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Research on Engineering Student Knowing: Trends and Opportunities

In this paper, we focused on a specific form of scholarship of discovery in engineering education: the scholarship of discovery that investigates what engineering students *know* and how this knowledge evolves over time. For us, this type of research is as fundamental to education as research on the functioning of the heart is to efforts to design interventions that support people with heart conditions. To illustrate the state of this scholarship, we presented twelve studies and analyzed these studies across the dimensions of aspect of knowing (e.g., teamwork, intellectual development, design), level of experience of the population (e.g., freshman, senior), and research approach (e.g., survey, ethnography). We then used these analyses to identify trends in the existing research and opportunities for future work.

The basic ideas underlying the paper were described in section II—current perspectives on what it means to know, thoughts on why research on knowing is valuable and how it can affect educational practice, and ideas about how researchers can approach investigation of student knowledge. Section III then described our strategy for identifying a sample of studies on engineering student knowing. We did not aim for a comprehensive review but rather a selective sample of papers that illustrate research on what engineering students know so that we could then discuss themes represented by the collection of papers.

The studies themselves were individually described in the appendix, so that section IV could focus exclusively on the analysis of the studies and how they fit together. Our first analysis focused on how the studies were distributed across the two dimensions, aspect of knowing and level of experience. Supporting the analysis was a representation in which each study is placed on a grid defined by the two analysis dimensions: aspect of knowing and level of experience. From this analysis, we observed that the collection of studies in the sample, although limited, does provide a starting point for a description of what freshmen know (eight studies), what seniors know (six studies), and also how between-subject and within-subject longitudinal studies can shed light on the changes of knowledge over time. Our second analysis focused on how the studies were distributed across the two dimensions: aspect of knowing and research method, which was complemented by a similar grid-based representation of the studies. From this analysis, we were able to get a sense of the number of research methods used to investigate the aspects of knowing represented in the sample (10 methods in total, including surveys, concept mapping, multi-dimensional scaling, and ethnography) as well as the distribution of method use across different aspects of knowing. For example, we noted that the insights into intellectual development (one aspect of knowing) stemmed from research using individual interviews and the insights into design stemmed from three research studies using complementary methods.

Building from these analyses, we then identified and discussed three types of opportunities: opportunities to more densely populate the space defined by the current set of studies (e.g., same aspect of knowing with different method), opportunities to expand beyond the space

defined by the current studies (e.g., add new subject populations to the studies, add new methods), and opportunities to ensure that the studies end up having an effect on practice (e.g., standardize reporting, guidelines for establishing credibility, recognizing the importance of such scholarship of integration). We hope that the information included in this paper not only illustrates the structure of this type of research, but also helps to illustrate the scope of research that is possible, generates ideas about specific research projects, helps to calibrate expectations about the amount of effort involved in this research, and excites engineering educators about the possibility of contributing to this growing research area.

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