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Connecting the Hands-On to the Minds-On: A Video Case Analysis of South African Physical Sciences Lessons for Student Thinking

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In South Africa, there is a strong curriculum imperative for South African school science teachers to not only involve learners in practical inquiry activities but also to support students in making a connection between the construction of substantive scientific knowledge to these activities. The research reported in this article investigated the extent to which South African teachers at historically disadvantaged township schools engaged students in the construction of science ideas in inquiry lessons. To this end, video transcripts of thirty two lessons were analysed and coded using a framework of student thinking lens developed by the Biological Sciences Curriculum Study (BSCS) for the Science Teachers Learning from Lesson Analysis (STeLLA) project. The trends on the teaching features are explicated in the presentation of an in-depth analysis of a chemistry lesson. This research suggests the need for a re-alignment of inquiry-based science education with the development of science ideas.

Keywords: inquiry-based science education,; student science ideas, student thinking, video case analysis, chemistry teaching

INTRODUCTION

A key curriculum goal in school science education in many countries has been to encourage teachers to use an inquiry-based approach in their instruction, as a means to develop students' understanding of science concepts. This goal is articulated in the South African Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education, 2011) where the integration of science content knowledge and science inquiry processes is expressed through Specific Aim 1 that states through inquiry, students should construct and apply scientific knowledge. Furthermore, Specific Aim 2 highlights the envisaged role of inquiry in student construction of scientific knowledge by stating that "learners should develop not only procedural skills but also cognitive skills that would support the construction of learner ideas" (Department of Basic Education, 2011, p. 8). Examples

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of such skills that are listed in CAPS include hypothesizing, identifying and controlling variables, designing an investigation, drawing and evaluating conclusions, formulating models, inferring, interpreting, and reflecting.

A similar role for inquiry is portrayed in the National Science Education Standards (1996) of the US where inquiry teaching refers to "the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (National Research Council, 1996, p. 23). This conception of inquiry is in concert with definitions offered by the Science Education Project of the IAP (InterAcademy Panel). The IAP, now known as the Global Network of Science Academies is a global network of 104 scientific academies who participate in discussions on scientific policies at important international forums. They state that "Inquiry-based science education means students progressively developing key scientific ideas through learning how to investigate and build their knowledge and understanding of the world around them" (IAP, 2010, p. 5). Harlen (2013) points out that there is confusion about what is meant by of inquiry-based science education, with the view sometimes that inquiry is concerned exclusively with the development of skills. She states that because inquiry "depends on the use of processes or skills it is sometimes viewed as being concerned exclusively with developing these skills as outcomes in their own right" (p. 14). As a result there exists in classroom practice a discord between the "hands-on" and "minds-on" outcomes of inquiry learning. However, previous research does point to inquiry lessons where "minds-on" outcomes have been achieved (Yakar & Baykara, 2014).

State of the literature

- Research reports that teachers worldwide tend to engage students in routine practical activities where they execute procedure without much thought on the development of scientific ideas
- In classroom practice, practice a discord between the "hands-on" and "minds-on" outcomes of inquiry learning.
- Research that has been done in South Africa on inquiry-based teaching has focussed predominantly on the extent to which inquiry is being implemented across schools of diverse socio-economic status.

Contribution of this paper to the literature

- There is a strong curriculum imperative worldwide for school science teachers to not only involve students in practical inquiry activities but also to connect the construction of substantive scientific knowledge to these activities. This research informs further on the manner and extent to which science teachers in South Africa enact strategies to engage students on the development of scientific ideas.
- This study employed a conceptual framework of a student thinking lens to investigate the extent to which South African teachers at historically disadvantaged township schools engaged students in the construction of science ideas in inquiry lessons.
- The strategies underlined in this framework can be effectively adopted as indicators of teacher action in facilitating student thinking in the lesson. Accordingly, the lessons can be coded for visible evidence of a teaching feature on student thinking.

