

TEACHERS' CONFIDENCE IN TEACHING STATISTICAL IDEAS

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Teachers lack confidence in their ability to teach statistical ideas. Although understanding of school students' development of underpinning ideas in statistics has grown, this has not been matched by a deeper realisation of how best to develop teachers' confidence and competence in teaching statistics. As part of a larger project, 42 teachers completed a profile instrument that included a 20-item confidence inventory and, a 5-item scale addressing beliefs about statistics in everyday life. A factor analysis of the teaching confidence items indicated four factors that could be interpreted as procedural statistics, probability, the application of statistical ideas, and underlying ideas of variation and inference. To explore teachers' confidence further individual "KidMaps" provided a profile of items unexpectedly endorsed as high or low confidence. Dissimilar patterns of response to items that loaded onto the identified factors were identified among teachers who had different overall levels of confidence.

INTRODUCTION

Among the affective variables associated with teaching statistics, confidence appears to be one of the more elusive. Thinking of confidence as "firm trust or belief: faith: self-reliance" (Kirkpatrick, 1983, p. 263), confidence in teaching mathematics and statistics generally, or indeed specific topics within these domains, is a trait to be desired and engendered (Sowder, 2007). Confidence is related to self efficacy, which Bandura (1977, p. 79) defined as "the conviction that one can successfully execute the behaviour required to produce the outcomes", and may be seen as a contributing element to wider constructs associated with teaching such as developing a sense of teacher efficacy. Hoy and Spero (2005) asked preservice and first-year teachers to use a 6-point scale to rate their confidence on classroom skills such as managing a classroom, evaluating student work, and teaching basic concepts of fractions. All respondents reported overall high levels of confidence. Beswick, Watson, and Brown (2006) used a 5-point Likert scale and asked 42 teachers their level of confidence in teaching 13 topics in middle school mathematics, including fractions, decimals, percents, measurement, space, pattern and algebra, and chance and data. Although all means were on the more confident side of neutral, 55% of teachers lacked confidence or were neutral in relation to ratio and proportion, which are important mathematical concepts used in statistics.

In a teacher profiling instrument specifically addressing Chance and Data, Watson (2001) included a nine-item sub-scale where teachers marked their confidence in teaching on a continuous scale from "low confidence" to "high confidence" for various chance and data topics. When scaled from 1 (low) to 5 (high), the lowest mean for primary teachers was for "median" with a mean of 3.00. For high school teachers the lowest mean was 3.68, for "odds." Another subscale of the profile measured teachers' beliefs about Statistics in Everyday Life, adapted from Gal and Wagner (1992). For a group of 72 Australian teachers on the two sub-scales of nine confidence in teaching items and four everyday life items respectively, high school teachers were more confident than elementary teachers, and males more confident than females (Callingham, Watson, Collis, & Moritz, 1995).

METHOD

Instruments

Teachers in three Australian states completed a profile instrument including a 20-item confidence inventory. On a five-point Likert scale from Low (1) to High (5) confidence, teachers indicated how confident they felt to teach statistical concepts, including some with a curriculum focus, such as mean, median and mode, pie graphs and histograms, and probability; some important underpinning ideas, including variation, inference and prediction; and some related

mathematical ideas such as measurement, and fractions, decimals and percents. Two questions also addressed applications of statistics to other subject areas and in the media. Where teachers indicated that they would not be teaching the topic, no code was allocated and these data points were treated as missing data.

Teachers also answered 5 items, 4 of which were previously used by Callingham et al. (1995), reflecting confidence when meeting statistics in everyday life. These items were coded from 1 (strongly disagree) to 5 (strongly agree).

Demographics

Of the 42 teachers who responded, nearly half were teaching at least some senior secondary classes (n=20, 48%), nine (21%) taught in junior secondary grades, five (12%) taught across primary and secondary grades in the middle years of schooling, and the remaining eight teachers (19%) were teaching only in the primary grades. The three states of Australia were equally represented (nstate=14). The group was highly experienced with more than half (23/42, 55%) having more than 15 years of teaching experience. Given the teaching responsibilities, it was expected that a majority of teachers would have a mathematics major in their degree. Of the 40 teachers who answered this question, 12 (30%) had a mathematics major, and nine of these teachers taught senior secondary years. Of the remaining teachers, 17 (43%) had one year of tertiary mathematics study, and the others (n=11, 27%) had studied mathematics for one semester or less. It was not possible to find out how many of the teachers involved had undertaken some level of statistics as part of their mathematics training, but it is likely, given the number of years since these teachers had undertaken their initial degrees, that little statistics had been included in their courses. In summary, the sample of teachers was experienced, but with surprisingly limited mathematical backgrounds, and was teaching across the grades of schooling from upper primary to senior secondary years.

