CHAPTER 14

Formative Assessment for Quality Environmental Learning in Natural Sciences Classrooms

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Background and context

The study that informs this chapter aimed at exploring how teachers used formative assessment strategies to support higher order thinking in environmental topics taught in Natural Sciences classrooms (Mgoqi 2019). Higher order thinking is used widely by educational curriculum developers and assessment experts to design test items that measure a variety of thinking skills (Haladyna 2004). For example, the Curriculum Assessment Policy Statement (CAPS) Natural Sciences developers have framed low, middle and high order cognitive levels for guiding classroom assessment (South Africa DBE 2011). These levels describe the way in which learners are expected to work with knowledge as follows: knowing (low order); understanding and applying (medium order); and evaluating, analysing and synthesising (high order). These cognitive levels are closely linked to Bloom's Taxonomy of Learning which Zohar and Dori (2003) used to describe higher order thinking as analysing, evaluating and creating. These latter three levels build on the lower order thinking levels of remembering, understanding and applying. These higher order thinking skills are important for environmental learning which promotes 'critical thinking, understanding complex systems, imagining future scenarios, and making decisions in a participatory and collaborative way' (Unesco 2014: 33). In this chapter, a revised Bloom's Taxonomy as proposed by Krathwohl (2002) is discussed and used as a lens to review the cognitive levels evident in the activities planned and implemented by teachers.

Black and Wiliam (1998a; 1998b) argued that formative assessment, when used properly, could raise classroom standards. According to this assertion, we consider how formative assessment can contribute to the development of higher order thinking. Wylie and Lyon (2013: 7) define formative assessment as ‘a process used by teachers and students during teaching that provides feedback to adjust ongoing teaching and learning to improve students’ achievement of intended instructional outcomes’. According to Black (1998), teaching and formative assessment are indivisible. He argued that effective teaching begins with planning activities that elicit evidence of learning; in other words, activities should be justified in terms of the learning aims that they serve. This suggests that formative assessment is important to all learning. However, Taylor (2017) argued that there is little coherence within most South African schools regarding the use of assessment to improve teaching and learning. He described the general focus as summative assessment and learner promotion, rather than formative assessment which focuses on giving learners feedback in relation to their learning.

This study combines the concepts of higher order thinking with the practice of formative assessment to create an interest in how Natural Sciences teachers use formative assessment strategies to raise classroom standards and foster higher order cognitive development of learners. Zohar and Dori (2003) suggest activities for developing higher order thinking, such as the construction of arguments; posing research questions; making comparisons; solving non-algorithmic complex problems; handling controversies; and identifying hidden assumptions. We suggest that these are useful activities to use in supporting formative assessment practices in classrooms.

The study that informs this chapter sought to answer the following question:

What are teachers’ perspectives, experiences and challenges in using formative assessment for supporting higher order thinking in the teaching of environmental curriculum content?

For the purposes of this research, the environmental topic of focus was biodiversity, which has substantial coverage in the Natural Sciences (see Mmekwa and Schudel, Chapter 3).

Theoretical framework

The Vygotskian theory of the Zone of Proximal Development (ZPD) provides useful insight into formative assessment processes (Vygotsky 1978). The ZPD is an area of dialogue and interaction for teacher-learner and learner-learner, in which the teacher can support learners by using different formative assessment techniques. The concept of scaffolding, which is related to the concept of ZPD, is also used in this study to look at *how* teachers used the teaching and learning activities and tasks to support student learning. In education, the idea of scaffolding originated from the work of Bruner who defined scaffolding as:

A process of setting up the situation to make the child's entry easy and successful and then gradually pulling back and handing the role to the child as he [sic] becomes skilled enough to manage it. (1993: 60)

Scaffolding, as a metaphor used in teaching and learning, offers the relevant description of how teachers provide successive levels of temporary support that help learners reach higher levels of comprehension and skill acquisition that they would not be able to achieve without assistance. It is a useful concept for conceptualising how formative assessment can support movement from low to medium to higher order thinking. Scaffolding can include a variety of instructional techniques used to move learners progressively towards stronger understanding and, ultimately, greater independence in the learning process or within their ZPDs. According to Larson and Marsh (2006), a teacher can create activities in the classroom to promote learning that is outside the developmental level of his/her learners and provide any necessary scaffolding (help) to broaden the development. Like physical scaffolding, the supportive strategies are incrementally removed when they are no longer needed, and the teacher gradually shifts more responsibility for the learning process to the learners.

