South African Journal of Education
Copyright © 2010 EASA
Vol 30:591-604

Exploring alternative assessment strategies in science classrooms

Michèle Stears and Nirmala Gopal
stearsm@ukzn.ac.za; gopal@ukzn.ac.za

The knowledge children bring to the classroom or construct in the classroom may find expression in a variety of activities and is often not measurable with the traditional assessment instruments used in science classrooms. Different approaches to assessment are required to accommodate the various ways in which learners construct knowledge in social settings. In our research we attempted to determine the types of outcomes achieved in a Grade 6 classroom where alternative strategies such as interactive assessments were implemented. Analyses of these outcomes show that the learners learned much more than the tests indicate, although what they learnt was not necessarily science. The implications for assessment are clear: strategies that assess knowledge of science concepts, as well as assessment of outcomes other than science outcomes, are required if we wish to gain a holistic understanding of the learning that occurs in science classrooms.

Keywords: alternative strategies; interactive assessment; interpretive assessment; range of outcomes; social constructivism

Introduction

Social constructivism acknowledges that the learner brings a rich source of prior knowledge to the learning situation (Kasanda, Lubben, Campbell, Kapenda, Kandjeo-Marenga, & Gaoseb, 2003). This knowledge may find expression in a variety of activities and is often not measurable with the traditional assessment instruments used in science classrooms. Pen-and-paper tests cannot adequately assess the complex competences that underpin Curriculum 2005 (DoE, 1995). While the specific outcomes of the National Curriculum Statement (NCS) (DoE,1997), the working document of C2005, were replaced by the learning outcomes of the Revised National Curriculum Statement (RNCS), (DoE, 2003) with the intention of streamlining and strengthening C2005, the critical and development outcomes remained the same. C2005, through these outcomes not only advocated the development of knowledge and skills, but also emphasised education for democracy and citizenship, including social justice. The challenge is to find ways to assess a range of outcomes that cannot be tested by measuring performance, as pen-and-paper tests form one small measure of what learners actually experience in the classroom (Veronesi, 2000).

Background to and rationale for the study

A comprehensive evaluation of the Primary Science Programme (PSP) of the Western Cape, South Africa, prompted this research. The evaluation was commissioned by the Joint Education Trust (JET) and conducted by the research centre of the University of KwaZulu-Natal. The evaluation included various aspects of teaching and learning, including assessment practices with regard to science outcomes. The research was prompted by the fact that the evaluation had shown that learners performed poorly in pen and paper tests. Classroom observations made it clear that learners had learnt more than the tests were assessing. This made us realise that we were not assessing everything the children were learning and prompted us to consider alternative assessment strategies. As ethical clearance was granted for the evaluation, permission to conduct research with regard to alternative assessment strategies in one classroom that was part of the evaluation, was required from the principal of the school and the class teacher.

The PSP works mainly in historically disadvantaged schools, where children have to learn through a language which is not their mother tongue. Most learners are isiXhosa speakers, while the language of instruction is English. All these factors create a complicated environment which impact in various ways on teaching and learning. This has implications for assessment.

Purpose of the study

It is important to distinguish between strategies to assess science outcomes and strategies to achieve non-science outcomes. The purpose of this study was therefore to find out which outcomes, other than science outcomes have been achieved when teaching science to Grade 6 learners. This may mean that there are no predetermined criteria by which learners are assessed and the assumption is that different learners achieve different outcomes. Alternative assessment strategies had to be devised to enable us to assess which non-science outcomes were achieved.

