Physics education research's implicit views of physics faculty

Maxwell Franklin
Kansas State University, Manhattan, Kansas 66506, USA and
Drexel University, Philadelphia, Pennsylvania 19104, USA

Linda Strubbe
American Association of Physics Teachers, Vancouver, British Columbia, V6T 1Z1, Canada

Eleanor C. Sayre
Kansas State University, Manhattan, Kansas 66506, USA

Physics education researchers sometimes conduct research on physics faculty change; we also write about faculty when we do research on implementing reforms in physics classrooms, or when we talk about how faculty affect students' understanding. This study classifies mentions of physics faculty in PERC and PhysRev-PER journals in order to study implicit frameworks used by the PER community when viewing and writing about faculty. Furthermore, mentions are categorized to give a sense of what aspects of instructors are most often commented upon. While no overall tendency towards positive or negative mentions was found, in the category of faculty beliefs, mentions were significantly negative, while in the category of faculty goals, mentions were significantly positive. We report this as a starting point for PER researchers to analyze the way we view and talk about other faculty.

I. INTRODUCTION

Though much of physics education research involves education researchers working closely with other physics professors, researchers haven't engaged in much public self-reflection in the community about our views of faculty and the influences it has on our partnerships with them. A literature review determined that there has been no prior work done studying researcher's views of faculty. In community development, the way that developers approach the community to be developed is important [1] and is something that must be carefully planned. As the underlying ideologies of a group are reflected by the discourse the group uses [2], one great way to study how PER researchers view physics faculty is through our writing in published papers.

This study looks at how the PER community writes about university physics faculty in order to open a conversation around our approaches to research related to faculty and faculty development. We categorize this on a framework based around agency and asset-based or deficit-based approaches to community development. This is done by looking at the individual mentions of faculty in PER journals and analyzing how the author frames the faculty's agency, beliefs, or actions.

II. THEORY

In community development, we think about two major ways of viewing a group that one is trying to develop. The first is known as a deficit-based paradigm: one that focuses on the shortcomings of the community[1]. In contrast, the asset-based paradigm focuses on the strengths present in a community and on building those strengths [1], which is a more effective model for education [3]. In this paper, we describe a coding framework based on the asset-based agentic paradigm [4], which includes both the resources [5] that faculty bring and agency [6] that faculty have in their teaching. We look separately for researchers' views of faculty assets and agency by examining the ways they talk about faculty in their papers.

Mentions of faculty were done by describing specific faculty beliefs, goals, and practices related to classroom teaching. For example, "Some faculty expressed that being innovative in the classroom was generally valued by their departmental colleagues" is an expression of faculty goals. We seek evidence in published texts for how authors consider faculty beliefs, goals, and practices; and how their treatment of faculty is asset-based or agentic (or not).

Faculty agency around teaching does not have a straightforward definition. Bandura (2001) defines agency as "intentionally mak[ing] things happen by one's actions" [6]. A more specific definition of teacher agency includes taking an active role in shaping their work [7]. Agentic treatment of faculty foregrounds the goals and materials created and used by faculty in PER research, or it allows space for faculty goals and materials in PER reforms. This combination of asset-based community development and agency is not new; when applied to communities, an asset-based mindset is one that focuses on the agency of the community members [8]. These groupings of asset or deficit models and agency or the lack thereof were applied to each category we created for our coding framework (Table 1), to create *positive* (asset-based or agentic) and *negative* (deficit-based or non-agentic) subcategories of each.

While this asset-based agentic framing guided our coding, there are aspects of it that we were unable to map to our categories as they did not have a clear positive or negative judgment. These included mentions that touch on instructor agency without explicitly supporting it or harming it, such as advice to instructors or tools designed to support instructors. They were merged with a large population of 'neutral' snippets that do not affect our analysis.

III. RESEARCH GOALS

In this paper, we extracted snippets of text from two physics education journals, the Proceedings of the Physics Education Research Conference ("PERC"), Physical Review Special Topics – Physics Education Research, and Physical Review – Physics Education Research (together, "PhysRev"), about faculty and coded relevant snippets into categories of positive or negative. Our main research questions were

- Which paradigm was in use more when writing about faculty?