Ten dimensions of formative assessment

One of the analytical lenses used in this study was Wylie and Lyons' (2013) 'Ten dimensions of formative assessment' which reviewed the detail of the kind of work teachers can do to support formative assessment in the ZPD. This includes: clarifying goals/learning intentions; sharing criteria for success; tasks and activities that elicit evidence of student learning; questioning strategies that elicit evidence of student learning; instituting feedback processes during questioning; descriptive feedback, peer-assessment, self-assessment and collaboration. Wylie and Lyons saw these dimensions as areas that could bring out the hidden integrations of formative practices. Hence, they argued: 'Focusing on just a single dimension likely would not result in a robust implementation of formative assessment. Rather an integrated approach is required' (Wylie & Lyon 2013: 12).

Below, brief descriptions of each dimension of formative assessment practices is presented. The descriptions highlight specific aspects of learner involvement and engagement with formative assessment across the 'ten dimensions'. In some cases, the dimension may directly focus on the learner's role in the formative assessment process (e.g. peer assessment or self-assessment). In other cases, the degree to which learners are involved may be minimal compared to the teacher's role (e.g. in the clarifying of goals and criteria of success). What is significant across all dimensions is the role of the teacher in facilitating the process in a way that enables learners to be deeply engaged at all levels and take ownership of their learning.

Dimension 1: Clarifying goals/objectives

The focus of this dimension is on the teacher's presentation of the learning goals/objectives. Teachers need to clarify the goals and write them in a language that is accessible to the learner (Wylie & Lyon 2013).

Dimension 2: Clarifying criteria for success

The focus of this dimension is on how the teacher identifies the criteria for success in a lesson and explicitly shares this with his/her learners. Formative assessment begins when teachers share achievement targets with learners, presenting those expectations in learner-friendly language accompanied by exemplary learners' work (Stiggins 2007).

Dimension 3: Tasks and activities that elicit evidence of student learning

This dimension focuses on the activities or tasks that the learners are engaged in, excluding classroom discussions. Here the learners need to show that they have learnt something through being engaged in those activities or tasks (Wylie & Lyon 2013: 33). Teachers' teaching and learning activities and tasks should match the intended learning target both in terms of what the students learn (content) and what they can do with the learning (cognitive complexity).

Dimension 4: Questioning strategies that elicit evidence of student learning

The focus here is, first, on the key questions the teacher plans to ask the learners and, second, on how the teacher orchestrates classroom discussion in order to collect evidence of learning. The questions should be those that will encourage learners to use cognitive processes or dispositions. Questions that require learners to respond with complex answers, such as asking them to explain their answers, can be a better view into learners' thinking and their ability to move forward to solve subsequent problems. Responses to such questions could also provide evidence of metacognition and can help teachers to elicit evidence of student learning (Erickson 2007). Setting and asking these questions is not enough. It is only through paying careful attention to students' responses and allowing them to ask their questions in relation to what they are engaged with, that the teacher can collect evidence of learning (Wylie & Lyon 2013).

Dimension 5: Feedback loops during questioning

This dimension focuses on the teacher providing ongoing feedback that will help learners to develop science ideas and content. The formative assessment dimension of the feedback process informs both teacher and learners about learner understanding and what can be done to increase knowledge. However, assessment is formative only if both teacher and learner do something with the feedback to facilitate 'shifting' forward

the learner's understanding within the ZPD so that new challenging activities can be presented that draw on the child's previous experience. Feedback can be used in closing the gap between current learning and intended learning (Wylie & Lyon 2013).

Dimension 6: Individualised descriptive feedback (written or oral)

This dimension focuses on the teacher as the provider of feedback. This feedback should be in relation to the intended outcomes and the criteria for success. Learners, in return, need to attend and respond to the feedback (Wylie & Lyon 2013).

