
Title	Elementary science teachers' beliefs and enactment of assessment during inquiry-based lesson
Author(s)	Poh Hiang Tan
Source	<i>11th European Science Education Research Association (ESERA) Summer School, Bad Honnef, Germany, 22 - 27 July 2012</i>

This document may be used for private study or research purpose only. This document or any part of it may not be duplicated and/or distributed without permission of the copyright owner.

The Singapore Copyright Act applies to the use of this document.

Elementary science teachers' beliefs and enactment of assessment during inquiry-based lesson

Poh Hiang TAN, Nanyang Technological University (Singapore),

Supervisors: Dr Aik Ling TAN and Dr Benny YUNG

Introduction

Assessment plays a central role in education and constitutes an important aspect in the professional practice of teachers. However, in her review of nine models of pedagogical content knowledge (PCK), (Kind, 2009) found that only two models include assessment as part of PCK. In fact, in the model proposed by Shulman (1987) from which the term PCK originated, assessment was noticeably missing. This lack of attention to assessment issues indicates a gap in our knowledge of teachers' understanding and ideas about assessment and their assessment literacies.

In their seminal paper on classroom assessment, (Black & Wiliam, 1998) concluded that assessment, or more specifically formative assessment, when used appropriately, increases students' motivation and improve students' achievement. Formative assessment is described as any activity that provides information about students' learning for both teacher and students themselves so that instructions can be adapted to meet learning needs. As a result of the promises that formative assessment holds for improving classroom learning, many research studies delve into examining effective generic classroom strategies for teachers and neglect the disciplinary components of formative assessment practices (Coffey, Hammer, Levin, & Grant, 2011).

This study aims to address the two issues of (1) teachers' understanding of formative assessment and (2) practices and issues of formative assessment in the discipline of science, particularly in science as inquiry. The research questions that guide this study are informed by Tobin and McRobbie (1995) framework of "thinking about" and "enacting" assessment. The research questions for the "thinking about" component are:

- What are primary science teachers' conceptualisations of science learning?
- What are primary science teachers' conceptualisations of science as inquiry?
- What are primary school teachers' conceptualisations of assessment of students' understanding of science?

As for the "enact" component, the sub-questions studied are:

- How do primary science teachers enact science as inquiry?
- How do primary science teachers help their students develop understanding through formative assessment of their learning?

Theoretical Background

This study adopts a sociocultural perspective of learning (Vygotsky, 1978). Learning is viewed as mediated by resources and interaction with knowledgeable others. The resources here refer to the language of communication, the kinds of materials used for hands-on activities and the textual resources in the form of worksheets and textbooks. The interaction here includes the repertoire of questions raised in the classrooms and the types and frequencies of feedback given. The notion of learning science through inquiry is also informed by sociocultural theory which views learning as a social activity and teaching as managing of ideas and interaction between learners (Duschl, 2008).

Literature Review

A search through the EBSCOhost database revealed few relevant articles that examine formative assessment during science inquiry-based lessons. Google scholar revealed an article by Harlen, Brand and Brown (2003) and a book search reveals a guide book on formative assessment for elementary and middle school teachers using the 5E instructional model developed by BSCS. The absence of current and compelling research in teachers' understanding of formative assessment practices in science as inquiry classrooms is indicative of a need to examine the three aspects of teachers' understanding, formative assessment, and science as inquiry collectively as one entity. As such, this literature review will examine formative assessment, science learning and inquiry separately before drawing links to the three aspects since earlier studies have indicated the strong influence teachers' beliefs have over their classroom practices (Brown, 2004; Tobin & McRobbie, 1996).

Formative assessment

Over the past decade there were many studies on formative assessment which focused on strategies used in formative assessment. Recent studies have continued with this trend, focussing on strategies such as questioning, feedback, clarity in criteria (Cooper & Cowie, 2010) or teachers' formative assessment practices (Buck, Trauth-Nare, & Kaftan, 2010). However, Coffey, Hammer, Levin and Grant (2010) issued a timely reminder that research into formative assessment practices need to give attention to the disciplinary substance of the assessment.