Research conducted elsewhere reports that teachers typically involve students in routine practical activities where they slavishly follow teacher directions and procedures without much thought. Abrahams and Millar (2008) investigated the effectiveness of practical work by analysing a sample of 25 typical science lessons involving practical work in secondary schools in the UK. They concluded that teachers predominantly focus on making students manipulate physical objects and equipment. There was little evidence of teachers supporting students in linking observations and experiences to conceptual science ideas. A similar finding was made in the US. The Third International Mathematics and Science Study (TIMSS) 1999 Video Study of eighth grade science teaching in five countries revealed in contrast with higher-achieving countries such as Australia, the Czech Republic, Japan, and the Netherlands, science activities in US lessons involved students following teacher directions with little or no explicit engagement on content ideas (Martin, et al., 2000). Students were not required to think about scientific explanations for their observations and results, with the result that science content ideas were only weakly connected to the activities. Science content, when present, was usually organized as a collection of discrete facts, definitions and algorithms rather than a connected set of ideas (Roth, et al., 2009). Chinn and Malhotra (2002) indicate that this practice reinforces an unscientific epistemology that promotes a belief that "science is a simple, algorithmic form of reasoning; as a result, students are likely to fail to learn the heuristics scientists use to reason under uncertainty" (p.213).

According to Gaigher, Lederman and Lederman (2014) these shortcomings in inquiry teaching are addressed through the recent publication of the NRC (2012) entitled "A Framework for K-12 Science Education" where when referring to inquiry, the term "practices" is used instead of "skills" to stress that engaging in inquiry requires the coordination of both knowledge and skills simultaneously. The following "practices" are identified: asking questions (for science) and defining problems (for engineering); developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations (for science) and designing solutions (for engineering); engaging in argument from evidence; and obtaining, evaluating, and communicating information (p. 42). This is now carried forward in the Next Generation Science Standards (NGSS; NGSS Lead States, 2013) that promulgates a dramatic departure from approaches to teaching and learning science, especially inquiry-based science education (Reiser, 2013).

Research that has been done in South Africa on inquiry-based teaching has focussed predominantly on the extent to which inquiry is being implemented across schools of diverse socio-economic status. It has been revealed that there is increasing traction for teachers to engage learners in inquiry-based learning (Ramnarain, 2014; Dudu & Vhurumuku, 2012; Hattingh, Aldous & Rogan, 2007). In light of this, the research reported in this article investigated the extent to which South African teachers engage students in the construction of scientific ideas in inquiry lessons. The study adopted as a conceptual framework a student thinking lens proposed by Roth et al. (2011). They state that the student thinking lens is based on findings from research on science learning where it is inferred that students build their own explanations of how the world works based on their everyday observations and experiences (e.g., Driver, Squires, Rushworth, & Wood-Robinson, 1994; Hewson, Beeth, & Thorley, 1998; Osborne & Freyberg, 1985). Students therefore construct personal theories of the world that are sometimes resistant to change. Roth, et al. (2011) maintain that "teachers need to trace and guide their students' thinking by eliciting, analyzing, and challenging students" (p. 2).

A STUDENT THINKING LENS

The student thinking lens proposes seven specific teaching strategies that teachers can enact in making student thinking more visible during inquiry lessons (Schwille, et al., 2011). The strategies are: elicit student ideas and predictions; ask probing questions; ask challenging questions; engage students in using evidence to build explanations; engage students in using and applying new ideas in a variety of ways and contexts; engage students in "making connections" through synthesizing and summarizing work; and engage students in communicating in scientific ways. Each of these strategies is now discussed briefly.