Dimension 7: Self-assessment

The importance of the self-assessment dimension is to provide students with an opportunity to reflect on or assess their learning (Wylie & Lyon 2013). This is an opportunity to think meta-cognitively about their learning. Students should take ownership of their learning, as self-regulated learning is a key outcome of formative assessment. Self-regulated learning can be defined as a child's capacity to plan, guide and monitor his/her behaviour within the changing circumstances (Diaz & Amaya-Williams 1990). Student self-assessment, therefore, serves a cognitive development purpose as well as increasing learners' responsibility for their own learning, thus making the relationship between teachers and learners more collaborative. The role of the teacher in the self-assessment dimension is to make sure that learners are effectively and successfully engaging with the process of self-assessment.

Dimension 8: Peer assessment

The peer assessment dimension focuses on learners' thinking about other learners' work, and the process allows learners to support their peers. Some of the scholars of formative assessment (Black & Wiliam 2009; Black & Harrison 2004) saw the role of learners in formative assessment as important not only in order for them to assess themselves, but because once they master self-assessment they should be able to look at their peers' work and give them feedback. Harlen (2004) argued that peer-assessment should go beyond the simple and obvious form that we see operating in many classrooms, where learners mark each other's test or activity. True peer assessment would mean learners helping each other with their learning by giving each other feedback and suggesting the next steps to be taken to improve their work.

Dimension 9: Collaboration

The collaboration dimension focuses on classroom culture, on the relationship between teacher and learners and learner-learner interactions. It capitalises on an open learning and teaching environment, where teachers and learners are partners in learning. How the teachers and learners work together towards a common goal is key in this dimension.

This common goal is evidenced by the clear focus on learning, collaboration, respect and an appreciation for multiple viewpoints (Wylie & Lyon 2013).

Dimension 10: Using evidence to inform teaching and learning

The focus of this dimension is on how the teacher collects and uses evidence to adjust his/her teaching. This dimension highlights that assessment should not be designed solely to measure learners' progress but also to advance teaching (Miller & Seraphine 1993). The teacher gathers evidence from engaging with learners and observing them as they explore science concepts. The evidence can be gathered through learner oral or written work. The dimension focuses on how the teacher capitalises on the opportunities to collect evidence that prevail during the teaching. Assessment becomes formative once the teacher uses the evidence gathered, or feedback, to adjust teaching and learning (Exploratorium 2006).

Student cognitive development

Krathwohl's 'Revised Bloom's Taxonomy' (2002) was a second analytic tool used in the study for insight into cognitive development in classroom contexts. In this taxonomy, objectives are classified in a two-dimensional fashion. Cognitive processes, namely the ability to remember, understand, apply, analyse, evaluate and create, are set in a matrix against knowledge described at three levels, namely facts, concepts/principles, procedures and meta-cognitive knowledge. The taxonomy enables teachers to consider what cognitive processes are being employed at what level of knowledge. The higher levels of analysing, evaluating and creating (or synthesising, as included in the CAPS curriculum) are those that are considered to constitute higher order thinking (Zohar & Dori 2003; South Africa DBE 2011).

The taxonomy table is further meant to help teachers and other educators in at least three ways:

1. It can help teachers and educators answer what is referred to as the 'learning question' – What is important for learners to learn in the limited school and classroom time available?
2. It can help teachers answer the 'teaching question' – How does one plan and deliver content that will result in high levels of learning for large numbers of learners? And also the 'assessment question' – How does one select or design assessment instruments and procedures that provide accurate information about how well learners are learning?
3. It can help teachers to answer the 'alignment question' – How does one ensure that the objectives, instruction and assessment are consistent with one another? (Anderson et al. 2001: 6–10)

However, a limitation of the taxonomy is that higher order thinking can be oversimplified when only defined by cognitive processes and levels. Further insight into

higher order thinking is offered by Resnick (1987) who suggests the following broad characteristics of higher order thinking:

- Non-algorithmic: That is, the path of action is not fully specified in advance.
- Complex: The total path is not 'visible' (cognitively speaking) from any single vantage point.
- Yielding multiple solutions, each with its own costs and benefits, rather than unique solutions.
- Involving nuanced judgement and interpretation.
- Involving the application of multiple criteria, which sometimes conflict with one another.
- Involving uncertainty. Not everything that pertains to the task at hand is known.
- Involving self-regulation of the thinking process.
- Involving imposing meaning and finding structure in apparent disorder.
- Effortful: There is considerable mental work involved in the kinds of elaborations and judgements required.

