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TEACHERS' ORCHESTRATION OF BODILY EXPERIENCES AND THEIR RE-REPRESENTATIONS FOR LEARNING FORCE CONCEPTS

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Primary science teaching has a tradition of grounding children's learning in direct experiences of phenomena. Concepts of force and momentum provide opportunities for teachers to engage students in embodied experiences; however, embodied representations need to be re-represented into other modalities if they are to effectively support the development of abstract-symbolic knowledge. The purpose of this study was to analyse learning sequences captured on video in the EQUALPRIME project to investigate how accomplished teachers of primary science orchestrate and connect new and re-enacted embodied experiences and transform these into other representational forms for the development of force concepts. Analyses revealed that rich opportunities were provided for students to encode sensorimotor experiences into episodic memory, prior experiences were re-enacted and transformation of these into graphical and verbal modalities were used to support students generate abstract-symbolic meaning for these concepts and provide multiple anchor points for recalling and applying this knowledge in the future.

Keywords: Embodiment, re-representation, concept development

INTRODUCTION

Embodied cognition is a term used to describe a class of theories "which emphasize the importance of sensorimotor experience gained through our bodily interactions with the environment for acquiring and representing conceptual knowledge" (Wellsby & Pexmen, 2014, p. 1). Kiefer and Trumpp (2012) argue that there are close links between the sensory and motor brain systems and cognition, and explain that "Cognition and thinking is critically based on a reinstatement of external (perception) and internal states (proprioception, emotion and introspection) as well as bodily actions that produce simulations of previous experiences" (p. 16). Wellsby and Paxman (2014) explain that higher order and offline cognitive processing that is removed from the site of learning "involves re-enactment of the bodily states from the previous experience" (p. 1). Past learning events are stored in episodic memory and when recalled the sensorimotor experiences are activated with the associated abstract-symbolic knowledge (Ionescu & Vasc, 2014). Studies of word learning indicate that the recall of abstract-symbolic knowledge is enhanced where there are associated sensorimotor experiences (Engelkamp & Jahn, 2003).

Our representations of phenomena are multimodal and are grounded in the sensorimotor modalities of the brain and in our actions (Barsalou, 2008). There is an established history of grounding science learning in sensorimotor activity as students engage in forms of inquiry through experiencing phenomena and manipulating objects, representing and communicating ideas through gesture and inscription, and modelling processes through role-play (Ibrahim-Didi, Hackling, Ramseger & Sherriff, 2017). Prior research shows that highly accomplished teachers of primary science orchestrate a variety of experiences into learning sequences that combine sets of complementary modalities that offer rich semiotic potential for meaning making and learning (Hackling, Murcia & Ibrahim-Didi, 2013). Tytler and his colleagues (2017) argue that this generation and coordination of multiple representations of different modalities is key to knowledge building and this paper explores how accomplished teachers maximise the semiotic potential of sensorimotor experiences to ground conceptual learning.

Purpose

The purpose of this study was to analyse learning sequences captured on classroom video in the international EQUALPRIME project (Hackling, Ramseger & Chen, 2017) to investigate how accomplished teachers enable students to re-enact bodily states, have new bodily experiences and re-represent these experiences into other modalities for the development of force concepts.

METHOD

Participants of the case study were two accomplished teachers of primary science who co-taught a unit on forces to a Grade 4 class of Australian students. Classroom video was the primary data source supplemented with teacher interview data. Video data were captured for the teaching of an entire unit of work on forces and teachers were interviewed before and after the unit and individual lessons. The video was viewed in its entirety to identify episodes where bodily experiences of forces were utilised to support conceptual learning. These episodes were repeatedly viewed with and without sound so that embodied modalities could be analysed and related to other modalities in play. Individual episodes were mapped and connected across learning sequences to see how the teachers drew on sensorimotor experiences, other representational modalities and re-representation to ground conceptual development.

RESULTS

In the second of a sequence of nine lessons, Ms Young and Ms Peters used a range of embodied experiences which were transformed and coordinated with other representational modalities in teaching about forces and momentum to their Grade 4 students. Students were initially engaged in physically reviewing pushing and pulling before running then walking down a steep incline and attempting to abruptly stop. These bodily experiences were re-represented as verbal descriptions of the felt experiences scaffolded by questions such as “How did you feel when…?”. Further investigations of rolling cans of tomatoes, and by hand, applying a force to stop them from rolling, provided a different perspective of applying a force to halt the movement of an object in motion. Transformation of these experiences into verbal representations and then into arrow-based graphical representations extended the range of representational forms students could access to ‘grasp’ the phenomena of force and ground an emerging sense of momentum. Students’ re-enactment of prior bodily experiences of braking hard when riding a bicycle in a fully embodied manner which included squeezing the brakes, lurching forwards, facial grimaces and grunting re-activated and represented prior experiences that were connected to notions of speed of travel affecting the forces required to arrest motion. Additional re-enactment of stopping the movement of light and heavy objects were connected through discussion, to speed of travel and to a formalised statement about the contributions of mass and speed to momentum presented on a PowerPoint slide. Following lessons engaged students in other re-enactments of bodily experiences such as pushing a loaded shopping trolley up a slope and new bodily experiences of magnetic forces that would further elaborate the experiential grounding for developing meaning for the concept of force and notions of contact forces and forces that act at a distance.

DISCUSSION AND CONCLUSIONS

Ms Young and Ms Peters engaged students in re-enacting past bodily experiences and enacting new experiences so that the feeling of forces and momentum could provide a grounding for the formalisation of conceptual understandings through various transformations and re-representations into descriptions and definitions using teacher-led and whole class teaching. Rich opportunities were provided for students to encode new sensorimotor experiences into episodic memory and prior bodily experiences were activated and re-enacted to extend the range of experiences that could be related to and connected with other representations. Transformation of sensorimotor experiences into other representational forms provides opportunity to establish abstract-symbolic models in semantic memory. From a Piercian semiotics perspective and concepts of transmediation (Siegel, 1995), it would be expected that these acts of re-representation would be generative and enrich the meanings constructed by the students. The creation of an extensive range of associations between the numerous representational forms would enrich the students' emerging force-momentum schema and provide many anchor points that would enable students to recall and transfer learning in the future.

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