Throughout the lesson, the teacher should ask questions that elicit student ideas and predictions, and probe student thinking. These questions provide information about students' prior knowledge, experiences and misconceptions, and this information enables the teacher to adapt the instruction to support students in developing ideas that are scientific and evidence-based. An example of a probing question is "What do you mean when you say….?". During the lesson the teachers must also ask challenging questions. Such questions move beyond merely eliciting information on student thinking but are formulated to change student thinking so that scientific understanding can be established and hence to improve student learning outcomes in science (Koufetta-Menicou & Scaife, 2000). They are designed to force the student to "reconsider his/her thinking, to make new connections, and to use new vocabulary" (Schwille, et al., 2011, p. 3). The importance of quality questioning is critical in synthesising and summarising activities that help students pull together the new ideas by making a connection between the ideas and the practical activity. An example of a synthesis activity on electricity might entail the teacher giving the students a list of words (e.g. electrons; circuit; current; battery; resistor; open and closed) and then asking students to draw a concept map. A summary might be constructed by the teacher and students together during a class discussion or by students working independently in small group or on individual writing tasks.

Student thinking becomes visible when the teacher creates opportunities for students to use evidence to build their own explanations. Students are required here to support their claims with evidence and logical arguments. The teacher must allocate sufficient time to class discussions so that students can be afforded these opportunities. Furthermore, the teacher must establish a classroom environment whereby student ideas are solicited and welcomed. Furthermore, students need to be encouraged to read and write in the language of science in order to effectively communicate in science. In this regard the teacher should be alert to promoting dialogical interactions in which students are regarded as active agents in classroom discourse. In this way they become participants in in the construction of their own knowledge (Alexander, 2006).

RESEARCH CONTEXT

The legacy of the apartheid policy is that South Africa is a country where there is much diversity in the provision of education, especially science education. According to Naidoo and Lewin (1998), due to disparate funding, schools located in townships and rural areas that are mainly attended by Black students have lacked facilities for science such as laboratories and basic equipment. Furthermore, these students tend to be taught by poorly qualified science teachers (Murphy, 1992). It is not surprising that Black students have performed poorly in science compared to White students who have enjoyed much better physical resources and are taught by competent science teachers (Foundation for Research Development, 1993). With the advent of a democratic South Africa in 1994, policies such as the White Paper 1 on Education and Training (Department of National Education, 1994) and the Framework for the National Strategy for Learner Attainment (Department of Basic Education, 2007) were aimed at redressing historical imbalances and ensuring quality student achievement for all.

Despite these attempts at transforming education in post-Apartheid South Africa, township and rural schools remain poorly resourced in terms of both facilities and the competency of teachers (Ramnarain, 2014; Magopeni & Tshiwula, 2010). The disparate funding policies of the previous regime, have resulted in urban and suburban schools that are still largely attended by White students, generally having better facilities. These schools are located in communities with a higher socio-economic status (Bayat, Louw & Rena, 2014; Erasmus & Ferreira, 2002; Spaull, 2013). In view of the poor student performance in physical sciences, especially in disadvantaged South African township schools (Department of Basic Education, 2013), this study focused on science lessons at some disadvantaged schools..

Major school science curriculum reform in South Africa has centred on the introduction of inquiry-based education that facilitates the construction of student ideas through investigations (Department of Basic Education, 2011). This is a signification shift from the previous science curriculum, which placed much emphasis on the transmission of scientific knowledge, was teacher-centred, and portrayed the learner in a passive role. In such a teacher-centred science classroom, communication flows from the teacher to the student and teacher talk dominates the lesson. Large scale research on the implementation of the new curriculum reveals that there is little to suggest that the quality of learning has improved for all students. International assessments such as Trends in International Mathematics and Science Studies (TIMSS) repeated over the years from 1990 to 2003 show alarmingly that the performance of South African students in mathematics and science, especially Black learners from impoverished communities such as townships was very poor compared to other developing countries (Mullis, Martin, Gonzales & Chrostowski, 2003). Furthermore, according to the Global Competitiveness Report (2010-2011), South Africa ranks 137 out of 139 countries in mathematics and science education quality (Sala-i-Martin, 2010). More recently, the World Economic Forum (2013) ranked South Africa second to last in the world for math and science education, just ahead of Yemen. Against this background, the study was guided by the following research question:

> To what extent do physical sciences teachers at township schools make visible student thinking in inquiry-based teaching?

