

Metaphors we teach by: A method for mapping metaphorical lay theories

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Abstract

People frequently use metaphors to communicate and reason about complex topics. However, many studies of metaphorical reasoning exclusively rely on researcher intuitions about different metaphors and their associated entailments. Here we describe a more principled method for mapping the structure of metaphorical lay theories, focusing on metaphors for teaching. Across two studies, we identified four common, apt metaphors for the teacher-student relationship and used factor analysis to explore whether these metaphors reflect systematically different intuitions about the qualities of college teachers. Our findings demonstrate that (1) people endorse a variety of different teaching metaphors, and (2) these metaphors bring to mind distinct, coherent clusters of teacher attributes. This work demonstrates a novel method for systematically mapping the structure of metaphorical lay theories and sets the stage for future research on metaphorical reasoning as well as innovative educational interventions centered on shifting lay theories of teaching.

Keywords: metaphors, lay theories, concepts, teaching

Introduction

According to a popular cognitive science metaphor, people are amateur scientists who actively explore the environment and develop intuitive theories for how the world works (Furnham, 1988; Gopnik, Meltzoff, & Kuhl, 1999). In turn, these intuitive, lay theories help people make sense of and respond to new experiences, guiding thought and action. For example, research over the last two decades suggests that students' lay theories about the malleability of intelligence (also known as *mindsets*) drive educational achievement (Yeager & Dweck, 2012). Students who think of intelligence as something that can improve through hard work—the *brain-as-muscle* metaphor—react better to performance setbacks, resulting in superior long-term learning outcomes (but see Sisk et al., 2018).

As we have just illustrated, one way that intuitive beliefs are conveyed is via metaphor. To take another example, when we describe a teacher as “*molding impressionable* students,” we imply that the teacher is like a *sculptor* and students are like *clay*. Metaphors allow people to draw on familiar, common knowledge of a basic source domain (*building muscles; sculpting clay*) to communicate about a more complex or abstract target domain (*how brains learn; teaching*; Lakoff & Johnson, 1980). A large body of research finds that the metaphors people use to talk about complex

issues both reflect and shape how they think about those topics (for review, see Thibodeau, Hendricks, & Boroditsky, 2017). The *teacher-as-sculptor* metaphor, for example, may reflect the intuitive belief that learning is passive and that the teacher (not the student) largely determines the learning outcomes.

How can we best understand the structure of these metaphorical lay theories and the extent to which they influence thought and action? An important first step is to map out the *entailments* of the metaphors; that is, the associated ideas and inferences licensed by the metaphorical comparison. For example, one potential entailment of the *brain-as-muscle* metaphor described earlier is that, while hard work may increase someone's intelligence or abilities, working too long on any one task may be cognitively exhausting (much like continuous physical exertion tires out muscles). These sorts of entailments, it is argued, provide critical insight into the mental model people use to represent the target domain and allow for empirically-informed predictions about how metaphors reflect and shape thinking.

The most common approach to mapping entailments is to examine the figurative language people use in everyday speech and apply a commonsense understanding of the observed source domains (as we have demonstrated in the preceding paragraph). Cognitive linguists have used this approach to isolate the structural schemas that underlie many fundamental concepts, from emotion to politics to time, across a variety of languages and cultures (Kövecses, 2005; Lakoff and Johnson, 1980).

However, there are several theoretical problems with relying on intuition and patterns of language alone to make inferences about underlying conceptual representations (Keysar & Bly, 1995; Casasanto, 2009; Murphy, 1996). For example, the meaning of common metaphorical expressions might seem obvious and intuitive but could also reflect a post-hoc rationalization based on one's preexisting understanding of the expression (Keysar & Bly, 1995). Indeed, some (non-linguistic) experiments have shown that metaphors in language do not always reflect how people mentally represent a given topic (see Casasanto, 2009). How, then, can researchers more reliably map the structural entailments of metaphorical concepts?

