MEASURING RECOGNITION OF THE PROFESSIONAL OBLIGATIONS OF MATHEMATICS TEACHING

Patricio Herbst
University of Michigan
pgherbst@umich.edu

Inah Ko
University of Michigan
inahko@umich.edu

We show validation data of surveys that estimate high school teachers' recognition of four obligations of the mathematics teaching profession. Measures of internal consistency show three instruments reliably measure three of the four obligations, while the fourth has lower internal consistency. Factor analyses support a 3-factor model for the disciplinary obligation and 2-factor models for each of the individual, institutional, and interpersonal obligations. We inspected correlations between recognition of obligations and teachers' beliefs: Low correlations found suggest recognition of obligations and beliefs are different constructs.

Keywords: Instructional Activities and Practices, Measurement, Teacher Beliefs, Research Methods

The Study of Mathematics Teaching: Background and Theoretical Framework

Our research contributes to theoretical and methodological progress understanding the work of mathematics teaching. Teaching has often been described as the expression of teacher characteristics or as the enactment of behaviors (Shulman, 1986). In mathematics education these have led to studies of teachers' beliefs and teacher knowledge (e.g., Even, 2009; Leatham, 2004), on the one hand, and studies of classroom discourse, norms, and patterns of interaction (e.g., Cobb, 1998) on the other hand. These two approaches have complemented each other, often drawing data from classroom observations, but seeing it alternatively as projection of an individual teacher goals, beliefs, and orientations (Schoenfeld, 2010) or as adaptations of the teacher to the context of his or her interactions with the students and the content (Voigt, 1985).

Less prominent has been attention to how the environments of instruction (Cohen, et al., 2003) frame both what it means to be a mathematics teacher and what a teacher is required to do in mathematics teaching. Yet these environments warrant the encounters among teacher, students, and content. How do those environments create expectations that frame the position of mathematics teacher? Herbst and Chazan (2012) proposed the notion of *professional obligations* to identify those expectations. The position of the mathematics teacher obligates mathematics teachers to stakeholders that look at mathematics teaching from four different perspectives, which Chazan, Herbst, & Clark (2016) call Knowledge, Client, Society, and Organization. From the Knowledge perspective, mathematics teachers are obligated to the discipline of mathematics--to engage students with mathematically correct knowledge and practice. From the Client perspective, mathematics teachers are obligated to the individual students--to tend to their cognitive, emotional, physical, and other needs. From the Society perspective, mathematics teachers are obligated to the interpersonal collective of their class--to promote social values such as fairness and respect. From the Organization perspective, mathematics teachers are obligated to institutional policies and practices of the system, district, school, and department.

These obligations are hypotheses; confirmation requires looking at how much mathematics teachers themselves recognize being under those obligations in contrast with other people that might not be so obligated. We developed the PROB surveys to measure the extent to which teachers recognize each of the four obligations and describe its properties below.

Galindo, E., & Newton, J., (Eds.). (2017). *Proceedings of the 39th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education.* Indianapolis, IN: Hoosier Association of Mathematics Teacher Educators.

The PROB Surveys

There are four PROB surveys, PROB-MATH, PROB-INDV, PROB-INTP, and PROB-INST, designed to measure recognition of the obligations to the discipline, the individual student, the interpersonal collective of the class, and the institutions of schooling respectively (see also Herbst et al., 2014). Each of the items in all four surveys asks participants to consider a statements that avowedly describes mathematics teaching (e.g., "Mathematics teachers take time to discuss school policies") and then asks participants to "Rate the degree to which mathematics teachers are expected, as professional educators, to act in the manner that this statement describes" using a 4-point Likert-type of scale that ranges from (1 = Teachers are never expected to act in this manner to 4 = Teachers are always expected to act in this manner). We developed the survey through several iterations that included brainstorming, item writing, cognitive pretesting, internal and external vetting, piloting with teachers, and examining the collected pilot data using classical test theory (Crocker & Algina, 1986). The rating prompt, resulted from a design process informed by cognitive pretesting, oriented to elicit the participant's sense of whether mathematics teachers were expected by others to act in the way described.