Methodology

Seven primary school Natural Sciences teachers in Cape Town, Western Cape, participated in the study. Data was generated through semi-structured interviews with the initial seven teachers, as well as a lesson observation with one of the teachers (including a pre-lesson discussion, stimulated recall interview, and analysis of the summative assessment task handed out at the end of the lesson). The observation was done on the teaching of biodiversity in a Grade 7 Natural Sciences lesson. In this lesson, the teacher conducted the following activities:

- Biodiversity cards were arranged to spell out the word BIODIVERSITY.
- Learners watched a video clip on biodiversity after which the teacher asked questions about what they had seen.
- Learners read notes on biodiversity.
- Learners read passages from the textbook and the teacher asked questions about what they had read.
- As a summative assessment task, learners were given a research project guided by eight questions with a marking rubric.

As the initial interviews had focused on the general perspectives of teachers on formative assessment, the lesson observation was important in the study for giving insight into the challenges of formative assessment practices when applied to the teaching of an environmental topic. In this case that topic was biodiversity.

Teachers' perspectives, experiences and challenges regarding the use of formative assessment for supporting environmental learning

The findings presented in this section describe the data in terms of the 'Ten dimensions of effective formative assessment', with additional reflections on what the implications are for higher order thinking as described above.

Regarding the first dimension of quality feedback, namely clarifying goals and objectives, the teacher expressed her intended learning goals in the interview. These were: to give information about biodiversity; raise awareness of human impact on biodiversity; and for learners to research ways of protecting biodiversity. However, the objectives were not made explicit to the learners at the beginning of the observed lesson. This is not to suggest that to hand out and discuss a summative task is equivalent to sharing learning objectives, but only to point out that had the teacher shared the summative assessment task at the beginning of the lesson, it may have helped learners implicitly to see these objectives and understand the point of the formative tasks leading up to this one.

Regarding the second dimension, namely clarifying criteria for success, the teacher in the observed lesson was clear on both the expectations and criteria by which learners would be judged through her sharing of the summative task and rubric for assessment. On a number of occasions, she reminded learners to take note of the important information that would help them to succeed in their project. This can be seen in the three quotes below:

Now just bear in mind, how does this apply to your project? That is what you should think about all the time. Yes, it's nice, but how does it apply to your project that we've got to do? That's what I want you to keep on thinking about ... I want you just to pick up few points about our topic, biodiversity. I want you to be able to use these notes in your project.

And:

Grade 7s are we getting the idea of these terms? I need to see them in your project, right? They are so important. That's why I've spent so much time talking about them yesterday.

And:

Look at the rubric now, keep that next to you, but cast your eye on the rubric please so you can see how the questions match the rubric ... Number one, what is biodiversity? ... so, in the first criteria it says 'Knowledge of biodiversity, definition ... do you see that? Question one is asking what is diversity? Is that not a definition?

The detailed summative task developed for the observed teacher's lesson included the following questions:

- *What is biodiversity?*
- *When is an area regarded as having a high biodiversity?*
- *What is meant by preserving biodiversity?*
- *Why is it so important to preserve our natural plants?*
- *Why has it become so important to be serious about protecting biodiversity?*
- *Why is South African biodiversity regarded as being so important?*
- *List at least 5 ways in which humans have negatively affected the earth's biodiversity.*
- *List at least 4 ways in which you can help in preserving biodiversity.*

The first three questions are pitched at a lower order cognitive level, requiring simply the recalling of definitional skills. The three 'why' questions are moving towards the medium order cognitive level at least, requiring understanding and application to the South African context and, depending on the degree to which learners would need to search for and synthesise information, also requiring higher order cognitive skills. The assessment rubric for this task requires '*excellent interpretation*', '*excellent understanding*' and '*excellent insight*' for the 'why' questions, respectively. If Resnick's conception of higher order thinking, as explained above, was applied to these 'why' questions, the teacher might be able to find evidence of complexity thinking and nuanced judgement here.