METHODOLOGY

Initially thirty physical sciences teachers who were teaching at township schools in the north-eastern province of Gauteng were invited to participate in this research. Of these teachers, sixteen of them agreed to participate in the study. The other teachers declined as they felt they were not depicting inquiry-based education in their teaching. This group of teachers were probed on their reasons for not teaching inquiry in interviews, and the findings are disseminated in another article (Ramnarain & Schuster,2014).

Over a period of four weeks, two inquiry-based lessons were observed for each teacher. Each lesson was between 35-55 minutes long. The lesson was video recorded, and the audio was transcribed. The student thinking lens already described was adopted as an analytical framework in the analysis of these videos. The strategies underlined in this framework were adopted as indicators of teacher action in facilitating student thinking in the lesson. Accordingly, the lessons were coded for visible evidence of a teaching feature on student thinking. The following coding scheme was adopted for each feature: 0 = not achieved; 1 = partially achieved; and 2 = completely achieved. This coding enabled both the frequency of the evidenced teaching feature, as well as the duration of time spent on each feature to be established. Thereafter, the lesson was looked at holistically and an overall qualitative judgment was made on how teachers made student thinking visible in these practical lessons. The coding was done independently first by the author, and then by another two researchers in science education. The inter-rater reliability in the coding of the teaching features underlining student thinking was 76%. The differences in the coding were discussed until agreement was reached. An external "member check" was conducted with the participant teachers in order to ensure the trustworthiness of the interpretations of the researchers (Lincoln & Guba, 1985).

RESULTS

Table 1 presents descriptive statistics on the thirty two lessons that were taught by the sixteen teachers who formed the focus of this research. It is inferred from the

Table 1. Means and standard deviations of observed teaching feature

Observed teaching feature	Mean score for achieved teaching feature (N = 32)	Standard deviation (N = 32)
Eliciting student ideas and predictions	1.58	0.28
Asking probing questions	0.96	0.25
Asking challenging questions	0.77	0.48
Engaging students in using evidence to build explanations	0.85	0.39
Engaging students in using and applying new ideas in a variety of ways and contexts	0.76	0.29
Engaging students in "making connections" through synthesizing and summarizing work	0.86	0.31
Engaging students in communicating in scientific ways	0.89	0.30

results depicted in Table 1 that teachers only weakly make visible student thinking in inquiry lessons. The mean scores for all the features apart from one ranged between "0" (not achieved) and "1" (partially achieved). The low standard deviations suggest much consistency in the extent to which these features were observed in the lessons. There was also little deviation in the scoring of the features for the two lessons that were taught by each teacher, and the average standard deviation was 0.26. The scores in Table 1 serve as compelling evidence that teachers when doing inquiry lessons, pay scant attention to engaging students in the development of scientific ideas.

In order to exemplify some of the findings depicted above, a grade 10 chemistry lesson is considered. The teaching features associated with the student thinking lens are discussed in detail for this lesson. This lesson represents some of the trends and patterns that were revealed for the great majority of the lessons observed.

The township school

The school that forms the focus of this article is situated in a densely populated township in the province of Gauteng. The school has inadequate facilities for practical work. There is no science laboratory, and practical work takes place either in the classroom, or outside in a sheltered area that is demarcated for morning assembly. Due to government initiatives to address historical imbalances in the education system, this school did receive at the start of the school year a supply of chemicals and equipment so that requirements for practical work as specified by the South African Curriculum and Assessment Policy Statement (CAPS) could be met. The students attending this school come from a community that is afflicted by a high unemployment rate, especially amongst the youth. In most homes, the family is reliant on a social grant for food and the provision of facilities such as electricity and water. The annual school fee is low ($100) and the school is heavily subsidised by the government.

Academically, the school has been categorised as underperforming by the Gauteng Department of Provincial Education. In a previous high stakes national grade 12 exit examination, the overall pass rate was 63%, with only 27% of students achieving above 50% in the physical sciences examination.