- Were the individual aspects of faculty that the PER community talks about positive or negative?

Additionally, we investigated whether positivity or negativity changed over time and whether there were differences between PERC and PhysRev. The purpose of this research is to gain a broad understanding of the position of the PER field as a whole, that can later be refined by looking at individual papers.

IV. METHODOLOGY

We gathered all of the papers published in PERC and PhysRev from the years 2008, 2009, and 2012-2018, which were the years for which we were able to gain full PDFs. For each paper, we looked for mentions of the words "faculty" and "instructor", then used python to extract the 20 words preceding and following each mention. These 41-word "snippets" became the basis for our analysis. This yielded a pool of 17,988 snippets from 1468 papers.

To code these snippets, we first engaged in a generative and iterative process by which two authors repeatedly considered a subset of snippets from one issue of

Category	Description	Example
BELIEFS	Faculty beliefs about teaching are framed as good or bad, or the author agrees or disagrees with them	"There is evidence that at least some faculty are thinking logically about the TPS implementation and not just filling in memorized words" "Instructors often take for granted that advanced physics students will learn from their own mistakes in problem solving"
MOTIVATION	Faculty do or do not desire to become better teachers or improve teaching. Faculty are or are not motivated to try new reforms	"Some instructors expressed an interest in using research-based trouble-shooting assessments in their classrooms" "Also, instructors may be resistant to the idea of such a drastic overhaul from traditional-lecture to inquiry-based curricula. "
PRACTICE	Faculty actions in the classroom are framed as good or bad. Faculty have or lack competence teaching	"Our data suggest that many physics faculty have the capacity to engage in both doing school and pedagogical sense-making" "At least one of those faculty "regressed to the mean," returning to more traditional instruction"
GOALS	Faculty goals are or are not foregrounded in research Faculty have productive or unproductive goals for students	"This creates a strong case for involving faculty as partners in instructional change" "This state of affairs places strong and consistent pressure on instructors to ease student anxiety by adapting PER-based tasks "
MATERIALS	Faculty create materials, and that is framed as good or bad. Faculty make positive or negative changes to materials. Faculty are willing or unwilling to try good reforms	"The instructor chose to use the E-CLASS without external pressure from our research group," "Faculty often modify in ways that may be less likely to lead to effective outcomes"

TABLE I. Description of Coding Framework. The first example is positive, the second is negative.

PhysRev at a time to figure out how to robustly apply the asset-based agentic framework. As we collaboratively interacted with the framework, the snippets, and each other (including the rest of the research team), our coding scheme evolved substantially as we sought to both embody the ideas in the snippets and connect to the theoretical framework. This paper focuses on the final coding scheme and results, not our development process.

Our final scheme first judges whether a snippet discusses faculty qualities (which we marked as 'relevant'). To be labeled as relevant, a snippet needed to be explicitly related to faculty teaching or beliefs about teaching. A snippet was coded as relevant if it referred to an instructor having either agency or a lack thereof [4], or if it contained a value judgment from the author about the instructor. Snippets about actions that the instructor took that were judged basic classroom actions with no value judgment from the author, such as the example "when faculty launch an assessment, their students receive emails", or were judged to be done as part of a PER experiment, such as "consequently, both genomics and non-genomics trained biology faculty were invited to use the GEP curriculum" were not included in the relevant snippets. No further analysis was done on irrelevant snippets.

We sorted snippets into new categories and deemed them as positive or negative depending on what the snippets said about instructors' agency or assets. Our final categories were GOALS, on the goals of the instructor in class or on the agency of the instructor in pursuing those goals; MATERIALS, on the instructor creating or choosing to use certain materials; MOTIVATION, on the instructor's desire to improve; PRACTICE, on an instructor's competence or actions in class and BELIEFS, on an instructor's beliefs about teaching. More details about these categories, as well as positive and negative examples in each category, is shown in table 1.