Theoretical underpinning of the study

The way in which a learner constructs reality and makes meaning is influenced by social and cultural factors as well as physical and personal ones. Making learning meaningful for learners has to take into account social and cultural environments. Vygotsky's theory of social constructivism, which views the direction of development from the social to the individual (Vygotsky, 1986) is influential in this regard. Learning does not take place in cognitive isolation, but within the context of activities and social interaction informed by the day-to-day contingencies of culture. From a social constructivist viewpoint, learning occurs best in a social environment that is mutually and actively created by the teacher and learners. A strong feature of Vygotsky's view of social constructivism is situated cognition which focuses on learning as participation in a socially constructed world (Agee, 2002; Rodriguez, 1998; Lave & Wenger, 1991). Learning is a situated activity (situated cognition) that occurs in communities of practitioners. Theories on situated cognition emerged from work that examined the relationships among learning and thought processes in particular social and cultural contexts. McCaslin and Hickey (2001) use the term socio-historic constructivism to describe the work of Vygotsky. They view learning as 'increasingly meaningful participation in knowledgeable socio-physical contexts' (McCaslin & Hickey, 2001:137). The classroom should therefore provide an environment that relates closely to the learners social and cultural world if learning is to be effective.

While individual work accommodates divergence, co-operative or collaborative learning provides opportunities for convergence expressed as group products. Although the literature (Robinson, 1990; Stevens & Slavin, 1995; Malcolm, 2005) reveals different schools of thought regarding the value of this approach in terms of enhancing learning ability, the value of co-operative learning lies in the possibility of achieving other outcomes besides conceptual development. Another advantage of co-operative learning is the fact that the teacher interacts with smaller groups and this may make it easier for them to 'listen' to their learners. Co-operative learning may well facilitate the achievement of a range of outcomes, not only outcomes related to learning science.

Towards a broader view of assessment

A substantive body of research points to the inadequacy of the traditional psychometric model of assessment as this assessment paradigm is unable to deal with the trend towards a broader purpose of assessment (Gipps, 1994). In her view, assessment has to do so much more than in the past; hence the need for a paradigm shift. Traditional assessment techniques are advantageous in measuring content related knowledge and are easy to administer and useful for policy decisions (Kelly, 2003). They are often used to improve marks, especially in poor socio-economic environments as learners are often given tests that cover small sections of the curriculum and focus on rote learning.

The problem with the psychometric paradigm is the assumption of universality. By this is meant that a test score has essentially the same meaning for all individuals. This is in contrast to social constructivism as a learning theory which assumes that the environment plays a crucial role in the way knowledge is constructed. Integrated learning theory (ILT) which is a variant of social constructivism holds that the measurement paradigm is untenable as it argues that learning takes many forms, some of which are more measurable than others. ILT argues that learning is influenced in different ways for any given individual by the complex mixture of understanding beliefs and attitudes which are the products of past learning experience (Broadfoot, 1996). This type of assessment is not designed along psychometric principles and highly standardised procedures are not appropriate. The implication is that reliability needs to be re-conceptualised in terms of quality assurance (Gipps, 1994). Proponents of alternative assessments practices claim that these assessments take place in more authentic contexts, use a wider range of assessment tasks and assess a wider range of outcomes.

The Revised National Curriculum Statement (RNCS) (DoE, 2003) defines assessment as "a process of gathering information about learners and is measured against assessment standards". Assessment standards describe the various levels at which the learning outcomes may be achieved. They describe what learners should know and be able to do — they provide criteria against which learners are assessed in each particular subject. They serve to provide a standard by which all learners are assessed and in this way assessment is judged to be valid as it demonstrates the actual competence of the learner. While this policy is advanced in its criterion-referenced approach, as opposed to a norm-referenced approach, and proposes that a range of assessment strategies other than written examinations should be implemented it still only focuses on science outcomes (and critical outcomes through science outcomes) and ignores the possibility of other outcomes that may be achieved.