Another approach is to ask a set of naïve participants to freely generate the structural entailments of a source domain in order to derive a set of conceptually coherent metaphorical

entailments for the target domain. For example, for the metaphor “crime is a *virus*,” participants might be asked how they would solve a *literal* virus problem in their city. The responses would then be used to predict which solutions to a city’s crime problem would be conceptually congruent with the *crime-as-virus* metaphor (Thibodeau & Boroditsky, 2011). To validate these experimenter intuitions, another set of participants might be asked to match specific solutions to a crime problem to specific metaphors (i.e., match a solution to a city’s crime problem to either a *crime-as-virus* or *crime-as-beast* metaphor; Thibodeau & Boroditsky, 2013).

In this paper, we build on this approach and offer a systematic method for mapping the structural entailments of a complex metaphor, focusing specifically on metaphors for teaching. Our approach was inspired in part by traditional psychometric methods that have been used to uncover the dimensional structure of personality traits and other psychological constructs.

In Study 1, we first identified six common metaphors for the college teacher-student relationship, drawing on the literature in teacher education (e.g., Patchen & Crawford, 2011; Shaw, Berry, & Mahlios, 2008). We assessed the relative aptness of these metaphors by asking participants to rate their agreement with each metaphor, select the one they liked best, and explain their choice. In Study 2, we presented a new set of participants with one of the four most popular metaphors from Study 1. With this one metaphor in mind, participants rated the degree to which a wide range of statements describing the attributes of college teachers fit with the metaphor (as well as rating each metaphor on a few additional features). We used exploratory factor analysis to identify a smaller set of latent factors underlying the larger collection of teacher attributes. This allowed us to identify a distinct, coherent cluster of teacher attributes associated with each metaphor, providing a principled way of mapping the structure of metaphorical lay theories.

Study 1

Methods

Participants We recruited 119 participants to complete the survey through Amazon’s Mechanical Turk. We required that participants be a current or former college student living in the U.S. or Canada, with an approval rating greater than 95% on at least 100 prior Turk tasks. We excluded data from nine participants: two that came from duplicate IP addresses, four that provided duplicated (i.e., copy and paste) responses to all free response items, and two who reported that they had never attended college.

Of the 110 participants included in the final data set, 54% were male, 83% identified solely as White, 7% as Black, 2% as Asian, 3% as Hispanic/Latino, and the remaining 4% as multiracial. About 71% had graduated from college, 15% were currently enrolled students, and 15% had attended college at one point but were not currently enrolled. About 43% had attended college less than 4 years ago, and 57% had been out of college for more than 4 years. Mean age was 35 ($SD = 11$) with a range of 20-74.

Materials & Procedure We designed a survey using Qualtrics online survey software in which participants considered six possible metaphors for the teacher-student relationship (see Table 1). We derived these metaphors based on qualitative findings of the metaphors that teachers use to describe their roles (e.g., Patchen & Crawford, 2011; Shaw, Berry, & Mahlios, 2008). Each metaphor described both the teacher and the student and suggested a relationship between them (e.g. “*A teacher is like a sculptor and students are like clay*”).

Participants viewed all six metaphors in a random order and each was described as a metaphor for college teaching. Participants first rated their agreement with the metaphor on a 6-point scale (strongly disagree to strongly agree, with no neutral midpoint) and then freely explained their response by typing in a text box. After considering all six metaphors, participants considered the entire collection of metaphors and selected their favorite. They explained why they preferred this metaphor and, specifically, how it fit their experiences and views of college teaching. Finally, participants answered a series of basic demographic questions.

Results

What are the most popular metaphors? As shown in Table 1, participants leaned toward agreement ($M > 3.5$) for all the metaphors except the *app store* metaphor, but they agreed the most with the *gardener* metaphor, followed closely by the *coach*, *tour guide*, and *sculptor* metaphors. Participants’ selection of their preferred metaphors showed a similar pattern of popularity. Of the six metaphors, the most popular was the *gardener* metaphor (32.7%), followed by the *tour guide* (19.1%) and *coach* metaphors (18.2%). The *sculptor* (10.9%), *app store* (9.1%) and *ship captain* metaphors (8.2%) were less favored.