Any snippet about the foregrounding or lack thereof

Category	Overall	PhysRev	PERC
BELIEFS	Negative (p=.006, h=.2)	Negative (p=.01, h=.22)	No Trend
MOTIVATION	No Trend	No Trend	Positive (p<.001, h=.54)
PRACTICE	No Trend	No Trend	No Trend
GOALS	Positive (p<.001, h=.69)	Positive (p<.001, h=.69)	Positive (p<.001, h=.69)
MATERIALS	No Trend	Negative (p=.02, h=.23)	No Trend

TABLE II. Significant results for each category, with the corresponding p-value and effect size

of the goals and materials of instructors in the classroom or in physics education research was judged based on the agency of the instructors. Snippets about the instructors' practices, beliefs, or materials with a value judgment were judged based on whether the author spoke of the instructor in a positive or negative way. The only mentions included were ones that made positive or negative statements about the agency or asset value of the faculty; others, such as ones giving advice or ones without a clear value judgment, were not used. Snippets in the BELIEFS, MOTIVATION, and PRACTICE category were all asset/deficit related, while snippets in the GOALS and MATERIALS category were either agency or asset/deficit related, with no clear majority towards either. We attempted to apply our asset-based agentic framework to all snippets; however, agency was only seen when faculty were creating materials or making active choices about teaching. This limits agentic snippets to the GOALS and MATERIALS category.

Once these snippets were all coded as positive or negative and had at least one category, we ran proportion tests in order to compare the two journals and to see if any category was predominantly positive or negative. We also looked at both journals individually over time to check for any time-dependent changes in either positivity or category predominantly mentioned.

Because this work is looking for often-implicit views espoused in published works, we need to treat ambiguous snippets carefully. In the development process, ambiguous snippets were given careful discussion to both determine category boundaries and to help develop new categories. If an ambiguous type was seen repeatedly, such as snippets regarding competence, it was worked into the coding framework. Conversely, some versions of the coding scheme were too fine-grained and suffered in inter-rater reliability testing. For example, we attempted to create subcategories within the positive and negative groups based on how strongly positive or negative a snippet was; this was abandoned due to a lack of agreement between the raters. We also had a third category we called 'semi-positive,' in which authors acknowledged that instructors had beliefs or goals but did not give a value judgment. This category was eventually abandoned and semi-positive snippets were reclassified as neutral.

Our final coding scheme balances reliability of coding (as measured by multiple raters) against fineness of detail. We recognize that our field contains subtleties that this scheme may not examine closely; however, both schemes as they are now have been validated by inter-rater reliability, with about a 95% agreement rate. We are confident that they are a reliable way of assessing these snippets of text.

V. RESULTS

We found no significant overall trend towards either paradigm in the data, answering research question 1. This overall effect is true when we separate PERC and PhysRev.. While it is encouraging that there is no negative trend, the lack of a positive trend shows that PER views on physics faculty are far from perfect. When looking at individual categories, however, the results were much more interesting. We found that overall, the category of BELIEFS was negative and the category of GOALS was positive. In the PhysRev articles alone, both BELIEFS and MATERIALS were negative while GOALS was positive, while in the PERC articles, no category was negative but MOTIVATION and GOALS were positive. A full list of significant results with attached effect size can be found in Table II. Exact percentages of positive and negative for each journal and for the overall sample can be found in Figure 1. These two figures answer research question 2.