Research in science education that promotes the humanistic and cultural aspects of science and technology education claim that a variety of research instruments exist with which to assess students' acquisition of humanistic and cultural content taught in science and technology courses (Aikenhead, 2004). Such instruments may assess improved understanding of social issues, improved attitude towards science and learning, modest gains in thinking skills such as application of formal science to everyday events, critical and creative thinking and decision making, as well as improved socially responsible actions. All of these improvements are of course dependent on the chosen content, as well as the pedagogical approach, but what is important is that assessment strategies that are able to assess these competencies are available (Aikenhead, 2004). Without this option, assessment strategies to assess science outcomes often suggest that little learning occurs in environments that are socially and financially deprived (*Ibid.*). The purpose is therefore to determine if any learning occurs in such settings by applying alternative or non-conventional assessment strategies.

Research has shown that very few science teachers assess outcomes such as self-confidence, social skills or language as they are not regarded as science outcomes (Malcolm, 2005). Consequently assessment strategies that assess such outcomes are rarely used. Sato and Atkin (2007) point to practices where teachers use strategies to assess concepts and skills as well as effort, creativity and a number of additional affective outcomes. They acknowledge that traditional assessment does not assess aspects such as motivation, participation and commitment, strengthening the beliefs that alternative assessment strategies are essential. Research conducted by Monk and Olufunmilayo (2002) which focused on the design of instruments to gauge learners' participation, enjoyment and learning in science, supports this view.

Fensham (2004) suggests that there are outcomes that learners may achieve in science classrooms that are as important and, in fact, necessary, to achieve science knowledge outcomes in the longer term. There is increasing evidence that the assessment strategies used do not necessarily reflect what learners learn in science classrooms. Science educators should take cognisance of the fact that there may be other personal and social outcomes that need to be met in assessing what learners know, in order to enable learners to benefit from schooling. Alternative assessment strategies allow learners to demonstrate outcomes in different ways like drawing or writing, observing and communicating. While some of these outcomes are not science outcomes, they should be assessed as separate in their own right as developmental or critical outcomes and not linked to science learning as such (McMillan, Myran & Workman, 2001). Such outcomes are best assessed through a variety of strategies.

Cowie and Bell (1999) report on such a strategy described as interactive assessment. Interactive assessment involves the teacher noticing, recognising and responding. It may be implemented when no specific assessment activity is planned. This type of assessment hinges on learner-teacher interactions and allows assessment of a wider range of learning outcomes than specific science outcomes. It allows the teacher to gain ephemeral information that is of a verbal nature (comments and questions) and non-verbal (body language) interactions with others. This is called noticing as part of assessment. The teacher will notice different information from different learners at different times. This information may be connected to science, but is also related to social and personal development. An interactive teaching approach provides the challenge of what and when to assess and keeps the process manageable (Zeegers, 1996).

Such alternative assessment practices, which are essentially contextual assessment, raises issues of validity and reliability (Klassen, 2006).The fact is that conventional assessment and alternative assessment practices represent two different paradigms. Conventional assessment strategies are useful when assessment criteria are clearly defined and the results of such assessments are highly valued. As such assessment is mostly objective, it does not require intimate knowledge of the learner. In contextual assessment it is an advantage that the person who assesses, knows the learners well in order to make a better judgement. Without such knowledge teachers will not be able to assess the kinds of outcomes described by Cowie and Bell (1999). Contextual assessment strategies can only be valid if the assessor knows the learners well and this is the only way to judge the evidence as trustworthy. Reliability is a more complex issue as the outcomes assessed may differ under different circumstances, producing different results at different times. Unfortunately, the value departments of education, learners and the general public attach to marks do not bode well for an approach where learners are assessed by interpreting their actions, attitudes and emotions (Donald, Lazarus & Lolwana, 2002).