An initial examination of participants’ justifications for the metaphors shows that they frequently extended the metaphors in their free response descriptions. For example, the *gardener* metaphor prompted descriptions of teachers as “sowing information,” “planting seeds of knowledge,” and “cultivating students.” The *coach* metaphor elicited descriptions of teachers working with students “toward the same goal,” helping students “win and succeed,” giving students “exercises,” and creating “a plan of attack.” The *tour guide* metaphor led to descriptions of teachers “showing students around”, taking them into “the unknown,” “showing the way,” helping students “navigate” and taking them along “the path of learning.” The *sculptor* metaphor prompted descriptions of teaching as “molding,” “shaping,” and being “hands-on,” and described students as “impressionable,” “raw material,” and “undefined” but becoming “polished.” This suggests that participants were actively using the metaphor to reason about the qualities of a teacher associated with a given metaphor (Thibodeau, Crow, & Flusberg, 2017).

Table 1. Rank-ordered ratings of agreement with each of the teaching metaphors on a 6-point scale. Higher numbers indicate higher levels of agreement.

Metaphor	<i>M</i>	<i>SD</i>
"A teacher is like a gardener and students are like plants"	4.36	1.29
"A teacher is like a coach and students are like athletes"	4.28	1.21
"A teacher is like a tour guide and students are like tourists"	4.19	1.31
"A teacher is like a sculptor and students are like clay"	4.15	1.25
"A teacher is like the captain of a ship and students are like sailors"	3.79	1.40
"A teacher is like an app store and students are like smartphone users"	2.95	1.56

Discussion

The findings from this initial study suggest that people with college experience endorse a variety of metaphors for the teacher-student relationship, but the most apt are the *gardener*, *coach*, *tour guide*, and *sculptor* metaphors. That participants spontaneously extended these metaphors in articulating their personal preferences provides some evidence that they were *thinking* about the nature of college teaching in terms of the metaphorical lay theory.

The primary goal of Study 2 was to identify and map out the conceptual entailments associated with each of the four most popular metaphors for the teacher-student relationship; that is, the associated beliefs and expectations that logically follow from the metaphor. Identifying the entailments of various metaphors is critical for making informed predictions about how metaphors may shape beliefs, attitudes, and behaviors. As a starting point, we examined entailments that focused on the characteristics of *teachers* (as opposed to students). Our key question was whether different metaphors would be reliably associated with distinct clusters of teacher attributes, and whether this can be measured in a systematic, principled way.

Study 2

Methods

Participants We recruited 201 participants to complete the survey through Amazon's Mechanical Turk using the same exclusion criteria as in Study 1. We excluded data from two participants who provided duplicated (i.e., copy and paste) responses to all free response items.

Of the 199 participants included in the final data set, 54% were male, 75.6% identified solely as White, 9% as Black, .5% as American Indian or Alaskan Native, 5% as Asian, 2.5% as Hispanic/Latino, and the remaining 7% as multiracial. About 70% had graduated from college, 13.4% were currently enrolled students, and 17% had attended college at one point but were not currently enrolled. Only 39% were recent college students who had attended college less than 4 years ago, and 61% had been out of college for

more than 4 years. Mean age was 36 ($SD = 11.6$) with a range of 18-76.

Materials & Procedure Participants were randomly assigned to view one of the four most popular metaphors from Study 1: the *gardener*, *coach*, *tour guide*, and *sculptor* metaphors. Participants then viewed a list of 43 statements describing college teachers (e.g., "*Teachers transfer their knowledge to students*") and rated how well each item fit the metaphor that they were given (see Table 2). The statements were generated by consulting measures of teacher behavior (e.g., teacher behavior checklist, Keeley, Smith, & Buskist, 2006), examining free response data from Study 1, and the personal experience of the researchers). Participants were specifically instructed to rate how well each item agreed with the metaphor they received, not whether they personally believed each item was true.