Method

We administered the PROB surveys to a national representative sample of U.S. high school mathematics teachers (497 teachers, 47 states), along with other questionnaires using the Lesson*Sketch* online platform. Participants were majority Caucasian (83%) and female (59%), which is consistent with nationally representative data obtained from the NCES database. On average, participants had been teaching mathematics for 14.1 years (SD = 8.7), and had taken 14 college-level mathematics courses (SD = 7.25). The analysis looked at the internal consistency of the surveys and dimensionality of the constructs we attempted to measure.

Analysis

Reliability as Internal Consistency

To document the reliability of the PROB surveys, we evaluated internal consistency of retained items using both Cronbach's Alpha and the mean inter-item correlation (MIIC). Cronbach's Alpha values over .7 are usually seen as acceptable and over .8 as good, while acceptable mean inter-item correlation values range between 0.15 and 0.25 (Kline, 1995; Clark & Watson, 1995). As can be noted in Table 1, the disciplinary, interpersonal, and individual surveys had good internal consistency, but the institutional survey had acceptable Cronbach alpha and low MIIC.

Table 1: Internal Consistency of PROB Surveys

Obligation	Number of items	Mean inter-item correlation	Cronbach's Alpha
Disciplinary	18	0.273	0.8711
Institutional	20	0.1117	0.7154
Interpersonal	29	0.2226	0.8925
Individual	18	0.3082	0.8891

Dimensionality Validation

Cronbach's Alpha is a good measure of internal consistency if it is possible to assume that items are unidimensional, that they are all equally good to measure the construct, and that their errors are

uncorrelated. Because the possibility existed that one or more of those assumptions was not met, we examined the factorial structure of disciplinary, individual, and interpersonal scales using factor analysis. The WLSMV estimator, which is optimal for categorical variables with a small sample size was used to test the factor model. To find the best model that is not only meaningful but also satisfies fit criteria, we considered the Root Mean Square Error of Approximation (RMSEA) looking for a value of RMSEA <0.6, the Tucker-Lewis index (TLI) and the Comparative Fit Index (CFI), in both of these looking for values greater than 0.95 (Hu & Bentler, 1999). Factor means were set to 0 and factor variances were set to 1. The specific factor models tested are described in detail below.A three-factor model, where 7 items have the same estimated loadings (discrimination) and two pairs of items are correlated due to the same wording, fits our PROB-DISC data well with all standardized factor loadings greater than 0.5. Three suggested factors are interpretable in regards to the item statements (see Figure 2).

F1: Obligation to the discipline insofar as member of a community contributing to increase and extend appreciation of knowledge outside of the classroom (9 items)
F2: Obligation to the discipline insofar as responsible for its correct representation in classroom interaction (5 items)
F3: Obligation to the discipline insofar as responsible for its correct representation in study resources (3 items)

Figure 2. Factors of the disciplinary obligation.

Using similar procedures we determined that the items in the PROB-INDV survey could inform a two-factor model of recognition of the individual obligation. The two individual factors we found are defined in Figure 3a. The items in the PROB-INTP survey were also best accounted for by a two-factor model which are defined in Figure 3b. Items in the PROB-INST also loaded in a hypothesized two factor model (Figure 3c). The results above show a mostly positive outcome of the PROB surveys. It is of interest to investigate how these measures relate to other constructs being used in research on teaching, particularly other measures of teacher characteristics. Years of experience teaching showed significant positive correlation with the all three PROB-DISC factors though no significant correlations with either of the others.

F1: Obligation to the academic needs of individual students (12 items)
F2: Obligation to the socio-emotional needs of individual students (6 items)

Figure 3a. Factors of the individual obligation.

F1: Obligation to support social interaction among small groups of students (16 items)
F2: Obligation to support social interaction in the whole class (8 items)

Figure 3b. Factors of the interpersonal obligation.

F1: Obligation to support policies for school-wide events and activities (4 items)
F2: Obligation to support school policies that concern classroom activities (9 items)

Figure 3c. Factors of the institutional obligation.

Our participants had also taken the survey by Stipek, et al. (2001), which measures 7 different aspects of teachers' beliefs. We were interested in correlations between factor scores in the obligations and mean scores in belief factors. Significant correlations were found, yet the most

important finding is that those correlations are uniformly low. This suggests that recognition of obligations does not measure the same thing as this measure of beliefs.

Endnotes

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