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Explicit inclusion of topic specific knowledge for teaching and the development of PCK in pre-service science teachers

Mavhunga, Madlivane Elizabeth

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Abstract

Reflection about lessons delivered is a practice widely encouraged in teaching. Reasoning, particularly about transformation of subject matter knowledge of lessons yet to be taught, is an internal process and a speciality evident largely in expert teachers. The study investigates the feasibility of fast-tracking its development in pre-service chemistry teachers. It focuses on developing this specialty within a specific topic, as a theoretical construct called Topic Specific PCK (TSPCK). Five knowledge components of TSPCK are identified as the enablers that transform subject matter knowledge. The components are: (1) students' prior knowledge, (2) curricular Saliency, (3) what is difficult to teach (4) representations, including powerful analogies, and (5) conceptual teaching strategies. These components are identified, with reference to literature, as aspects specific to the subject matter knowledge of the teacher and useful in its teachability. A new tool to measure the quality of TSPCK is developed. The procedure for developing the tool consists of the following steps: (i) confirming the characteristics of the test items fitting the Topic Specific PCK construct, (ii) production of test items, (iii) judgment of items, (iv) construction of the instrument (v) piloting and (vi) validation of the instrument. Care is taken to ensure presentation of multiple evidence and discussions, addressing the interpretive and arguments as requirements for showing validity of the construct measured by the instrument. The Topic Specific PCK tool is validated with a group of 20 practicing teachers. The tool is scored, using a rubric corresponding to the five components with each being rated on a four point scale, from 1 (Limited) to 4 (Exemplary). The analysis of the generated scores is done using the Rasch statistical model (Winstep, version 3.72.3). The reliability indices as indicated by person reliability and item reliability are found to be high at 0.86 at 0.91, respectively. The persons and item scores reflect measures well inside the conventionally acceptable range of -2 and +2. A further indicator of validity of the tool is the empirically calculated hierarchy of test items' order of difficulty, found similar to the theoretically predicted pattern for the teacher group. Based on the above analysis and findings, I regard the tool as valid and reliable. My research design is based on mixed-methods research (MM). The research strategy takes the form of a case study. The study is located in a methodology class for final year physical science pre-service teachers. They formed an experimental group (N=16) for this study. I delivered an intervention, targeting understanding of

transformation of Chemical Equilibrium concepts, using the above listed five knowledge components. I collected data through a combination of tools, including the newly designed Topic Specific PCK tool in Chemical Equilibrium, an Achievement tool and a science teacher Belief tool. Both the Achievement and the Belief tools were adapted from existing tools, and were thus considered tried and validated. The findings suggest that the quality of Topic Specific PCK in chemical equilibrium may be improved in pre-service teachers by the explicit discussion of the knowledge enabling its transformation. They also suggest that, in the process of discussing aspects of subject matter knowledge related to its transformation, pre-service teachers improve their conceptual understanding of chemical equilibrium. Both these improvements were not affected by the shift or lack of shift in teacher beliefs from teacher-centred towards student-centred practices. I acknowledge the small size of the sample as a practical limitation to the generalization of the statistical findings in this study. I suggest that emphasis be placed on the trends displayed, as they are similar to those obtained from the multiple sources of the qualitative component of the study. Finally, I recommend that the development of PCK in pre-service teachers be considered in a topic by topic manner. I urge that the teaching of chemistry topics be explicitly organized in a format in which pre-service teachers would be expected to reason about them, and particularly transform them for teaching.

Keywords

Pedagogical Content Knowledge, Topic Specific PCK, Chemical Equilibrium, Transformation of Subject Matter Knowledge.