Next, participants viewed all four of the metaphors and selected their personal favorite. Finally, participants answered four questions aimed whether the metaphors captured beliefs about teacher responsibility and power: They rated, according to the metaphor, (a) how much responsibility college teachers have for students' learning, (b) how much responsibility students have for their own learning in college, (c) how much power college teachers have to influence what students learn, and (d) how much power college teachers have to influence how students to develop as people. Each item was rated on a scale of 0 to 100, with 0 meaning "none at all" and 100 meaning "a great deal."

Results

Factor structure of teacher characteristic. To begin, we performed a principal axes factor analysis on the 43 different teacher attributes (oblimin rotation) to identify the latent variables underlying the attributes. Based on the eigenvalues, as well as the ability to meaningfully interpret the clustered attributes, a 7-factor solution provided the best fit for the data. The eigenvalues for the first seven factors were: 21.81, 3.02, 2.59, 1.63, 1.25, 1.00, and .82, with the eighth being .75. The rotated pattern matrix is shown in the Appendix. Based on the highest-loading items, we interpreted the factors as:

- (1) **Community-building** (e.g., "Teachers encourage a sense of community")
- (2) **Knowledgeable** (e.g., "Teachers are knowledgeable about their subject matter")
- (3) **Authoritative** (e.g., "Teachers establish classroom rules")
- (4) **Influencing** (e.g., "Teachers powerfully influence their students")
- (5) **Philosophical** (e.g., "Teachers are abstract thinkers" and "Teachers provoke debate")
- (6) **Informing** (e.g., "Teachers present information")
- (7) **Nurturing** (e.g., "Teachers are sensitive to their students' needs")

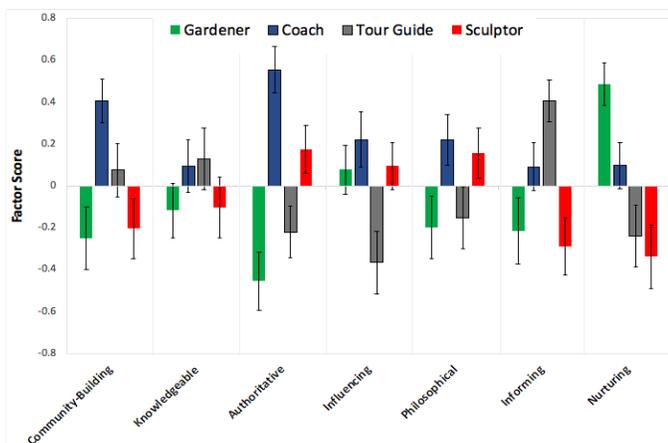


Figure 1: Mean factor scores for each of the seven factors, as a function of the conceptual metaphor that participants considered. The factor scores for the authoritative and nurturing factors are reversed for ease of interpretation.

Figure 1 shows the pattern of differences across the metaphors for each factor. Visual examination of the figure shows some striking differences in teacher characteristics across metaphors. The *gardener* metaphor entails that teachers are nurturing but low on other characteristics, especially authoritative traits. The *coach* metaphor entails that teachers build community, are authoritative, influencing, and even philosophical, in the sense of stimulating new knowledge and provoking debate. The *tour guide* metaphor entails that teachers are informing, but low on other characteristics, especially their ability to influence students. The *sculptor* metaphor entails that teachers are neither nurturing nor informing, but are somewhat authoritative, influencing, and philosophical.

How do teacher characteristics vary across metaphors? Once a 7-factor solution was applied, we saved the factor scores using the regression method. A multivariate ANOVA was performed on the seven factor scores with metaphor (gardener, coach, tour guide, or sculptor) as a between-subjects variable. Overall, metaphor condition showed a significant effect on the set of factors, $F(21, 552) = 6.98, p < .001, \eta^2 = .21$. Univariate analyses of variance revealed a significant effect of metaphor on the *community-building* ($F(3, 188) = 5.01, p < .01$) *authoritative* ($F(3, 188) = 12.72, p < .001$), *influencing* ($F(3, 188) = 4.02, p < .01$), *informing* ($F(3, 188) = 6.20, p < .001$), and *nurturing* factors ($F(3, 188) = 8.23, p < .001$). There was only a marginal effect of metaphor on the *philosophical* factor ($F(3, 188) = 2.43, p = .07$) and no effect on the *knowledgeable* factor ($F(3, 188) < 1$).

