

Thematic analysis of 18 years of physics education research conference proceedings using natural language processing

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We have used an unsupervised machine learning method called latent Dirichlet allocation (LDA) to thematically analyze all papers published in the Physics Education Research Conference Proceedings between 2001 and 2018. By looking at co-occurrences of words across the data corpus, this technique has allowed us to identify ten distinct themes or “topics” that have seen varying levels of prevalence in physics education research (PER) over time and to rate the distribution of these topics within each paper. Our analysis suggests that although all identified topics have seen sustained interest over time, PER has also seen several waves of increased interest in certain topics, beginning with initial interest in qualitative, theory-building studies of student understanding, which gave way to a focus on problem solving in the late 2000s. Since 2010 the field has seen a shift toward more sociocultural views of teaching and learning with a particular focus on communities of practice, student identities, and institutional change. Based on these results, we suggest that unsupervised text analysis techniques like LDA may hold promise for providing quantitative, independent, and replicable analyses of educational research literature.

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I. INTRODUCTION: THE CHALLENGES AND OPPORTUNITIES OF A GROWING LITERATURE BASE

There is now an overwhelming amount of scientific research literature, even in fields as relatively young as physics education research (PER). For example, since 2005 Physical Review Physics Education Research (formerly Physical Review Special Topics Physics Education Research) has published over 700 articles. The Physics Education Research Conference (PERC) Proceedings have published over 1300 papers since 2001. Journals like *The Physics Teacher* and *The American Journal of Physics* have published many thousands of articles on education, starting in 1963 and 1933, respectively. There are almost certainly thousands more relevant articles in the science education and general education research literature.

This magnitude of literature presents a significant challenge for researchers in that they will never have enough time to read every new article that comes out. Additionally, other than through targeted literature reviews, it is difficult for

researchers to find all of the papers that might be relevant to them. This is doubly the case with new researchers, who have an increasingly long history of research and scholarship with which to familiarize themselves. For this reason, we are more and more reliant on recommendations, whether by colleagues, automated tools such as Google Scholar, or periodic newsletters like those delivered by the American Physical Society.

However, this volume of literature also presents several opportunities. Most scholars have experienced the joy of stumbling on a useful article right when one needs it the most—with so many published articles, there are always likely to be a few undiscovered gems for every reader as long as one knows where to look. At a broader level, this amount of literature indicates that our field has now matured beyond its nascent stages—we have progressed to the point of having sustained several waves of methodological and theoretical development in our decades of existence. Thus, this body of literature can give us insight into the development of our field—where PER has come from and where it is going. However, to perform this kind of analysis we need new methods, as it is an unreasonable proposition to ask a single researcher (or even a research team) to read and summarize all of the articles within the field.

The subfield of machine learning known as natural language processing has, in recent years, developed techniques for this kind of large-scale data mining and text analysis. In this study, we use one such technique, an

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