Methodology

The study is framed by a qualitative methodology. The method of generating data was essentially participative as the learners provided input with regard to what was learnt by suggesting topics for a unit that was taught by the researcher. The decision was taken that the researcher would act as the teacher as she had worked with the learners in designing the unit. Her position in the classroom as teacher and researcher raised a number of issues. It raised the need to consider her position and actions in the classroom, as well as the need to interpret what happens in the class in a broader personal, social and political context. She had to be mindful of the fact that her imposition, as well as her teaching strategies, shaped the way the learners responded and learnt. The study lent itself to the implementation of different alternative strategies as the researcher was deeply involved in the teaching and assessment of the learners as she taught a 12-hour unit over this period. This unit was spread over 4 days where learners engaged in science activities for 3 hours each day. While data were collected during this period, the researcher knew the learners from previous contact and also relied on the class teacher to provide further information as well as act as interpreter when necessary. The class was a Grade 6 class of 45 learners who all live in a township on the Cape Flats; some in the established part of the township and others in informal settlements in the township.

Although the topic selected by the learners was fire, it was used to design activities related to knowledge strands from the Natural Science Learning Area ie Energy and Change and Life and Living. The unit was divided into three sections: Veld fires, Fire in our township, Fire and people. Work sheets were designed to guide the activities. Examples of activities were:

1. Veld fires: Learners gave accounts of their experiences with veld fires. These activities gave insight into the aspects of fire that were most important to different learners and what was most relevant to them with regard to fire.
2. Fire in our township: Activities covered the concept of flammability. One example was a predict-explore-confirm activity. This activity probed responses to relevance with regard to everyday knowledge. It also allowed for divergence as learners voiced their own ideas, but in the design of a house built with inflammable materials, a convergence of ideas was required.
3. One activity covered the concept of energy transformation. This activity tried to probe how learners related to formal science concepts and how they were able to link these constructs to their everyday understanding of fire.
4. In another activity causes of fires in homes were discussed, as well as the ways of putting out fires. This was linked to the scientific concepts with regard to fire, for instance what is required to make a fire burn. The purpose of this activity was to determine if these learners had any scientific explanation for the phenomena they experience all the time and if they were interested in the scientific explanations for these phenomena.

The study was based on the premise that a wide range of outcomes are achieved when learners engage in a variety of activities which allow them to participate in an interactive way. To enable the assessment of a possible range of outcomes, different types of assessment strategies were applied. These strategies were intended to include science outcomes, such as science knowledge (Learning Outcome 2) and process skills (Learning Outcome 1), critical outcomes as described in the RNCS (DoE, 2003), as well as personal outcomes. Although a pen-and-paper test was administered to determine which science outcomes had been achieved, and other assessments attempted to assess achievement of critical outcomes, the focus of this study was on personal outcomes that were possibly achieved while engaging in classroom activities.

As the assessment of possible non-science outcomes was an open-ended process, no specific assessment criteria were developed and no specific assessment tasks set for this purpose. As learners engaged in activities the focus was on outcomes that resulted from interactions and group activities. While class activities led to completion of worksheets and the written test (to assess achievement of possible science outcomes and selected critical outcomes) the data collected for this research were obtained as learners engaged in activities, communicating with each other, producing drawings, solving problems. They were observed closely as they interacted with each other and responded to the researcher/teacher during activities. The activities therefore also served as instruments of assessment. This approach was similar to the interpretive and interactive approach described by various authors (Cowie & Bell, 1999; Fensham, 2004; Sato & Atkin, 2007).

Data were collected in the following ways:

Observations: The complete unit was video-taped. Classroom observations allowed assessment of the ways in which learners engaged with the topic, how they engaged each other and how they used everyday knowledge.

The video-tape was analysed using the following categories:

- Level of participation: Groups were observed to see how many learners participated in their groups. Both talking to each other and participating in the actual activity were classified as participation.
- Verbal responses: These responses were analysed to see what learners regarded as important information.

Worksheets: Certain work sheets were designed in a way that learners could draw and write on them, sometimes writing creatively, at other times merely answering questions.

An unstructured interview schedule was used to interview groups of learners at the end of each day. The topics and activities engaged in on that particular day were brought up and learners were asked to comment on them. In this way we attempted to determine what learners thought was the most interesting and worthwhile activities they had engaged in during the course of the lessons.