Our other analysis of the data pertained to individual years of each journal. We tested both journals for change over time in percent positivity, percentages of each relevant category, and percent positivity in each category. There were no changes over time in any of these metrics, though early PhysRev journals had few enough snippets that drawing any conclusive results is difficult. This suggests that the ways that researchers talk about faculty in their papers has not changed substantially in these ways over time; however, we note that our entire research period is between 2008 and 2018. Following broader trends in science education research during this period [9], it may be that this 10-year period is too short to look for substantial changes in how we conceptualize faculty resources.
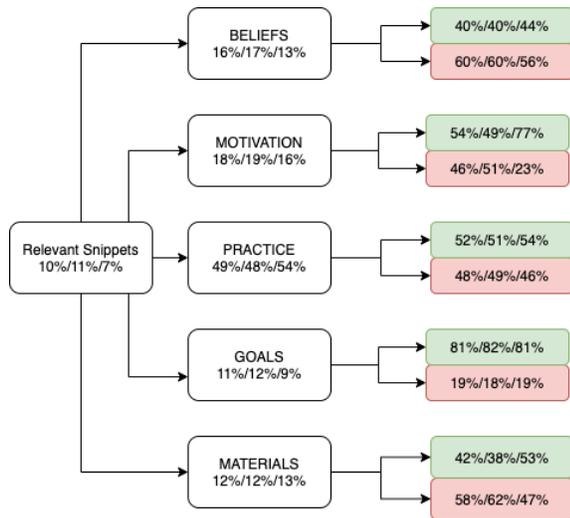
FIG. 1. A breakdown of how many snippets are in each category. The first number is overall, the second is for PhysRev, and the third is for PERC. In the final column, green boxes denote positive and red boxes denote negative

VI. CONCLUSIONS AND FUTURE RESEARCH

Our research found clear trends in the ways PER journals mention faculty, specifically when referring to their beliefs, goals, or materials used. However, there is future work to be done that can be achieved both by broadening or narrowing our coding scheme. There were several categories of snippets that we felt were promising but we excluded due to them not fitting into our positive/negative framework. Such categories include advice given to instructors, descriptions of collaboration between faculty members, and self efficacy of instructors, which has been tied to agency [6]. More work could be done to revise our model by making space for these categories in order to create a more complete framework.

Our framework could also be specified such that it distinguishes between agentic or asset-based views of faculty. Because our research goals referred to overall conceptions of faculty, we collected both of these views in the same positive/negative boxes without making a distinction. However, it is possible that looking at agency or asset/deficit-based development individually would show a strong slant towards positive or negative. This would be especially relevant to the GOALS and MATERIALS categories, as both of those contain both agentic and asset-based components.

Additionally, future work could be done on this topic by expanding to the paper level, as opposed to the journal and snippet level. The majority of snippets were found in a small percentage of papers, evidenced by the fact that the average total number of snippets per paper is

12.4 and the median number of snippets per paper is 3. It is likely that papers with many snippets, i.e. papers where faculty is a main focus of the topic, have different characteristics in their treatment of faculty than papers where faculty are not a major topic. This would shine more light into not only the precise breakdown of positive and negative snippets, but also onto how the statements are overall neutral. Our research did not show whether there are only two paradigms, asset and deficit models, that are balanced or whether there are more factors at work; a paper level analysis could answer this question.

Our work was also limited, as previously mentioned, in our study of changes over time. PhysRev papers yielded the vast majority of our data, but the earlier PhysRev volumes, which had few papers which mostly did not focus on faculty, did not have enough data points for any changes over time to be clear. We believe that this is not a question that can be answered now; future research must wait until more issues are available. It is possible to investigate this question by looking at earlier PERC papers; however, early Proceedings are not as easily collected for analysis as the ones since 2008.

We have been unable to find research on researchers' views of faculty of the same discipline. Though there are plenty of papers about research on disciplinary faculty, they don't systematically examine how researchers view faculty as research subjects or partners. Previous research of asset or deficit based views of individuals has been in fields such as social work [10]. There is much future research to be done on how different disciplines of education research view their corresponding fields. Though it is encouraging that there is not an overall deficit-based view of physics faculty, the lack of a clear asset-based view, as well as the deficit-based view of faculty beliefs, shows that there is room for improvement in our approach to faculty development. PER researchers need to be mindful in the way we write about faculty and in our approach to faculty development. When writing about faculty, we need to be aware of whether we are treating them as agentic partners or resistant to reforms. Furthermore, we need to be sure when writing about educational goals to goals of non-PER faculty.

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