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REPLICATION

The Connection Between Teaching Methods and Attribution Errors

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Abstract We collected data at a large, very selective public university on what math and science instructors felt was the biggest barrier to their students' learning. We also determined the extent of each instructor's use of research-based effective teaching methods. Instructors using fewer effective methods were more likely to say the greatest barrier to student learning was the internal deficiencies of the students (the "fundamental attribution error"). They listed deficiencies such as poor preparation and work ethic. In total, 37 % of the instructor attributions were to student deficiencies, but this fraction varied dramatically between departments.

Keywords Attribution · Teaching

The *fundamental attribution error* is the pervasive and well-studied tendency to explain another person's behavior primarily in terms of their internal characteristics while neglecting external factors (Ross 1977). An example of this would be a teacher attributing educational outcomes entirely to the characteristics of the student, rather than considering any factors such as the educational environment or the quality of the instruction. In our work examining teacher practices, we encountered a relationship between what teaching methods an instructor uses in college math or science courses and their attribution for what limits student learning. Others have reported changes in teachers' attitudes about students and their capabilities, particularly at younger grades, with changes in schools and student achievement (Gallimore et al. 2009; McDougall et al. 2007). However, to our knowledge, the relationship between specific teaching methods and teacher attribution has not been studied, but with this note we hope to inspire researchers to explore it and its implications for teaching effectiveness.

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We collected data on the teaching methods being used in math and science departments at a large, public, research-intensive North American university. The university is typical of such institutions, except that it is among the most selective in terms of the quality of entering students, particularly those students going into science. This is reflected in the retention rates, which are above 95 %. The data on teaching methods was collected using the Teaching Practices Inventory, an instrument developed to characterize the teaching in math and science courses (Wieman and Gilbert 2014). A rubric converts the raw inventory data into a numerical value, the extent of use of research-based effective teaching practices (ETP) score. When we gave the inventory to the instructors in five math and science departments to complete, we added three open-ended questions, the first of which is the focus of this paper: "1. What do you see as the biggest barrier to achieving more effective student learning in the courses you teach?"

One hundred eighty instructors completed the 2012 administration of the survey with a surprisingly large number, 126, responding to this first optional question. The nature of the comments implied they were referring to their students in general, and not just a subset, such as the small fraction that might be failing. Both authors coded all of the comments independently into categories, with an inter-rater reliability of 91 %. The responses largely fell into the categories of internal student deficiencies (poor preparation, work ethic, or lack of intellectual interest or ability), limited time and extensive demands on instructors, lack of resources, and classes too large. There were also a small number of "limited instructor skills" and "general other" comments.

There were 46 comments listing some form of internal student deficiency and 79 comments in all of the other categories combined. There are always a range of factors that affect student learning, with the internal qualities of the students always playing some role. However, as this is among the most selective public institutions in North America for math and science students, we would argue that seeing the single largest barrier to be the qualities of the students would appear to be an example of the fundamental attribution error of psychology. Whether or not one chooses to accept that interpretation, the important point is the correlation between the nature of the comments and the teaching practices used by the instructor.

We then compared the ETP scores of the instructors that made comments about student deficiencies with the ETP scores of the instructors that made comments on any other factors (Table 1 and Fig. 1). All those other factors were external to students.

Table 1 Summary of the comments on barriers to more effective learning and average ETP scores of the instructors making comments by department and in total

		Factors external to students			Student deficiencies		
		No. of comments	Average ETP score	Standard deviation	No. of comments	Average ETP score	Standard deviation
Department	All	79	32.4	8.9	46	28.6	8.3
	1	11	32.5	6.7	5	32.8	11.4
	2	25	33.4	8.1	4	20.3	8.1
	3	16	31.4	9.8	10	30.5	7.2
	4	12	25.3	7.9	18	26.1	6.3
	5	15	34.5	8.7	9	32.3	8.8

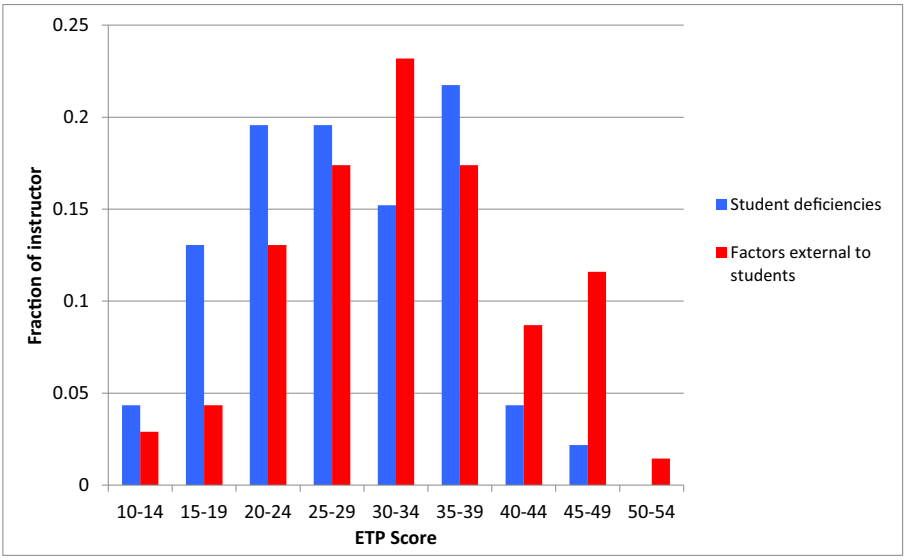

Fig. 1 Instructor ETP scores for different types of attribution they listed

There is a significant difference (3.8±1.6, P=0.006) between the ETP scores of the two groups. This is also reflected in the distribution shown in Fig. 1. There is also a substantial difference between disciplines, with 18 out of 30 instructors in department #4 commenting on student deficiencies, whereas only 4 out of 29 in department #2 did so.

Discussion

This data comparison does not establish causation. It could be that teachers with student deficiency attribution are less inclined to adopt better teaching methods, so the attribution causes the use of less effective methods. Alternatively, switching to more effective teaching practices may cause changes in attribution. Such practices encourage greater interaction with students and more opportunities to probe and understand their thinking and difficulties. Further study is required to determine which, if either, of these explanations is correct, but we do have some data that suggests the latter explanation may be true. There is one department (#3) for which we also have Teaching Practices Inventory (TPI) data for 2006. The 2012 data shows a 34 % increase in the department average TPI score due to a concerted departmental effort to improve teaching (Wieman and Gilbert 2014). Furthermore, the fraction of instructor comments in that department listing student deficiencies as the biggest barrier to learning dropped from 41 % in 2006 to 14 % in 2012.

If this is a causal relationship, it implies that the adoption of good teaching practices may lead to improved implementation of these practices, as teachers gain greater understanding of the barriers to student success. This is clearly an area for further study. To attain a better understanding of this relationship, it would also be good to investigate several other factors we are not able to address, such as getting a more nuanced view of how the instructors interpret "greater student learning" (reducing failure rate, or increasing achievement of the best students, or something else?); the degree to which these instructor comments are shaped by

general views about students and learning versus recent specific experiences; and how interventions, both targeting teaching practices and attribution for student success or failure, would affect the results. Finally, we have also only examined a sample of instructors at one university. It would be valuable to have data from a much broader range of institutions.

We have shown that it is quite common for university math and science instructors to exhibit fundamental attribution error when considering limitations in student learning. For efforts to improve instruction to be successful, it will be necessary to better understand and address this attribution error and how it affects and is affected by both the discipline and the instructional practices in use.

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