Miss Zodwa: The science teacher

The science teacher, Miss Zodwa (a pseudonym) has been teaching physical sciences for 18 years, and she been employed at this school for the past 12 years. She has a teaching degree, having majored in physical sciences and life sciences. She is also the head of department for life sciences, physical sciences and natural sciences.

Miss Zodwa's chemistry lesson

Miss Zodwa's grade 10 class has 46 students. The learners were organised in groups of 7 or 8. The lesson in question is on chemical change involving the reaction between zinc and hydrochloric acid. Students were handed a worksheet on this experiment. The worksheet included instructions on how to conduct the experiment and the following questions to guide their observations:

1. When you add the zinc granules to the hydrochloric acid, what do you think will happen?
2. Describe what happened.
3. Why do you think this happened?
4. What can you conclude based on your observation?
5. Write done the chemical equation for this reaction.

The lesson is now discussed according to the teaching features of the student thinking lens. Excerpts on the teaching features are cited, and then interpreted in terms of student engagement on their ideas. The lesson took place in the classroom, and was 50 minutes in duration.

Eliciting student ideas and predictions

At the start of the lesson, there was substantive evidence of this teaching feature. After announcing to students that they were going to investigate chemical change, Miss Zodwa posed the following question to the class: "What will happen when you drop a coin in hydrochloric acid?" After distributing a few zinc granules and a test tube containing dilute hydrochloric acid to each group, she asked students to make a prediction on what they were expecting to observe when the zinc was added to the acid. The students were encouraged to discuss their predictions within the group. They were also instructed to write their prediction on a worksheet provided. Thereafter, she asked a student from each group to share his or her prediction with the class. There was clear evidence of this teaching feature, it was decided to code it as "fully achieved".

Asking probing questions

There was scant evidence of the teacher asking probing questions. Although there were teaching situations where the teacher did have an opportunity to probe students on their conceptual understanding, the teacher did not fully exploit this. For example, when students stated that hydrogen gas was being evolved in the reaction, the teacher did not probe them on the source of this gas, but instead asked them about how hydrogen gas could be chemically tested for. There was a strong emphasis by the teacher for students to describe and write down all their observations, but there was little engagement on their development of scientific ideas based on these observations. As a result the opportunity to uncover possible student misconceptions was missed. This teaching feature was coded as "partially achieved".

Asking challenging questions

Students were not challenged on their assertions in explaining their observations of the chemical reaction. In cases where the student offered an incorrect explanation they were not challenged. The teacher merely dismissed their answer as incorrect and then stated the correct explanation. To a large extent this resembled a triadic discourse in which the teacher asks a question, calls on students to answer it, and then evaluates it by agreeing with the answer or rejecting it and correcting it (Treagust, 2007). There was an absence of a prolonged engagement between the teacher and students whereby students were asked to justify their responses. This is evidenced in the following excerpt where the teacher asked about what happens to the zinc when it reacts with the acid.

> Teacher: Okay class now think about the zinc that you added. What happened to it? Where did it go?
> Jabu: Mam, we could not see it again so it must have dissolved completely.
> Teacher: You are thinking of sugar or salt dissolving. No, you must say that metal is ionising and forming zinc two plus ions that combine with the chloride Cl minus ions. Make you remember this.

This excerpts shows that the teacher does not challenge the student on his conceptions of what happens to the zinc, but is quite dismissive of the student's idea and merely discloses the correct answer. There were other instances of this. Where the teacher did pose questions, these were mainly to focus students on the observations they were making. For example "What has happened when I lit the match in the gas?" This teaching feature was therefore considered "not achieved".

Engaging students in using evidence to build explanations

There were occasions in the lesson where the teacher did ask students to interpret their observations in order to build scientific explanation. The following excerpt from the lesson where Miss Zodwa interacts with a group of students is indicative of this:

> Teacher: What do the bubbles mean?
> Xolani: It could mean something like a gas is given off.
> Teacher: Good, now you must try and say what it could be. Yes, Susan do you want to try?
> Susan: Oxygen could be it.
> Teacher: Now, let's follow what we are reacting. Remember the zinc and hydrochloric acid (stresses hydro). Alright have another go at it.
> Susan: Oh ya, it is hydrogen gas.
> Teacher: Excellent!