The last two questions, requiring simple 'listing', were also pitched at a lower cognitive level. However, the assessment rubric presents an illogical order in the cognitive level, with the level 3 criterion for these questions being described at a medium or higher order request for explanation. The criterion reads: *Mostly capable of explaining the importance of human involvement in the situation*. This would be expected to be more difficult to achieve than the lists required at the level 4 criterion which was: *All five ways of negative impact and all four human contributions are evident*. Additionally, there is inconsistency between the instruction in the task (to 'list') and the assessment criterion (to 'explain' at level 3). Noting inconsistency in alignment is one of the affordances offered by the New Bloom's Taxonomy raised by Anderson et al. (2001).

Had the questions and rubric been tightly aligned with the notion of 'explaining', higher order thinking skills such as complexity thinking, cost-benefit analysis, nuanced judgement and interpretation, and application of multiple criteria might have been useful for the teacher in assessing the task. However, this is not to argue that all questions should be set at a higher order level, but to point out the potential for environmentally focused tasks to develop higher order thinking. An important consideration was for the teacher to have fewer questions set for higher order thinking, considering that the CAPS curriculum requires 15% of tasks to be set at higher order levels (South Africa DBE 2011). One of the teachers highlighted the importance of targeting a variety of cognitive levels, as well as being aware of the different levels at which learners can

perform. This understanding was evident in the teacher's statement that: *There should be different types of questions, lower order, and the higher order, depending on the level your learners are at.*

The above quote also raises an important caution in the South African curriculum, which highlights that high knowledge and high skills need to be attainable for *all learners* (South Africa DBE 2011). Thus, it is important to know 'where learners are at' (in the sense of their prior knowledge) but still teach towards developing higher order thinking for all. Zohar and Dori (2003) described a significant study in which they asked the question as to whether higher order thinking and low-achieving students are mutually exclusive. The conclusion from the study was that, while using certain methods in their study, they 'reached both low and high academic level students and prepared them to function in the increasingly sophisticated environment of the world today, and more so tomorrow' (p. 175).

Additionally, the importance of higher order thinking was highlighted by a number of teachers and is consistent with the CAPS curriculum principle requiring 'high knowledge and high skills' (South Africa DBE 2011: 4) to be set for each grade. Interviewed teachers implicitly highlighted the role of formative assessment in developing high knowledge and skills, as evidenced in the following quotes:

- *I mean when learners understand and pass well a piece of work they were doing, [formative assessment] indicates to me whether I achieved sufficient depth and scope.*
- *It is used to assess the deep understanding of the learners regarding the concepts taught.*

The third dimension of formative assessment was: tasks and activities that elicit evidence of student learning. Some teachers were clear regarding the kinds of formative assessment tasks that elicit evidence of learning. For example, one teacher explained that formative assessment is given orally and in written form. Another pointed out that:

Informal assessments in the form of classwork, home-works, and group work and formal assessment tasks e.g. tests, examinations and assignments and projects are requirement of the WCED (CAPS) nationally.

Regarding the link between formative assessment and learning, understanding was implicit in the statement that: *Critical thinking is essential, and this is assessed via questioning techniques and worksheets and giving them many opportunities.* Another teacher indicated the use of formative questioning: *To see if they understood the lesson.* A third teacher said that formative assessment is used to: *Assess if the set of objectives of the lesson have been reached or if the skills have been acquired.* Lastly, one of the teachers explained that: *Formative assessments are yardsticks to assess where learners are in their ability to understand test questions asked and their ability to answer them.*

Teachers further indicated the value of these tasks for identifying the need for further scaffolding of learning. For example, one teacher stated that formative assessments: *Help me to come up with activities so that I can help to close the gap my learners have.* Another teacher explained the use of Bloom's Taxonomy to: *Oversee all learners' abilities and also to know where to assist or give support.* A third teacher explained that formative assessment enables a teacher to: *Check misconceptions ... identify individual learning problems, design individual work to suit different learners.*

Teachers acknowledged that one of the reasons for formative assessment is for strengthening success in summative tasks. Another explained that she gives her learners tests frequently so that they can be familiar with written examinations with regard to both processes and environment, while two others argued that formative assessment builds confidence for summative assessment.

