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The teaching of electrolytic cell and its fundamental concepts: the case of a spiral curriculum

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ABSTRACT

The research explored in-service teachers' classroom practices in teaching for conceptual understanding with a particular focus on the topic of Chemical Change. The topic is taught at different levels in the FET, being Reactions in aqueous solution at Grade 10; Redox reactions at Grade 11; and Electrolytic cell at Grade 12. The study was inspired by continual reports of South African Grade 12 learners' failure to adequately answer examination questions that demand a conceptual understanding of scientific knowledge on the topic Chemical Change. The study aimed to understand current teaching and learning processes in real life classrooms as well as to evaluate the spiral nature of the Physical Science curriculum. Special focus was on how Physical Sciences teachers' teaching approaches foster meaningful learning to enable learner conceptual understanding and access to scientific content. Physical Science curriculum documents were scrutinised for features of a spiral curriculum. The study followed an explanatory interpretative qualitative research paradigm with a case study methodology. The five participating in-service teachers, teaching a total of six classes were drawn from five different schools in three different districts of Gauteng province. Eighteen lessons were audio and video recorded, three lessons from each class and five teacher interviews we done. Scott, Mortimer and Aguiar's model of pedagogical link-making (PLM) was used to analyse the lessons. PLM comprises three aspects, link making to support continuity, link making to support knowledge building and link making to promote emotional engagement. Pedagogical link-making to support continuity was used both to analyse the spiral nature of the Physical Science curriculum and to analyse how the teachers sequenced the scientific concepts during the teaching and learning process. Pedagogical link making to support knowledge building was used to evaluate how teachers used the five pedagogical teaching tools that enable learners to actively construct knowledge. The Physical Science curriculum was found to be limited in its claims to a spiral nature at least for the topic Chemical Change and its essential concepts from Grade 10 to 12. Fundamental concepts such as Oxidation numbers (Grade 10) and Electrolytes (Grade 11) were not included in the curriculum in the respective grades. The lesson presentations by the teachers showed challenges in macro and meso link-making especially in the introductory lessons which hampered continuity from related past and future chemistry topics. Link-making at the micro level was well executed by all participants while the use of meso link-making increased from the first lesson to the third lesson. As far as link-making for knowledge building is concerned, I found that four of the five teachers used integration more than differentiation between everyday ways and scientific ways of explaining. Also, the use of both integration and differentiation increased from Grade 10 to 12. Two findings emerged with respect to making links between scientific concepts. Firstly, teachers generally illustrated the links between connected concepts very well. However, the second finding was that teachers seldom involved their learners in the linking of scientific concepts. In other words, teachers tended to retain authority in terms of conceptual engagement thus, compromising learning of conceptual understanding. There was hardly any link-making between scientific explanations and real-world phenomena with only one out of five teachers managing this. In terms of modes of

representation, teachers successfully got learners to use multiple modes of representations. Finally, there was variation in how teachers moved between different scales and levels of explanation within a continuum in the way the triangle of levels of thought was used by the participants. On the one extreme of the continuum, all 3 levels of explanation were used by both teachers and learners while on the other teachers only used one level of explanation, either the macroscopic or symbolic. For meaningful learning to be a reality in science classrooms, the findings of my study suggest a need for both in-service and pre-service teachers to be introduced to approaches that promote conceptual understanding. The findings of this study recommend that the policy-makers consider the revision of the topic Chemical Change and align it to the features of a spiral curriculum.

Keywords

Pedagogical link-making, knowledge building, continuity, coherence, meaningful learning, conceptual understanding, the triangle of levels of thought, spiral curriculum.