Are different metaphors associated with different beliefs about responsibility? Metaphor had a small but reliable effect on ratings of how much responsibility college teachers had for students' learning, $F(3, 197) = 2.93, p < .05, \eta^2 = .04$. No pairwise comparisons across the conditions (using a Bonferroni adjustment) were significant. As shown in Figure 2, the *sculptor* metaphor promoted the highest rating of teacher responsibility, and the *coach* metaphor the least. Metaphor had a more dramatic effect on ratings of how much

responsibility students had for their own learning, $F(3, 197) = 11.42, p < .001, \eta^2 = .15$. Pairwise comparisons indicated that the *coach* metaphor promoted the highest ratings of student responsibility, significantly more than the *gardener* or *sculptor* metaphors. As shown in Figure 2, the *sculptor* and *gardener* metaphors promoted the lowest ratings, significantly lower than the *coach* and *tour guide* metaphors, but not different from one another.

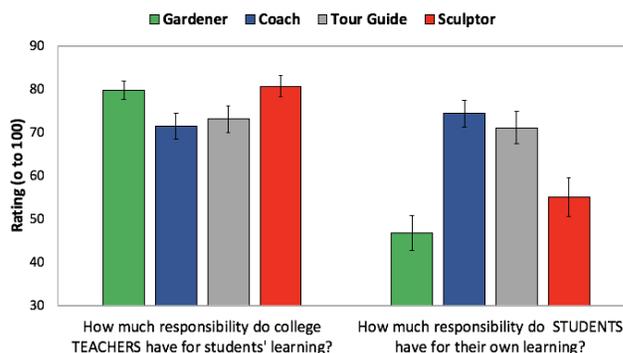


Figure 2. Effects of metaphor on ratings of how much responsibility teachers and students have for learning.

Are different metaphors associated with different beliefs about teacher's power? Metaphor condition had a small but reliable effect on ratings of how much power college teachers had to influence what students learn, $F(3, 197) = 3.02, p < .05, \eta^2 = .04$. No pairwise comparisons across the conditions were significant, however (all pairwise comparisons used a Bonferroni adjustment). As shown in Figure 3, the *sculptor* metaphor promoted the highest rating of teacher power over student learning, and the *tour guide* the least. Metaphor had a more dramatic effect on ratings of how much power college teachers had to influence how students develop as people, $F(3, 197) = 7.44, p < .001, \eta^2 = .10$. Pairwise comparisons indicated that the *sculptor* metaphor prompted the highest ratings of power to influence development, significantly more than either the *coach* or *tour guide* metaphor. The *gardener* metaphor did not significantly differ from the others.

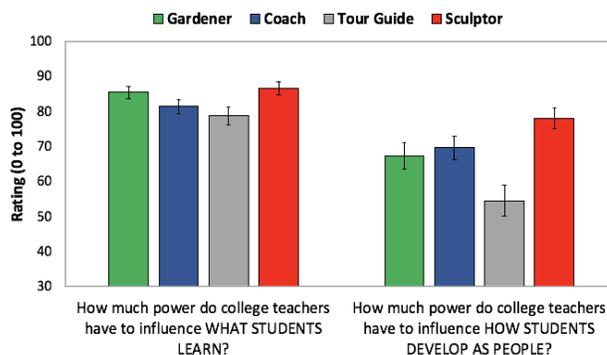


Figure 3. Effects of metaphor on ratings of how much power teachers have to influence what students learn and how they develop as people.