In the observed lesson, the summative task (research on human impact on biodiversity) called for the learners to use what they learned in class and take it further by looking for more information on this topic, and then to show by listing or stating, ways in which they could prevent biodiversity loss. All prior activities were aimed at preparing the learners for this research task, as was repeatedly pointed out by the teacher. These were opportunities for the teacher to elicit evidence of learning at each stage of the process, although the dimensions below illustrate that there were problems with the follow-through of these opportunities.

Regarding the fourth dimension of effective formative assessment, questioning strategies that elicit evidence of student learning, the teacher in the observed lesson raised questions as a direct way of checking student learning. However, the observation revealed that few learners were answering questions. Even though thought-provoking questions were asked, the waiting time for learners to engage and respond to the questions was not provided. Therefore, there was not much effective elicitation of evidence of student learning at the time of observation. The teacher indicated language-related problems with the questioning strategies at two levels. The first was a lack of reading ability, where she highlighted: *Reading to understand is different from just reading.* The second was: *To get students to understand the questions asked.*

The fifth dimension of effective formative assessment is the need for feedback to be given during questioning. As mentioned above, there was no evidence of such feedback in the observed lesson as the learners were not responding to the questions, and so it was hard to get insight into this challenge.

Regarding the sixth dimension of effective feedback, namely individualised descriptive feedback, the observed teacher's intention in the pre-lesson discussion was for the learners to have multiple submissions so that she could give them feedback and they could rework their project.

A plan is for them to bring their work, whether as a draft in their draft books or typed task so that I can give them feedback. The big challenge, as you know is time. I'm not sure if this will be possible to fit in, but it's a plan.

Evidence of whether the above-mentioned plan for individual feedback on drafts was ultimately achieved was not available for this study. However, further insight into the challenges of individual feedback (both written and spontaneous engagement during class) were obtained from the interviews with the larger group of teachers. Two mentioned the difficulties associated with large classes (one teacher had more than 50 learners in the classroom). Another explained: *The classroom that is dedicated for science experiments is small and the floors have holes. This makes it impossible to check if all learners are working.* Additionally, as with the above-mentioned questioning strategies, teachers do not necessarily get the required work in from learners in order to respond. One teacher explained: *Learners absent themselves, not submitting tasks. This is a problem to give them feedback.*

Regarding the seventh dimension of effective formative assessment, namely self-assessment, the observed lesson did not elicit relevant evidence of this. This is to be expected as a teacher cannot use too many strategies in one lesson. However, from the interviews, a significant deepening perspective on the role of formative assessment in the meta-cognitive aspects of learning (Krathwohl 2002) came from teachers who saw formative assessment not only as a tool for the teacher, but also for the learner to track their own learning. This was evident in the explanation that: *These practices affect learning by challenging both the teachers and learners to focus on [the] learning and teaching process. Enabling learners to see where they are weak or strong.* Another teacher explained that: *Learners can be asked to mark their work and identify their mistakes and this can help them when writing the test.* A third teacher stated: *It is better when the learner explores and learns by himself.*

The eighth dimension of effective formative assessment, namely peer assessment, was not evident in practice from the single observation reported in this study. However, teachers demonstrated understanding of the opportunities offered by formative assessment for peer learning. The following quotes are indicative of this:

- *Peers appreciate being evaluated by peers especially when it is positive.*
- *Informal and formal assessment is done so that peer and group can be involved in the assessment.*

