

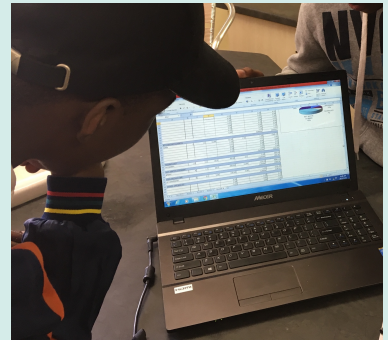
EXPLORING ENERGY AUDITS THROUGH OPEN ENQUIRIES IN PHYSICAL SCIENCE CLASSROOMS

Working with the Centre for Renewable and Sustainable Energy Studies, Therese Lambrechts developed learning materials to explore the topic of renewable energy in Physical Science classrooms. Early research on the material showed that it supported the development of factual and conceptual knowledge. The material was subsequently adapted to provide opportunities for learner-led inquiry work in the teaching of the energy audit topic in the Grade 11 Physical Science curriculum. For this topic, learners were required to engage with open-ended, problem-solving activities. These inquiry activities became the focus of the research with an interest in whether conceptual development and gained knowledge could be strengthened through open-ended problem-solving activities.

The learning material was workshopped with three individual teachers, followed by data generation from classroom observations, teacher accounts, focus group discussions and learners' work. Edward's task sequencing framework was then used to analyse whether the learning material scaffolded conceptual development that enabled learners to internalize and apply key concepts and 'ways of inquiring' (see Edwards'-inspired analytic tool below).

Quadrant 4 Students display their understanding and knowledge through summative assessment		Quadrant 1 Knowledge is displayed by the teacher or more expert learners as they model and instruct key concepts.	
<ul style="list-style-type: none"> • What are the learners doing? Complete the summative assessment task • Master the tool of uncertainty. 	What are the Teachers / Expert learners doing? <ul style="list-style-type: none"> • Summative assessment of learning • Give grades for the display of new found understandings. • Jumping point for new cycle. 	What are the learners doing? <ul style="list-style-type: none"> • Learners engage through meaning making. • Respond to teacher's questions 	What are the Teachers / Expert learners doing? <ul style="list-style-type: none"> • Introduce key concepts and revisit what is already known. • Help learner recognise knowledge gaps • Imitation(Vygotsky) • Demonstrate knowledge • Diagnose the interpretation by the learners • Introduce learners to new concepts • Courteous conversation leading learners to subject-specific knowledge mastery.
Quadrant 3 More open tasks which enable learners to apply key concepts and ways of enquiring. Task may be phrased as an open-ended question for learners to research		Quadrant 2 Tightly structured tasks which demand engagement with key concepts (substantive knowledge) and ways of enquiring (syntactic knowledge)	
What are the learners doing? <ul style="list-style-type: none"> • Open-ended, problem solving activities. • They take control of the knowledge they have just grasped and use it to solve problems. • Students show agency 	What are the Teachers / Expert learners doing? <ul style="list-style-type: none"> • Require high levels of teacher subject knowledge. • Knowledgeable resources responding to students questions. Only intervening if learners are experiencing real difficulty. 	What are the learners doing? <ul style="list-style-type: none"> • Students show thinking skills and respond to task demands, taking control and exploring what they can do. • Students scope the tasks, allocate time, and identify needed resources. • Students self-assess against criteria – referring to knowledge and strategies used. 	What are the Teachers / Expert learners doing? <ul style="list-style-type: none"> • Learners starting to make the connections between already known and new knowledge. • Individual, paired or grouped tasks are given. • Teacher giving actively formative feedback on use of knowledge and organization of learning.

Edwards' task sequencing helps us to develop an understanding that in quadrant 2 and quadrant 3, emphasis is on developing learners within their ZPD. Semiotic mediation takes place by the use of different mediation tools, for example language or readings. These are safe places, where mistakes can be made, misunderstandings revealed and risks taken. This is where learners acquire and use substantive and syntactic knowledge, internalise and externalise. Here, learners develop higher order thinking skills, taking control of their own learning through tasks given by the teacher. A Q3 learning activity was defined as a more open, problem solving activity where teachers show high levels of subject knowledge and intervene only when learners experience real difficulty and where learners take control of existing knowledge and use it to solve problems (Edwards, 2014).



In Case 1, the teacher conveyed the learning topic as a tightly structured Q2 task (Edwards, 2014) and the learners responded to the task demands by taking control and exploring what they could do. In Case 2, the teacher used it as a more open-ended Q3 task which enabled learners to apply key concepts and ways of enquiring (Edwards, 2014). The teacher responded knowledgeably to student's questions and only intervened when the learners (led by one of the more knowledgeable learners) were experiencing real difficulty. This resulted in the learners taking control and showing skills in performing the audit. In Case 3, there was little involvement from the teacher and not enough knowledge in the group to take control of the task demands (Edwards, 2014), therefore the required learning and development could not take place.

The audit itself proved to mediate learning mostly defined by Q2 and Q3 in the learning task sequence. From the presentations of the learners in Cases 1 and 2, it was clear that the learners understood how their energy use patterns influence the amount paid for electricity by the school, as well as the influence that energy use has on the environment. The solutions they gave to counteract the energy use were all feasible.

It was concluded that the energy audit learning task had the potential to achieve the goal of open-ended learner-led inquiry. The success of the activity appears to have been supported through mediation by the teacher across 3 quadrants (as in Case 1). In Case 2, the success of the activity appears to have been supported through mediation of the concepts and the problem-solving capacity of knowledgeable learners working pro-actively with the teacher – who had withdrawn from active mediation of the activity and who played more of a support role in Quadrant 3. The difficulties arise when there is no pro-active knowledgeable teacher or more expert learner to mediate in Quadrant 3 (as illustrated by Case 3).

The study recommends that, for successful open enquiries and agency in Q3, materials need activities to ensure that concepts are scaffolded through various process of mediation and opportunities for externalisation and internalization. This is achieved through teachers sharing knowledge (Q1) and through tightly structured tasks (Q2). Activities must also create the opportunity for learners to show that they have taken control of the knowledge and can use it to solve more open-ended problems. Teachers mediating the process need to be aware that support from a more knowledgeable person is still needed in Q3. They can therefore not withdraw their support, but need to be prepared to intervene if learners are experiencing real difficulty.

REFERENCE

Edwards, A. (2014) Designing Tasks which Engage Learners with Knowledge, in I. Thompson (Ed) Task Design, Subject Pedagogy and Student Engagement. London: Routledge