THE DESIGN OF AN INSTRUMENT TO MEASURE PHYSICAL SCIENCE TEACHERS' TOPIC SPECIFIC PEDAGOGICAL CONTENT KNOWLEDGE IN ELECTROCHEMISTRY

Abstract

Research has ranked electrochemistry as one of the more difficult topics to teach and learn. Examiners in South Africa have complained about the poor performance in electrochemistry related concepts in Grade 12 public exams. This may suggest that the physical science teachers may not be teaching it very well. Accomplished teachers use specialized knowledge to transform their knowledge of subject matter into a form that can easily be understood by learners, known as pedagogical content knowledge (PCK). Little is known about the quality of PCK of teachers within this topic and currently there is no instrument to measure quality of topic specific PCK of practicing physical science teachers. The main purpose of the study was to design and validate an instrument that could be used to measure the quality of topic specific PCK of practicing physical science teachers in electrochemistry. The study was a methodology study which used a Mixed Methods (MM) approach. MM were used because the design of the instrument requires both qualitative and quantitative methods in the various steps towards its creation. The topic specific PCK (TSPCK) theoretical framework guided the design of the instrument. TSPCK comprises of 5 components namely: (i) Learners' Prior Knowledge including misconceptions; (ii) Curricular Saliency; (iii) What makes topic easy or difficult to understand; (iv) Representations or models; and (v) Conceptual teaching Strategies that enables transformation of content knowledge into its teachability. The new instrument was designed to elucidate TSPCK in electrochemistry according to these five components which each component represented a test item. The design process followed these steps chronologically: (i) Conceptualization of test items, (ii) construction of the instrument and judgment of items, (iii) piloting and construction of the actual instrument and finally validation of the instrument. After its conceptualization and development, the instrument was validated with a convenience sample of 21 practicing physical science teachers in Johannesburg schools, Gauteng province, South Africa. A topic specific PCK rubric was used to score the teachers' responses on a 4 point scale-from 1 "limited" to 4 "Exemplary" Topic Specific PCK. The Rasch Winsteps program analysed the teachers' scores and ascertained the validity of the instrument through statistics of goodness of fit. In addition, the Rasch

model determined the hierarchy difficulty of topic specific PCK components as well as instrument reliability. Both the items and persons' responses fell within an acceptable conventional range of -2 and +2 *Infit/outfit* statistics. The item and person reliability indices of the developed instrument were 0.97 and 0.89 respectively. The results show that it is possible to design an instrument that is valid and reliable instrument. Data on content knowledge of teachers was collected using the Content Knowledge test. It was found that a high concentration of teachers possessed a sound knowledge of electrochemistry but with a corresponding low topic specific PCK. This is likely the reason of poor performance of grade 12 learners in exams on electrochemistry related topics. Furthermore, a positive statistically significant linear relationship was found to exist between Content knowledge and the measured teachers' topic specific PCK. The findings suggest that TSPCK instrument might be used for teaching purposes so as to boost the practicing teachers' TSPCK on electrochemistry. In addition, the findings suggest that the instrument might be incorporated as a training tool in in-service teacher workshops.

Keywords: electrochemistry, practicing teachers' topic specific pedagogical content knowledge

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