The ninth dimension of effective formative assessment, namely collaboration as a practice, was indicated by a teacher who explained: *The class is grouped heterogeneously and given a section of work to share with the class. This encourages them to help one another.* The fact that collaborative formative assessment is valued as a tool to promote inclusivity and participation was seen in the following quote: *Quality learning is when all learners engage and feel a sense of achievement.* The next quote also supports the perspective of the value of participation: *Quality learning is when learners are interacting. They are responding to the subject matter in a meaningful way, they ask questions. They are not afraid to give their opinions. They are learners that are not only recipients, they are participants.*

The tenth dimension of effective formative assessment is, 'using evidence to inform teaching and learning'. Interviewed teachers showed understanding of the role of

formative assessment for increasing their own reflexivity. The first move for reflexivity is recognising that one's own teaching needs to be critically considered. One teacher demonstrated recognition of this by stating: *Sometimes you might think your teaching is good, but when you assess you get the opposite of what you expected.*

The second move in reflexivity is adjusting one's teaching accordingly, and a number of teachers indicated that they use formative assessment in this way. One teacher explained that assessment could inform future planning, with the statement that formative assessment is: *Very important in guiding one's planning.* Another said: *It is important to give formative assessment during discussion to really know if learners are with you or understand. This helps me to re-teach it.* A third explained the use of formative assessment to: *Correct my methods or strategies, improve on my approaches.* While a fourth claimed that formative assessment: *Helps me to adjust the method, approach or even to divert the whole lesson to something of greater importance they should know before the concept at hand.*

Thus, while teachers clearly showed evidence of understanding the importance of using formative assessment to improve their teaching, in the context of practice, there is a limitation for this ideal. As one teacher expressed it: *The CAPS pacing does not allow time for even get deeper to content. It does not give time to look back and re-teach concepts that learners don't understand.*

Conclusion

Overall, the interviews illustrated that teachers had a good understanding of the strategies for, and possibilities offered by, formative assessment practices. They demonstrated awareness of the value of formative assessment in guiding scaffolding practices by teachers; developing meta-cognitive skills through self-assessment; supporting collaboration; and encouraging inclusivity for all learners. Peer assessment did not receive much attention, although one teacher commented that it was 'appreciated' by learners. Significantly, three of the teachers highlighted the role of formative assessment in teaching towards summative assessment, and, notably, the only 'criteria for success' offered to learners in the observed lesson were those in the summative assessment task. This, and the repeated emphasis on the assignment, indicates an emphasis on assessment-driven learning.

While much of the understanding and practice of formative assessment is generic for all quality education, the study revealed that there is a need for developing higher order thinking for environmental learning. Equally, the study revealed that environmental learning can require lower order thinking if questions are posed simply, for example with questions requiring learners to 'list'. The study illustrated that if 'clarifying criteria for success' is important for formative assessment, then care should be taken that low, medium and high order thinking requirements are consistently presented between assessment tasks and associated rubrics, and also that criteria are logically ordered in rubrics. Teachers demonstrated an awareness of the need for developing low, medium and higher order thinking in their teaching as well as the role of formative assessment in developing critical thinking. Where higher order thinking is required, a more

nuanced perspective on higher order thinking, such as Resnick's (1987), may be useful for guiding teachers' formative and summative assessment practices.

The teachers demonstrated an understanding of the value of teacher feedback in formative assessment, both during questioning in class and in written form (teacher-learner engagement), as well as learner-learner collaboration. However, four significant structural problems highlighted why this is not always successful. These were: time limitations in a full CAPS curriculum; language difficulties impeding learner understanding of questions during classroom questioning; exceptionally high numbers in classrooms; and learner absenteeism (failure to submit work). These problems need to be addressed especially if higher order thinking is to be achieved among learners.

The study highlights that formative assessment is a fundamental part of developing higher order cognitive skills, and fundamental to critical thinking and problem solving in environmental learning. Generally, teachers have a good understanding of formative assessment, but help with implementation strategies appears to be necessary in teacher professional development. Additionally, an over-emphasis on assessment-driven learning may over-shadow a broader perspective of what it means 'to learn' in a classroom. Furthermore, socio-economic, organisational and language problems, in both curriculum and schools, need to be addressed if higher order thinking is to be enabled in classrooms.

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