The concern raised by Coffey et al (2010) resonates with Pellegrino, Chudowsky and Glaser (2002) when they maintained that interpretation constitutes an important component in any assessment activity. Mislevy (2006) added that assessment is a process of evidentiary reasoning from what students do, respond or act in a particular circumstances to inferences about what they know, can do or attain. This definition, however, seems to indicate a more traditional view about assessment as something 'teachers do the students' with little attention on students' involvement and actions taken so to 'form' or shape students' learning.

William and Thompson (2007) thus developed a framework for examining formative assessment practice in the classroom. Instead of focusing on activities of questioning or feedback, the framework drew on the three key processes in classroom teaching and learning, namely establishing (1) the current location of the learners in their learning, (2) the goals, and (3) what needs to be done for the learners to achieve the goals. In current views on teaching and learning, the responsibility of the three processes does not lie with the teacher alone but is a collaborative effort among three parties – the teacher, the learners themselves and their peers. This framework seeks to move assessment towards one that is “instructionally oriented” (Popham, 2008) or promotes a “learning culture” (Shepard, 2000).

Science learning and inquiry

According to the National Science Education Standards (NRC, 1996, page 2), “inquiry is central to science learning.” Learning science is viewed as an active process that emphasizes students’ involvement in inquiry-oriented investigations which provide opportunities for students to interact with their teachers and peers. In the same document, it identifies the five essential features of inquiry – engage in scientifically oriented questions, prioritise evidence, formulate explanation, evaluating explanations and communicating explanations (NRC, 1996). Harlen, et al (2003) viewed these features within inquiry as opportunities for students to explore their ideas as well as those of their peers and also to communicate their ideas to others including their teacher. Through this, she saw a strong link between formative assessment and inquiry. Such development of students’ ideas has its basis in the socio-constructivist learning theory (Mortimer & Scott, 2003; Wells, 2000; Vygotsky, 1978)

Teachers’ beliefs

The success of any educational reforms depends on the teacher in the classroom. A recent study by Lefstein (2008) has shown that teachers’ enactment of new reforms may not always be consistent with the intent and the expectations of the reforms, thus limiting the success of educational reform efforts.

According to Nespor (1987), the ways classroom activities are conceptualised depend very much on teachers’ beliefs. Remesal (2011) argued that though they could be resistant to change, beliefs could still be subjected to influence by social contexts and how these beliefs shape the teacher’s practice in the classroom is complex. To help make sense of teachers’ action and beliefs, Tobin and McRobbie (1995) proposed a framework that portrayed teachers’ action as an holistic concept which involves an interaction between their beliefs, individual goals and behaviours within the complexity of social context in the classroom. They argued that beliefs and individual goals have a strong influence over behaviours within the context of actions.

Methodology

This study adopts a mixed method paradigm and consists of two phases of data collection. Phase 1 is a preliminary study consisting of a probe in the form of questionnaire. A total of about 39 teachers from six different schools participated in the study. The probe consists of three activities assessing students' understanding in the same learning outcomes on the topic of electricity (Tomanek, Talaquer, & Novodvorsky, 2008) in which teachers explained their rationale for selecting the activities for formative assessment. The teachers' responses were analysed using open coding or InVivo Coding to honour the voices of teachers in their reasoning on their selection of activities (Saldana, 2009).

The next phase is developing case study of four grade four teachers during their lessons in a pre-determined class of students. The data collected in this phase includes documents like schemes of work, lesson plans, activity sheets, worksheets and test papers as well as classroom observations and pre- and post- observation interviews. Pre-observation interviews are conducted to understand teachers teaching and assessment plans and also to elicit teachers' views on formative assessment as well as science inquiry. The classroom activities are video and audio taped and transcripts and the field notes would be analysed. During the post-observation interviews, teachers will be shown snippets of the video to allow them to reflect on their actions and at the same time to ensure accuracy of our analysis and interpretation, i.e. this allows member check of interpretation (Lincoln & Guba, 1985).