The study has its limitations in that data were collected from one class of learners over a relatively short period of time. Nevertheless, the fact that the research covered a complete unit lends more credibility to the study as the learners were observed in different situations. Trustworthiness was enhanced by obtaining data at different times as well as through three different methods. The findings cannot be transferred to other contexts as the research is about learners in a particular environment at a particular time. It is not the intention of the study to generalise the findings, however, it may serve to alert educationists to similar problems with regard to assessment in contexts such as the one described here.

Findings and discussion

While the pen-and-paper test showed that a significant number of learners had shown little progress in achieving Learning Outcome 2 (construction of science knowledge), the classroom activities focused on a broader range of outcomes. As learners' responses to various dimensions of science learning are interconnected in various ways and not always distinguishable as separate entities, assessment is a complex process. Nevertheless, intensive observation of learners as they engaged in various activities made it possible to determine which outcomes had been achieved. Analysis of the video-footage and their worksheets, as well as interviews allowed us to identify a number of themes that demonstrated what learning was occurring that may be difficult to assess by conventional means. As social constructivism, and by extension, situated cognition implies that learning is mediated by the learner's social environment and best occurs during interaction between participants, this was used as a lens through which to analyse the data.

Critical Outcomes

While conventional assessment strategies allow for the assessment of critical outcomes to some extent, for example problem solving, learners were assessed for the achievement of these outcomes by other means. Interactive (obse-rvation of learner-learner and learner-teacher interactions) and interpretive assessment (analysis of drawings and stories) allowed us to determine whether the critical outcomes above were achieved. However, it is not within the scope of this paper to report on how the critical outcomes were achieved as this is reported elsewhere (Stears, 2005). Instead the findings will focus on outcomes that were neither pre-determined, nor foreseen. As the activities that learners engaged in are described, evidence of outcomes achieved are mentioned.

Social and Personal Outcomes

The ability to apply everyday knowledge

Learners were able to share their everyday knowledge with other learners in the classroom. For example they could use their knowledge to compare flammability, and also explain how to help people whose clothes were on fire. As many of these learners do not usually contribute much, the ability to contribute had a positive effect on these learners. When formal science concepts are taught many of these learners show little interest, but when learning is linked to their everyday experiences the levels of participation are much higher.

While some learners achieved science outcomes, all learners contributed to the discussion, using their everyday knowledge. The importance of linking their learning to everyday knowledge is that it provides learners with the science they can use in their everyday lives and enable them to build on their experiences, interests and prior knowledge (Stears *et al.*, 2003). Duschl and Hamilton (1998) support Vygotsky's view that mental functioning (science learning) can only be understood by examining the social and cultural processes from which it is derived.

When covering the concept of air as a requirement for a fire to burn, learners were shown a picture of woman with her dress on fire and people wrapping a blanket around her. They were then asked why the people were doing this. Learners were able to use their everyday knowledge as they knew that this action would extinguish the fire, though they were not yet familiar with the role of oxygen, but their everyday knowledge could serve as scaffolding to possibly acquire more advanced science knowledge in the future.

Participation and building relationships

In the design of this lesson series, the purpose of science education was carefully considered as it was the intention to strike a balance between 'learning science' and 'learning through science'. It would, however, seem that there are more complex issues involved that influence science learning and that the nature of the everyday environment has a strong influence in determining whether learning will occur, as well as deciding what is worth learning. The lack of adult involvement, which provides very little opportunity to imitate a more competent person, and the absence of collaborative learning place a limit on the development of the potential of the child as very little mediation occurs in the home environment of these children. The school environment becomes the focus of social interaction informed by a common culture. From a social constructivist viewpoint, the school context is a more appropriate environment for learning to occur as it creates the context for situated cognition — where situated cognition focuses on learning as participation in a socially constructed world (Agee, 2002; Rodriguez, 1998; Lave & Wenger, 1991). It is this environment and the learners' sense of being part of a community of practice that may provide the foundation for further learning. If the child does not learn to do through collaboration today, she will not be able to do it independently (Vygotsky, 1986).