However, on other occasions, the teacher failed to support students in making the connection between evidence and scientific explanation. For example, in testing for hydrogen gas a 'pop' sound was heard. The teacher told students "this sound show that hydrogen is being formed" but she did not seek an explanation for the 'pop' sound. This teacher feature was considered only "partially achieved".

Engaging students in using and applying new ideas in a variety of ways and contexts

There was no evidence of this teaching feature. As indicated above, although there was some attempt at engaging students in building ideas based on evidence, the teacher did not support students in applying this knowledge in other contexts or in other ways. There was no attempt by the teacher to reinforce the notion of chemical change by referring to other examples of chemical reactions. Furthermore the teacher did not ask students to write a general equation for the reaction between and acid and a metal. This teacher feature was "not achieved".

Engaging students in "making connections" through synthesizing and summarizing work

There was no explicit attempt by the teacher in getting students to synthesize and summarize their work. However, the teacher did announce at the start of lesson that students would be required to write a report on their experiment. In the report they were expected to state their prediction, describe their observations made, write an equation for the chemical reaction taking place, and formulate a conclusion. Although the writing of the report may be regarded as a form of synthesizing and summarizing work, the teacher did not at the end of the inquiry, stimulate a discussion amongst students whereby they connected their prediction, observations made, explanations and conclusion. Students did not have the opportunity to engage in a post-practical discussion in which they evaluated their conclusion against documented scientific knowledge. This teaching feature was evaluated as "partially achieved".

Engaging students in communicating in scientific ways

There was only limited attention given to getting students to communicate scientifically, and thereby acquire greater facility in the scientific language. In cases where students were unclear in their responses, the teacher did occasionally ask them to rephrase and articulate their responses more concise and clearly. This aspect was not addressed explicitly by the teacher, but emerged only in situations where teacher has unable to follow what the student was stating. This is evidenced in the following excerpt from the lesson:

> Petrus: I think what happens here is because we feel this test tube it must be the temperature is given to be produced and we feel it like being hot.
>
> Teacher: I am not following you. What do you mean by "temperature is being given to be produced?" Is it producing temperature or heat?
>
> Petrus: Sorry mam, I meant it like heat is being given.

Due to the teacher not explicitly addressing this teacher feature, it was coded as "partially achieved".

Overall assessment of Miss Zodwa's lesson

Overall, the lesson revealed only limited evidence of teaching strategies that made student thinking visible. This is underlined quantitatively by the total score 6 for the teaching features out of a possible score of 14. This equates to an overall representation of 43% for visible evidence of student thinking. Although students were actively involved in making predictions and describing their observations, their experiences were not directly connected to the construction of scientific ideas. At times, the teacher did seek explanations from students on observations made, but the teacher did not engage their thinking in synthesizing the evidence in a manner that would lead to the development of epistemological assertions from the evidence. This is also underlined by the scant attention given to getting students to express their explanations through a scientific discourse, often associated with conciseness and clarity. Students were not overtly encouraged to communicate scientifically, and as a result were not acquiring the distinctive grammatical features and language structures of the discipline.

DISCUSSION

This study used video analysis to investigate the teaching of inquiry lessons at poorly performing township schools in South Africa. The findings of the research show that students in large part are not guided in scientific thinking. This was evidenced quantitatively by the low scores achieved for the visibility of teaching features associated with the student thinking lens. A similar trend was observed at the other township schools that formed the focus of this research. The form of interaction at these schools was largely authoritative in nature and heavily dominated by teacher talk. There was limited evidence of the teacher adopting an interactive dialogic approach that explores and exploits students' ideas (Mortimer & Scott, 2003).