Preliminary Findings

The responses from the teachers revealed many recurring ideas which in the preliminary analysis were categorized under four themes namely, (1) nature of task, (2) students, (3) learning outcomes, and (4) implementability. Below is a summary of the major concerns and implications:

1. Teachers drew a clear distinction between the activities used for learning and that used for assessment as they described tasks as 'enrichment' or 'reinforcement' and "not very suitable for formative assessments".
2. Teachers saw assessment with a distinct purpose for summative or formative but not serving both purposes.
3. There was a strong emphasis on matching task difficulty to abilities so that students could tackle them competently.
4. There was a strong emphasis on acquisition of knowledge and skills as spelt out in the curriculum.

While these are preliminary findings, they suggested that teachers struggled as they try to reconcile demands of formative assessment with their enactment of science as inquiry.

References

- Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation & Accountability*, 21(1), 5-31.
- Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7-71.
- Brown, G. (2004). Teachers' conceptions of assessment: Implications for policy and professional development. *Assessment in Education: Principles, Policy & Practice*, 11(3), 301-318.
- Buck, G. A., Trauth-Nare, A., & Kaftan, J. (2010). Making formative assessment discernible to pre-service teachers of science. *Journal of Research in Science Teaching*, 47(4), 402 - 421.
- Coffey, J. E., Hammer, D., Levin, D. M., & Grant, T. (2011). The missing disciplinary substance of formative assessment. *Journal of Research in Science Teaching*, 48(10), 1109-1136.
- Cooper, B., & Cowie, B. (2010). Collaborative research for assessment for learning. *Teaching and Teacher Education* 26 7.
- Duschl, R. (2008). Science Education in Three-Part Harmony: Balancing Conceptual, Epistemic, and Social Learning Goals. *Review of Research in Education*, 32(1), 268-291.
- Harlen, W., Brand, J., & Brown, R. (2003). *Enhancing inquiry through formative assessment*. San Francisco, Calif.: Exploratorium.
- Kind, V. (2009). Pedagogical content knowledge in science education: perspectives and potential for progress. *Studies in Science Education*, 45(2), 169-204.
- Lefstein, A. (2008). Changing classroom practice through the English National Literacy Strategy: A mirco-interactional perspective. *American Educational Research Journal*, 45(3), 701-737.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. California: Sage Publications, Inc.
- McRobbie, C., & Tobin, K. (1995). Restraints to reform: The congruence of teacher and student actions in a chemistry classroom. *Journal of Research in Science Teaching*, 32(4), 373 - 385.
- Mislevy, R. J. (2007). Validity by design. *Educational Researcher*, 36(8), 463-469.
- Mortimer, E. F., & Scott, P. H. (2003). *Meaning making in Secondary Science Classrooms*. Maidenhead: Open University Press.
- Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, 19(4), 317 - 328.
- Pelligrino, J. W., Chudowsky, N., & Glaser, R. (Eds.). (2001). *Knowing what students know: The science and design of educational assessment*: National Academy Press.
- Popham, W. J. (2008). Classroom assessment. In C. A. Dwyer (Ed.), *The Future of Assessment - Shaping Teaching and Learning*. New York: Taylor & Francis Group, LLC.
- Remesal, A. (2011). Primary and secondary teachers' conception of assessment: A qualitative study. *Teaching and Teacher Education*, 27(2), 472 - 482.
- Saldaña, J. (2009). *The coding manual for qualitative researchers*. Cornwall: Sage Publications Ltd.
- Shepard, L. A. (2000). The role of assessment in a learning culture. *Educational Researcher*, 29(7), 4-14.
- Tobin, K., & McRobbie, C. J. (1996). Cultural myths as constraints to the enacted science curriculum. *Science Education*, 80(2), 223-241.
- Tomanek, D., Talanquer, V., & Novodvorsky, I. (2008). What do science teachers consider when selecting formative assessment tasks? *Journal of Research in Science Teaching*, 45(10), 1113-1130.
- Vygotsky, L. S. (1978). *Mind in society the development of higher psychological processes*. Cambridge: Harvard Univ. Press.
- Wells, G. (2000). Dialogic inquiry in education: Building on the legacy of Vygotsky. In C. D. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research - Constructing meaning through collaborative inquiry* New York: Cambridge University Press.
- Wiliam, D., & Thompson, M. (2007). The future of assessment. In C. A. Dwyer (Ed.), *The Future of Assessment - Shaping Teaching and Learning* (pp. 53-82). New York: Taylor & Francis Group, LLC.