards). Similarly, professional organizations such as NCTM have at times advocated for including the history of mathematics with its teaching as means to show students that mathematics is a human activity; such recommendations add transdisciplinary resources and constraints to instructors. The investigation of the instructors' position needs to account for the various knowledge sources of the disciplinary obligation. Because these disciplinary sources come from different origins and epistemologies, it seems important to inventory not only the ways they present themselves as opportunities or as constraints to instructors, but also to document how instructors handle them when they might not align with each other.

Conclusion

In their approach to improvement science, Bryk et al. (2015) argue that a needed step toward improvement is to secure an understanding of the system in need of improvement—how the system works—from the multiple perspectives that are called upon to work toward improvement. Instructors are important in improvement not only because their agency can (and needs to) be co-opted to realize improvement but also because their perspective on how the system works can help anticipate what may happen with those improvement efforts (including their own). Instructional improvement thus requires not only relying on instructors as agents of change but also incorporating the rationality (in the sense of sensibility or sense-making) of instructors as a vital component of improvement efforts. We contend that incorporating this rationality means seeking ways to reconcile (a) what instructors are disposed to accept as part of their roles in instruction and how they perceive their position in the higher education system and (b) how their position in a system of power relations and institutional regulations conditions them to be so disposed (Bourdieu, 1990). We argue that at the college level, where traditionally instructors of record have had much authority to decide what to do, it is important to understand not only who the instructors are and what they know or believe, but also how they see the system in which their effort is inscribed and that avowedly needs to be improved. In our discussion of the obligations as they apply to instructors of mathematics courses for teachers, we elaborate on how each of these obligations might split into different branches. Better understanding empirically how these various branches of professional obligations actually show up for instructors of mathematics courses for teachers can help in the quest of improving the mathematical preparation of teachers. Eventually, measures can be constructed to assess the extent to which individual instructors recognize the different aspects of each obligation as hypothesized above. Further, similar kind of layout for empirical inquiry could guide the study of instruction in mathematics classes for other professionals (e.g., engineers, nurses).

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