As indicated already, there is a strong curriculum imperative for South African school science teachers to not only involve students in practical inquiry activities but also to connect the construction of substantive scientific knowledge to these activities. Indeed the findings of this study cohere well with those in other countries such as the US and UK where studies show a similar disconnect between practical work and the construction of scientific knowledge. It is encouraging to note that today in post-Apartheid South Africa, students in disadvantaged township schools whose previous experiences in science learning were content-based with little or no opportunity to do practical work (Taylor & Vinjevold, 1999), are now given some opportunity to do practical work. However, the concern is that these experiences are centred on routine activities in laboratories, with teacher-student interactions focussed on low-level procedural questions and answers. As noted in the 1999 TIMSS video study of eighth grade science teaching in five countries, in high achieving countries the development of student ideas always remains in the foreground when students are predicting, observing, and manipulating materials. However, in the US and as is now also evident in South Africa, such hands-on learning does not necessarily lead to minds-on learning.

It is clear that in South Africa there needs to be a re-alignment of inquiry-based science education with the development of science ideas. If inquiry learning is to continue to be regarded as contributing to conceptual understanding in science (Gott & Duggan, 2002; Westbrook & Rogers, 1996), consolidated efforts will need to be made to emphasise this goal for inquiry. As alluded to already in the US such a shift in curriculum emphasis is being made through publications of the New Generation Science Standards (NGSS; NGSS Lead States; 2013) and the Framework for K-12 Science Education (NRC, 2012)

The role of the teacher is key to any curriculum initiative, and a shift towards an inquiry-based practice that makes student thinking more visible, will redefine the role of the teacher from one who directs student actions to one who facilitates student thinking (Anderson, 2007). Hence, teacher professional development is critical. Bybee (1997) underlines the pivotal role of the teacher in curriculum implementation by maintaining that teachers are the “change agents” and the ones that shape the nature of classroom instruction and curriculum reform efforts. This research provided some insight into the science teaching and learning practices in inquiry-based lessons through an analysis of video lesson transcripts using a student thinking lens.

Video cases can be used as a professional development tool, and McDonald and Kelly (2007) suggest that professional development using video can help teachers develop a professional vision whereby they “reframe the way they look at classrooms by the shift from a pedagogical view of observing to focusing on the development of students’ disciplinary ideas” (p.175). The analysis-of-practice approach exploited in this study was used in the Science Teachers Learning from Lesson Analysis (STeLLA) project (Roth et al., 2011) in the US in which teachers underwent professional development where they learned to analyze videos for strategies that supported student thinking, and then teach using these strategies. It is recommended that such an approach be exploited in planning professional support for teachers in this country. In this regard, the author of this article together with colleagues at a South African university are exploring a partnership with the Biological Sciences Curriculum Study (BSCS) of the US in offering professional support for science teacher along similar lines to that in the STeLLA project.

Although this was not the focus of the research reported in this article, there was some evidence of the viability of using videos in promoting teacher reflection. After the teachers had watched video recordings of their lessons, the strategies within the student thinking lens framework were discussed with them. The teachers recognised that to a large extent these strategies were absent in their lessons, and agreed that my assessment of their lessons according to the framework was valid. All teachers agreed that the strategies could be adopted as a guideline in supporting development of ideas during inquiry lessons, expressed interest in implementing some of the strategies in future. Shifting from a hands-on to a minds-on approach in inquiry is not an easy task and will require teachers to examine what they do and how they might do it differently. The sharing of videos with teachers in an analysis-of-practice approach using an appropriate framework such the student thinking lens does have potential in achieving this and should be exploited in in-service professional development programmes. Follow-up observations could then be done of how these teachers instil in their practice the features of a student thinking lens that were made visible to them in in this programme.

Further research could investigate the influence of school context on the enactment of a student thinking lens by teachers. Due to the academic performance of students at township schools, this research concentrated on lessons at such schools. In trying to understand more fully the role of disparate contexts on teacher classroom practice and student learning experience, future research could be on a comparative study on the extent to which a student thinking lens is evidenced in lessons taking place at township schools, and more privileged suburban schools.

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