What are the most popular metaphors? Participants most preferred metaphors replicated the pattern found in Study 1. Of the four metaphors, the most popular was the *gardener* metaphor (26.9%), followed by the *coach* (25.9%) and *tour guide* metaphors (25.4%). The *sculptor* metaphor was the least favored (20.4%). Participants' preferred metaphor was not influenced by condition. That is, participants did not select a favorite metaphor that simply matched what they had been presented with in earlier questions. This suggests that people have stable preferred metaphors for thinking about the teacher-student relationship.

Discussion

The findings from this study suggest that different metaphors for teaching are associated with distinct entailments, specifically with respect to the characteristics of teachers. Different metaphors imply that teachers have different "profiles" or clusters of characteristics that can differ dramatically from one another. Notably, the metaphors differ in their implications for students' responsibility for their own learning. The *coach* and *tour guide* metaphors hold students more responsible for their own learning than do the *gardener* and *sculptor* metaphors. The metaphors also differ in how much power the teacher has to influence a student's general development. The *gardener* metaphor entails the most power to influence students' development, and the *tour guide* metaphor the least.

General Discussion

People use metaphors to express their lay beliefs about everything from the nature of intelligence to how the economy works. Though it seems quite natural to identify the conceptual entailments of such metaphors based on common sense knowledge, there are issues with theorizing about the structure of people's metaphorical lay theories based on patterns in language alone. In this paper, we aimed to provide a more principled method for mapping the structure of metaphorical lay theories, using metaphors for teaching as a case study. Our approach was inspired in part by psychometric methods used to uncover the latent structure of other theoretical psychological constructs.

In our first study, we used participant ratings to identify four common, apt metaphors for the college teacher-student relationship (*gardener*, *coach*, *sculptor*, and *tour guide*). In Study 2, participants were provided with one of these metaphors and rated the extent to which a large set of teacher attributes conceptually cohered with the metaphor. We then used exploratory factor analysis to uncover a small subset of meaningful dimensions underlying the larger set of teacher attributes. This revealed that our four teaching metaphors reflect systematically different intuitions about the qualities of college teachers, which can be captured by distinct, coherent clusters of teacher attributes. We contend that this method offers a useful, principled way for researchers interested in metaphorical reasoning to empirically derive the conceptual entailments of different metaphors.

In ongoing and future work, we are continuing to validate this approach by (1) replicating our findings in more representative samples of current college students, (2) applying the same factor analysis method to ratings of *student*, rather than teacher, attributes and (3) mapping the structure of these metaphors in the context of other types of teaching settings (e.g., high school or elementary school teaching). We also plan to measure the explanatory power of lay theories of teaching by examining whether the particular metaphor a student holds for the teacher-student relationship predicts their own attitudes and behaviors in the classroom. Based on the results of Study 2, for example, we would hypothesize that students who hold a *coach* metaphor should expect teachers to be more demanding and assertive than students who hold a *gardener* metaphor, and thus may expect higher and stricter standards in the classroom. Similarly, because the *gardener* and *sculptor* metaphors imply less responsibility on the part of the student, students who endorse these metaphors may hold a more passive view of the learning process and be less likely to engage in active-learning strategies (e.g., self-quizzing) than students who endorse the *coach* and *tour guide* metaphors.

Ultimately, this work could lay the foundation for novel educational interventions based around metaphor framing. Some studies have found that metaphors can shape student mindsets (Blackwell et al., 2007) and attitudes (Landau et al., 2014), but this work has not examined metaphors for teaching specifically. In addition, interventions aimed at changing intuitive lay theories of intelligence to improve student performance have generated inconsistent results (Sisk et al., 2018). One reason for this inconsistency may be that academic performance is shaped by *numerous* intuitive beliefs, not just about intelligence. It is possible that, because learning occurs in a social context that includes teachers and the broader classroom environment, the intuitive beliefs students hold about the nature of *teaching* will also influence academic behaviors and outcomes. As our current work offers a principled way to understand the structure of people's intuitive beliefs about teaching, it provides an important first step in developing such interventions.

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Appendix

Pattern matrix with the loadings of each of the teacher characteristics on the 7 factors. Highest loading items for each factor (>.39) are marked in color and bolded.