Analysis

A factor analysis was undertaken using Principal Components (PCA) extraction with varimax rotation and Kaiser normalisation, with Eigenvalues >1. The five beliefs statements relating to confidence in handling statistics in everyday life were not included in the factor analysis because these statements were substantively different from the confidence items. These items were included in a Rasch analysis undertaken as a secondary analysis. The Rasch analysis was undertaken using Winsteps 3.80.1 (Linacre, 2013). One item (C13, stem-and-leaf plots) showed inconsistent responses but the others appeared to work together consistently. Individual KidMaps showing person-by-item interaction were obtained. The responses were then categorised into high confidence with an overall measure greater than 1 SD from the person mean, middle confidence (lying between ± 1 SD) or low confidence (< 1 SD from mean) and the KidMaps were then examined qualitatively to identify unexpectedly high or low endorsement of items across the scales.

RESULTS

On the basis of the mean item scores, teachers were generally confident of their ability to teach all concepts, with the lowest mean value being 3.23 for item C14, Inference. The highest values were for topics common in mathematics curriculum documents over many years, such as C17, fractions, decimals and percents (mean = 4.43, SD = 0.83) and for the ability to apply statistics in everyday life, e.g., item B12 (I would find it easy to explain to someone what an average was), with a mean score of 4.31, SD = 0.75.

The PCA analysis identified four factors, accounting for 80.5% of the variance. Factor 1 (StatCon) was predominantly associated with procedural statistics, with some contribution from associated mathematical skills such as fractions, decimals and percents. Probability items loaded onto Factor 2 (ProbCon). These groupings are not unexpected. Factor 3 (AppStatCon) addressed applications of statistics across the curriculum and in the media, including C4, data collection, C5, sampling, and C16, ideas about variation. These are the kinds of underpinning notions that would be needed when applying statistics. The last factor (InfCon) was concerned mainly with the underpinning big ideas of statistics: inference, prediction and variation.

Relationships of Scales to Everyday Life Items

For each of the four identified factors, scale scores excluding Item C10 because it weighted almost equally on each factor, were computed for each teacher. A similar score was obtained for the five beliefs items based on Everyday Life. This scale was called Personal Confidence (PerCon). The means and standard deviations for each one of these scales is shown in Table 1.

Table 1. Means and standard deviations of teachers' scores on identified scales

Scale	Mean	Standard Deviation
StatCon (F1)	3.21	0.78
ProbCon (F2)	2.70	0.52
AppStatCon (F3)	2.29	0.59
InfCon (F4)	2.18	0.61
PerCon	4.09	0.53

The mean of the scores on PerCon, the Everyday Life items, show that teachers indicated strong agreement with items that addressed, implicitly, their confidence to deal with statistics in an out-of-school situation. They also indicated strong confidence in teaching procedural statistics (StatCon), less so in teaching probability (ProbCon), and considerably less confidence in teaching the big ideas of statistics represented by Factor 4 (InfCon).

A Pearson bivariate correlation among the five scale scores was obtained to determine the associations among the scales. All correlations were highly significant at the .01 level, and were relatively large, ranging from .82 for StatCon and InfCon, to .43 for PerCon and InfCon. This finding is not surprising for the factor scales, given that there was some overlap of items across the four factors. The Personal Confidence scale also showed large and highly significant correlations with the four factors.

The high levels of correlation indicated that a Rasch analysis was justified in order to consider different types of response. The KidMaps for individual teachers, however, showed some different patterns of response. Those teachers categorised as having high confidence showed no unexpectedly high endorsement of any items, but did tend to show unexpectedly low endorsement of the PersCon items, suggesting that despite high confidence in teaching statistics, they were wary of strongly endorsing items about statistics in everyday life. Those grouped under low confidence, however, endorsed the PersCon items unexpectedly strongly, and tended to have unexpectedly weak endorsement of the StatCon items, which were mainly curriculum based.

DISCUSSION

At one level, considering the high levels of confidence reported by these teachers through the Confidence Inventory, it would seem that this is an affective component of teachers' knowledge that may not need attention. The teachers in this study indicated high levels of confidence in teaching a variety of statistical topics but when examined further, the underlying factors identified indicated that the nature of teachers' confidence was not uniform across topics, with scale means showing that confidence in teaching the big ideas, indicated by InfCon, was apparently lower than that of procedural statistics, StatCon, although all teachers showed high agreement in the ability to deal with statistics in everyday life, PerCon. The finding that less confident teachers tended to endorse the everyday life items strongly, whereas highly confident teachers did not is intriguing. It may be that as teachers become more confident in teaching statistics, they begin to appreciate the subtlety of the applications of statistics in everyday situations.

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