ENHANCING ELEMENTARY PRESERVICE TEACHERS' UNDERSTANDING OF VARIATION IN A PROBABILITY CONTEXT

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The purpose of this paper is to report on research aimed at elementary preservice teachers' understanding of variation. Other research has already begun to illuminate precollege student thinking about variation in several contexts, such as sampling, data and graphs, and probability situations (e.g. Reading & Shaughnessy, 2004; Watson & Moritz, 1999; Shaughnessy & Ciancetta, 2002). However, as the picture begins to get painted about how precollege students reason statistically, the research on how teachers reason about variation remains thin. In particular, there is a paucity of research about how preservice teachers think about variation, or variability in data. Therefore, doctoral research was undertaken to explore the following research question: How do elementary preservice teachers' responses concerning variation in a probability context compare from before to after an instructional intervention? After describing the conceptual framework and methodology for the study, the results will next be presented, followed by further discussion.

Conceptual framework

Three key aspects of understanding variation that governed the overall study focused on how students were expecting, displaying, and interpreting variation. In dealing with expectations, students need an opportunity prior to conducting statistical investigations to express both what they expect and why. With displays of data, students need to create their own graphs to either highlight or disguise variation, depending on the context of the situation. They also need to evaluate displays and compare distributions in ways that take an aggregate view of data, considering shape and spread in addition to centers (Shaughnessy, Ciancetta, Best, & Canada, 2004). From discussions about probabilistic and statistical situations, students' interpretations of variation emerge as they speculate on both causes and effects of variation and also on ways of influencing variation and expectations.

Methodology

The thirty subjects in the study of EPSTs (24 women, 6 men) were enrolled in a ten-week preservice course at a university in the northwestern United States designed to give prospective teachers a hands-on, activity-based mathematics foundation in geometry and probability and statistics. During the first week of the course, prior to instruction in probability and statistics, subjects took an in-class survey (called a PreSurvey) designed to elicit their understanding on a range of questions about sampling, data and graphs, and probability. The probability question (PreSurvey Q7c) that relates to the current paper concerned six sets of fifty flips of a fair coin. For each of the six sets, students were asked how many times out of the fifty flips the coin might land heads-up. They were also asked why they had chosen the numbers they did. Following the PreSurveys but prior to the class instruction on probability and statistics, individual interviews were conducted with ten subjects to allow further probing of their thinking. After instructional interventions took place in class, a similar PostSurvey question (PostSurvey Q1c) was asked

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concerning six sets of fifty spins of a fair half-black and half-white spinner. For each of the six sets, students were asked how many times out of the fifty spins the pointer might land on black, and also why they had made the choices they did. Finally, after the PostSurveys the same students who had been earlier interviewed were interviewed once again.

Results

Both parts of the probability question (what students expected and why) were taken into consideration for coding purposes, primarily to retain consistency with an analogous rubric derived for a similar question asked in a sampling context (Shaughnessy et. al., 2004). The rubric places a higher value on responses that integrate proportional reasoning as well as variation. The codes and class results for this subquestion are presented in Table 1.

Code Level	Description of Category	Number of Students (Pre)	Number of Students (Post)
L3	Appropriate choice & Explanation explicitly involves proportional reasoning as well as variation	2 (7.4%)	9 (31.0%)
L2	Appropriate choice & Explanation reflects proportional reasoning or notions of spread	10 (37.0%)	15 (51.7%)
L1	Appropriate choice & Explanation left blank or lacks any specific reasons relating to details of the distribution	4 (14.8%)	3 (10.3%)
L0	Inappropriate choice (Regardless of Explanation) W(ide) = Range > 19, N(arrow) = Range < 2, H(igh) = Choices > 24, L(ow) = Choices < 26	11 (40.7%)	2 (6.9%)

Table 1: Results for PreSurvey Q7c & PostSurvey Q1c

Only inappropriate choices for listing what was expected (or blank answers) were coded at Level 0. Deciding what would constitute an appropriate choice for the results on six sets of flips or spins involves making a judgment call, and the subcodes used for this subquestion question help identify inappropriate choices as (W)ide, (N)arrow, (H)igh or (L)ow. Of the 30 students enrolled in the class, 27 were in attendance to complete the PreSurvey and 29 completed the PostSurvey.

Conclusion

If a goal is for teachers to provide students with authentic, inquiry-based tasks meant to develop children's reasoning about variation, then a natural step in achieving this goal is to improve teacher training courses. Thus, by discerning components of preservice teachers' reasoning, teacher educators can better design university experiences that promote an understanding of variation for preservice teachers, as well as an understanding on how precollege

students come to learn this topic. As research in the field of statistics education advances, one goal is that teacher education can improve not only the subject matter knowledge of EPSTs, but also the pedagogical content knowledge of teaching about variation. Steps toward improved pedagogical content knowledge can certainly be informed by recent research about how precollege students learn. Meanwhile, steps toward improved subject matter knowledge can be informed by a consideration of what are the conceptions of variation held by preservice teachers as they enter university programs. Collective discourse in the class, bolstered by activities and simulations targeted at eliciting conceptions of variation and developing these concepts, hold promise as ways of building EPSTs knowledge while also reflecting the kinds of practice they themselves will want to demonstrate in their own classrooms.

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