Chapter 1

Developing a Research-Informed Teaching Module for Learning About Electrical Circuits at Lower Secondary School Level:

Supporting Personal Learning about Science and the Nature of Science

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ABSTRACT

This chapter discusses the design and development of a teaching module on electrical circuits for lower secondary students (11-14 year olds) studying in the context of the English National Curriculum. The module was developed as part of a project: "Effecting Principled Improvement in STEM Education" (epiSTEMe). The electricity module was designed according to general principles adopted across epiS

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TEMe, drawing upon research and recommendations of good practice offered in curriculum guidance and the advice offered by classroom practitioners who tested out activities in their own classrooms. The module design was informed by the constructivist perspective that each individual has to construct their own personal knowledge and so rejects notions that teaching can be understood as transfer of knowledge from a teacher or text to learners. However, the version of constructivism adopted acknowledged the central importance of social mediation of learning, both in terms of the role of a more experienced other (such as a teacher) in channeling and scaffolding the learning of students and the potential for peer mediation of learning through dialogue that requires learners to engage with enquiry processes and interrogate and critique their own understanding.

BACKGROUND

Introduction

This chapter describes the development of a research-informed teaching module on electrical circuits for early secondary level (in particular aimed at 11-12 year olds) developed as part of the project 'Effecting Principled Improvement in STEM Education' (epiSTEMe). The principles informing the design of the module will be discussed, and the way those principles were applied in module development will be explored. Three levels of context for appreciating module development will be provided relating to issues of (i) research into student thinking and learning in the topic, (ii) the context of the epiSTEMe project more generally, and (iii) the wider curriculum context in which the work took place.

Student Thinking and Learning About Electrical Circuits

There is an extensive body of research exploring student learning and thinking in various science topics (Duit, 2009; Taber, 2009), including electricity and electric circuits (Driver, Squires, Rushworth, & Wood-Robinson, 1994; Shipstone et al., 1988). Learning difficulties relating to the topic of electrical circuits are well established, and these are found across the secondary age range. A common problem concerns students not appreciating how current will be constant around a series circuit. A naive view would be that this could be countered by demonstration: simply showing learners a series circuit and measuring the current at various points. A somewhat more informed view – informed by research into science learning (considered below) – might suggest that something more than this is needed: to first help learners make explicit their intuitive ideas about what would happen in the circuit, and then counter these by providing the evidence that their intuitions do not match what actually happens. This might be expected to lead to cognitive dissonance, and so motivate learning to make sense of the discrepant observations (Driver & Oldham, 1986).

This approach is commonly recommended because human beings generally manage to perceive the world as fitting expectations (finding matches between what is sensed and existing implicit knowledge elements such that perception is biased to fit existing cognitive structures) - what is sometimes known as confirmation bias (Nickerson, 1998). Driver noted how students put in open-ended discovery learning situations with minimal 'scaffolding' from teaching tended to fail to spot the patterns that it was hoped they would find salient and seldom 'discover' the scientific principles hoped for (Driver, 1983). Much

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