Increased levels of participation were observed in the class activities. Analysis of the video-tapes allowed us to record levels of participation in groups and individual learners. For example the activities to show oxygen is necessary for combustion and a second one on flammability showed intense participation by all learners. Many learners participated more in group activities than in individual activities, while others tended to participate less in a group situation. It was not possible, though, to quantify how each learner responded to each dimension of participation. Levels of participation were very high during lessons where learners demonstrated practical knowledge that helped them in day-to-day survival, knowledge of cultural practices that learners value and the fact that shared knowledge in a community of learners brings personal aspects such as relationships to the fore. The importance of participation lies in the fact that when learners work together, they socialise, strengthen social groupings, support each other and in so doing, build confidence. They took comfort in sharing experiences such as the one below, which was prompted by a discussion of fuels used to start a fire. Instead of focusing on the science of fuels, they focused on the effect on their personal lives:

> *My next door neighbour has six small children. One hot summer day she was busy cooking with a gas stove, she left the house for a few minutes to go fetch some water in the river nearby because there wasn't enough water in the house. The children then noticed that there was a bottle of 'water' which was on the table they then took the bottle of water and pour the water into the stove and the stove blew up. The children quickly ran off the house, but there was a small baby who was lying on the floor …*

As they strengthen social relationships, effective learning may be influenced by more capable others, in the learners' immediate environment. Strong social bonds enhance learning within a situated activity (Lave & Wenger, 1991).

Increased self-confidence

By contributing their practical knowledge in class discussions, learners were affirmed. Their self confidence increased, leading to even greater participation. Interviews with learners confirmed this. Interviews revealed that although learners valued their everyday knowledge, a number of learners were interested in learning more about natural phenomena that were unfamiliar to them. When learners move beyond everyday knowledge and wish to broaden their knowledge base, it is evidence of their increasing self-confidence and their need for individual growth and satisfaction (Fensham, 1988) when learning science. They were asking questions such as:

> *What are tornadoes?*
> *We want to learn about planets*
> *How can fire from a volcano flow like a river?*
> *How do floods happen?*
> *How do you get snow at Christmas*?

Increased enthusiasm as a result of the inclusion of cultural knowledge

The learners who were participants were from a non-western culture, although they are taught science from a western perspective. The socio-cultural background of these learners shapes their worldview and causes them to hold different views of science as well. Learners' drawings and the interviews revealed their intense interest in cultural aspects. While the science classroom does not usually address cultural aspects and specifically alternative explanations for phenomena, the fact that this topic was raised in the science classroom contributed to learners' confidence to express alternative beliefs and raised levels of interest. Their traditional culture is very much part of their social and personal experiences as one learner's account demonstrates:

> *My mother told me a story about* 'uvutha'. *She said that if you want* 'uvutha' *you must go to* 'ugqigha' (*herbalist*) *and tell him that you want*

> 'uvutha' *to be sent to someone. You will have to pay the herbalist some money to cast* 'uvutha' *onto another person. What happens is that the person or his clothes ignite spontaneously.*

It may be difficult for these learners to demonstrate understanding of concepts learnt at school while not believing them if they are in conflict with beliefs held in 'out of school' science. It is generally accepted that culture, as a contextual lens through which people view and understand the world has direct influences on their cognitive processes and understanding of science (Gao, 1998). Their word view may also cause them to place less value on what is being taught in the science class. Culture has an influence on the learning of science and learning results from the organic interaction among the personal orientations of a learner, the subculture of a student's family, peers, community, tribe, school and media, the culture of his or her country or nation and the subculture of science and school science (Cobern & Aikenhead, 1998). There is evidence that involvement of socio-cultural views about science concepts in science instruction develop positive attitudes towards the study of science (Baker & Taylor, 1995). The fact that these learners were given the opportunity to bring their cultural beliefs into the science classroom increased the enthusiasm of some learners that the class teacher thought were normally not involved at all. Including cultural beliefs in the science class could possibly reduce the feeling of alienation in many learners.

