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Exploring the development of pre-service teachers' topic specific PCK and its influence on learner outcomes

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Abstract

The construct of Pedagogical Content Knowledge (PCK) conceptualized by Lee Shulman is widely agreed upon among science education researchers as one important domain of teachers' knowledge for improving classroom instructions. The purpose of this study was to explore the development of Topic Specific PCK (TSPCK) of a group of physical sciences pre-service teachers in the topic of organic chemistry, the quality of enacted TSPCK demonstrated in the actual classroom teaching and its influence on learner outcomes in the same topic. The study was located in a physical sciences (chemistry) methodology class of 17 pre-service teachers who were in their 3rd year studying for a Bachelor of Education degree in a South African University. The study employed a mixed methods research design and a case study as the research strategy. The case comprised two mini-cases which included: the entire class of pre-service teachers for describing quality of planned TSPCK; a subset of 4 pre-service teachers with 4 classes of high school learners for describing the quality of enacted TSPCK and learner outcomes. The entire class of 17 pre-service teachers was exposed to an explicit TSPCK intervention over 6 weeks, focusing on the knowledge components for the pedagogical transformation of content knowledge of organic chemistry. Then, a subset of 4 pre-service teachers from the entire class was followed into the classroom where each of them delivered two lessons each on organic chemistry to 4 classes comprising a total of 88 physical sciences high school learners. The sources of data were: the pre-and post-TSPCK tests prior to and following the intervention; content representations (CoRes) completed during the intervention; video-recording of pre-service teachers' lessons; pre-lesson interview and stimulated recall interview conducted with the pre-service teachers after the lessons; and pre-and post-learner achievement tests and learners' views about the lessons. The TSPCK tests, CoRes and classroom lessons were analyzed using an in-depth qualitative method by identifying moments of interactive use of TSPCK components. The learners' tests were scored using a memorandum of correct answers and analyzed for significant difference via the Rasch Model Analysis. Using both the Statistical Package for the Social Sciences and Rasch Analysis softwares, the Pearson product-moment correlation coefficient was estimated to determine the relationship between pre-service teachers' enacted TSPCK and learner achievement. There were three major findings emerging from the entire analysis. First, following the intervention, the pre-service teachers' TSPCK improved significantly. Second, the pre-service teachers demonstrated enacted TSPCK at the simple, proficient and sophisticated quality categories of TSPCK episodes, one category built onto another in describing the quality of lessons delivered. Third, following the pre-service teachers' teachings, the learner achievement in the topic positively correlated with the PSTs' enacted TSPCK and the correlation increased in positive strength with higher categories of TSPCK episodes emerging from the pre-service teachers' lessons. The study provides novel understanding of the link across collective-TSPCK to personal-TSPCK to learner outcomes.

Keywords: Organic chemistry, Topic Specific Pedagogical Content Knowledge, Pre-service teachers**,** Pedagogical transformation competence, learner achievement.