Teachers...	Factor 1 <i>Community-Building</i> 50% of common variance	Factor 2 <i>Knowledgeable</i> 6.3% of common variance	Factor 3 <i>Authoritative</i> 5.3% of common variance	Factor 4 <i>Influencing</i> 3.0% of common variance	Factor 5 <i>Philosophical</i> 2.2% of common variance	Factor 6 <i>Informing</i> 1.6% of common variance	Factor 7 <i>Nurturing</i> 1.1% of common variance
encourage a sense of community	.695	.047	-.040	.058	.008	-.050	-.258
encourage students to get to know one another	.557	-.085	-.175	.041	.141	.024	-.223
are personable	.554	.127	.023	-.097	.166	.192	-.174
hold students' attention	.515	.203	-.083	.130	.061	.146	.136
encourage teamwork	.485	-.118	-.261	.136	.102	.088	-.239
encourage students to support one another	.484	-.172	-.281	.027	.110	.029	-.354
encourage students to actively participate in class	.311	.029	-.207	-.007	.214	.298	-.164
are knowledgeable about their subject matter	.014	.668	-.008	.049	.096	.293	.040
are experts in their field	.141	.628	-.035	.228	-.021	.126	.080
know what they are talking about	.210	.626	.022	.083	-.017	.123	-.100
know in advance what they are trying to accomplish	-.059	.619	-.217	.149	.003	-.010	-.164
are intelligent	.015	.531	.022	.004	.483	.026	-.106
work toward a clear goal	-.057	.495	-.179	.234	-.007	-.043	-.303
are prepared for class	-.051	.481	-.154	.001	.082	.323	-.205
are confident	.268	.376	-.262	.065	.259	.021	.206
establish classroom rules	.054	-.057	-.648	.049	.180	.218	-.076
are authority figures	.187	.366	-.532	-.041	.063	-.074	.160
command respect	.401	.129	-.489	.054	.134	-.032	.239
challenge students	.024	-.091	-.373	.272	.319	.188	-.092
powerfully influence their students	-.038	.100	-.140	.632	.025	-.120	-.032
stimulate students' thinking	.110	-.003	.311	.630	.267	.115	-.056
transfer their knowledge to students	-.028	.289	.036	.399	-.097	.379	-.008
motivate students to put effort into learning	.126	-.064	-.174	.376	.004	.307	-.247
give helpful feedback	.231	-.126	-.185	.307	.137	.280	-.176
are abstract thinkers	.027	.052	-.034	.017	.756	-.082	-.062
provoke debate	.045	-.074	-.018	.080	.704	.236	.011
question students' ideas	-.018	-.127	-.242	.104	.625	.139	.000
are creative	.168	.279	.013	.178	.447	-.207	-.167
promote class discussion	.297	-.018	.000	.066	.440	.342	-.041
have clear expectations for students	.070	.226	-.286	.187	.388	-.063	-.015
answer students' questions	.103	.106	.001	-.024	.125	.600	-.105
present information	-.082	.296	-.108	.028	.074	.564	-.001
communicate clearly	.268	.074	-.060	.089	.105	.462	-.094
engage students in conversation	.283	-.003	.001	-.012	.357	.393	-.109
are sensitive to their students' needs	.039	-.016	.066	-.040	.071	.052	-.806
adapt their teaching to different students' needs	.021	-.016	-.062	.174	.032	.085	-.677
care about students' well-being	.102	.001	.058	.314	-.012	-.099	-.652
listen to their students	.202	.107	.084	-.095	.160	.224	-.544
are understanding	.284	.025	.001	-.068	.285	-.001	-.538
are available when their students need help	.186	.214	-.038	.092	-.136	.212	-.504
put a lot of effort into teaching	-.182	.313	-.235	.214	.155	-.055	-.456
get to know their students	.248	.160	.025	.095	.209	-.027	-.411
create a positive classroom environment	.230	.254	.038	.089	-.057	.267	-.388