Conclusion

While many learners are able to process concepts in such a way that it enables them to build new conceptual knowledge on existing knowledge (as the written pen-and-paper tests revealed) a number of learners in this context were not able to process new knowledge in a way that allowed them to build on existing knowledge. The learning experiences of these learners may not have the purpose of developing a scientific view, but towards some other purpose. By meeting different needs, outcomes other than knowledge outcomes were achieved. These outcomes are interlinked and difficult to assess. An interpretive approach, where actions and interactions were closely observed as well as conversations with learners were conducted, provided a means of understanding which of these outcomes had been achieved. This study made use of interpretive and interactive approaches to find out what outcomes were achieved besides science learning outcomes.

As learners built confidence in an atmosphere where their everyday knowledge was appreciated and their interests were addressed, they were affirmed. This affirmation and nurturing shaped the climate of the classroom, providing new learning possibilities. The particular topic covered in the lessons addressed the social and personal aspects of learners' lives, especially the practical aspects of survival. The factors that influence their lives impact on their interests and thus provide a framework for deciding what is worth learning. This explained their lack of interest in explaining scientific phenomena. They wanted their needs expressed in the classroom and wanted to engage in activities that addressed their survival in their communities.

The implications for assessment are clear: strategies that assess more than learners' knowledge of science concepts are required if we wish to gain a holistic understanding of the learning that occurs in science classrooms. While many science educators may raise concerns that the achievement of science outcomes are the aim of science teaching, the argument raised here is that learners who live in physically, socially and emotionally deprived environments, as mentioned in this study, need to achieve these outcomes first, creating a possible foundation for the achievement of science outcomes at a later stage (Fensham, 2004).

References

Agee J 2002. "Winks upon winks": Multiple lenses on settings in qualitative educational research. *Qualitative Studies in Education*, 15:569-585.

Aikenhead G 2004. The humanistic and cultural aspects of science & technology education. Keynote address delivered at the *XIth International Organisation for Science and Technology Education Symposium*, July 2004, Lubland, Poland.

Baker D & Taylor PCS 1995. The effect of culture on the learning of science in non-western countries: The results of an integrated research review. *International Journal of Science Education*, 17:695-704.

Broadfoot P 1996. Liberating the learners through assessment. In: Claxton G (ed.). Liberating the learners: Lessons for Professional Development in Education. London: Routledge.

Cobern W & Aikenhead G 1998. Cultural aspects of learning science. In: Fraser B & Tobin K (eds). *International Handbook of Science Education*. Great Britain: Kluwer Academic Publishers.

Cowie B & Bell B 1999. A model of formative assessment in science education. *Assessment in Education*, l6:101-116.

Department of Education 1995. *White paper on Education and Training.* Notice 196, Parliament of the Republic of South Africa. Cape Town: Government Printer.

Department of Education 2002. *Revised National Curriculum Statement for the GET Phase*. Gazette No. 23406, Pretoria: Government Printer.

Donald D, Lazarus S & Lolwana P 2002. *Educational psychology in social context.* South Africa: Oxford.

Duschl RA & Hamilton RJ 1998. Conceptual change in science and in the learning of science. In: Fraser B & Tobin K (eds). *International Handbook of Science Education*. Great Britain: Kluwer Academic Publishers.

Fensham PJ 1988. Familiar but different: Some dilemmas and new directions in science education. In: Fensham P (ed.). *Development and Dilemmas in Science Education. Contemporary analysis in Education Series.* London: The Falmer Press.

Fensham PJ 2004. Beyond Knowledge: Other Outcome Qualities for Science Education. Keynote address delivered at the *XIth International Organisation for Science and Technology Education Symposium*, July 2004, Lublin, Poland.

Gao L 1998. Cultural context of school science teaching and learning in the Peoples' Republic of China. *Science Education*, 82:3-13. John Wiley & Sons.

Gipps CV 1994. *Beyond testing: Towards a theory of educational assessment.* London: Routledge Falmer.

Kasanda C, Lubben F, Campbell B, Kapenda H, Kandjeo-Marenga H & Gaoseb N

2003. Learner-centred teaching–The rhetoric and practice. The case of Namibia. In: Putsoa B, Dlamini M, Dlamini B & Kelly V (eds). *Proceedings, Southern African Association for Research in Mathematics, Science and Technology Education* Conference, 11th annual meeting, Mbabane, Swaziland.

Kelly V 2003. Assessment in a context-based teaching and learning approach. In: Putsoa B, Dlamini M, Dlamini B & Kelly V (eds). *Proceedings, Southern African Association for Research in Mathematics, Science and Technology Education* Conference, 11th annual meeting, Mbabane, Swaziland.

Klassen S 2006. Contextual assessment in science education: Background, issues and policy. *Science Education*, l90:820-851.

Lave J & Wenger E. 1991. *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Malcolm C 2005. *Learner-centred science education: Thoughts from South Africa*. Reprinted from Labtalk, Science Teacher's Association of Victoria, Australia.

McCaslin M & Hickey DT 2001. 'Educational psychology: Social constructivism and educational practice: A case of emergent identity. *Educational Psychologist*, 36:133-140.

McMillan J, Myran S & Workman D 2002. Elementary teachers' classroom assessment and grading practices. *Journal of Educational Research*, 95:203-223.

Monk M & Olufunmilay A 2002. A study of gender differences in learners' self and peer reports of enjoyment, learning and participation in translation activity and non-translation activity lessons. In: Malcolm C & Lubisi C (eds). *Proceedings, Southern African Association for Research in Mathematics, Science and Technology Education* conference, 10th annual meeting, Durban, South Africa.

Robinson A 1990. Co-operation or exploitation? The argument against co-operative learning. Point-counterpoint ... co-operative learning. *Journal for the Education of the gifted*, 14:9-27.

Rodriquez AJ 1998. Strategies for counter-resistance: Toward socio-transformative constructivism and learning to teach science for diversity and for understanding. *Journal of Research in Science Teaching*, 35:589-622.

Sato M & Atkin JM 2007. Supporting change in classroom assessment. *Educational leadership*, 64. Available at http://vnweb.hwwilson web.com/hww/results.

Stears M, Malcolm C & Kowlas L 2003. Using everyday knowledge in the science classroom. *African Journal of Research in Mathematics, Science and Technology Education*, 7:109-118.

Stears M 2005. The meaning of relevance in townships in Cape Town. DEd thesis. Durban: University of KwaZulu-Natal.

Stevens RJ & Slavin RE 1995. The cooperative elementary school: Effects on students' achievement, attitudes and social relations. *American Education Research Journal,* 32:321-351.

Veronesi P. 2000. Looking past the score board. *The Clearing House*, 74:27-30.

Vygotsky L 1986. *Thought and Language.* Alex Kozulin, Trans. Cambridge: The MIT Press.

Zeegers Y 1996. Rapping up assessment. *Australian Primary and Junior Science Journal*, 12:26-30.

Authors
Michèle Stears is Senior Lecturer in the School of Science, Mathematics and Technology Education at the University of KwaZulu-Natal. Her research interests include science learning, life sciences curriculum, experiential learning and teacher development.

Nirmala Gopal is Senior Lecturer in the School of Sociology and Social Studies at the University of KwaZulu-Natal. Her research interests span the disciplines of education and criminology and include school-based violence, women and violence, and curriculum issues at both basic and tertiary levels.