

## Developing a community of thinking in biological sciences

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### ABSTRACT

Globally, higher education institutions are constantly challenged to respond to changes in the political, social, economic, environment and other sectors in terms of their teaching practices. But, are tertiary institutions responding adequately and appropriately to these challenges in terms of Biological Sciences, their applications and their effect on the environment? The purpose of this paper is to discuss an instruction and assessment strategy in Biology to enhance eco-education. This paper is based on a study that recognises the significance and impact of education and (by implication) assessment in Biological Sciences on the environment. This paper therefore reports on an oral assessment intervention in Biology at two tertiary institutions in South Africa based on “practical activities and first hand experience” emphasized by The 1975 Belgrade and Tbilisi international agreements (UNESCO-UNEP 1976, 1978). Grounded in a social-constructivist framework, this qualitative study located learning and assessment in Biology within the framework of situated learning which focused on the construction and assessment of knowledge within the learner’s community of practice.

### Keywords:

### INTRODUCTION

Globally, tertiary education institutions are constantly challenged to respond to changes in the political, social, economic, environment and other sectors in terms of their teaching practices. A developing country like South Africa is no exception. Tainted by its apartheid or separatist history and therefore unequal distribution of finances and resources to education based on colour, the majority of the people in South Africa still bear the scars of apartheid education. The South African tertiary classroom is made up learners who come from diverse language, cultural, political, social, economic, geographic and historical backgrounds and the challenges faced by educators and learners alike are enormous. The fact that the majority of our learners are second or foreign language speakers of English in institutions where English is mainly the medium of instruction and assessment, just adds to these challenges. While innovative changes have been made (and are still being made) over the years in teaching practices to accommodate the diversity and challenges in our classrooms, assessment structures have remained largely unaltered. Yet, it is the assessment of our learners which determines their success and whether they graduate or not.

Educators often complain that in the written assessments “*students do not even bother to answer the question on the paper. They just write down chunks from their notes - verbatim*” and “*we may as well not even waste time setting specific questions. We should just have one instruction like, write down everything you know about ozone depletion*”. Singh (2004: 63) found that learners and especially second language

learners who experience difficulty in understanding (see also Superville, 2001) tend to memorise their notes for written examinations and then try to “fit” their answers into questions asked on the question paper instead of answering the question asked. Bradfoot (1996: 30, *see also* Darling Hammond and Falk, 1997) among others warn against rote learning or memorisation of facts simply for the purpose of regurgitation in a written exam adding that it makes the information “difficult to retain in the longer term”.

It has to be borne in mind that the purpose of assessment is not merely to pass or fail a student. According to Boud (2007) discourse of assessment should shift its focus away from the process of measuring effects and artefacts and move towards what education is intended for: that is, the formation of a capable person who can engage in professional work and contribute to society as an informed person. Boud and Falchikov (2007) explain that assessment is not sufficiently equipping students to learn in situations in which teachers and examinations are not present to focus their attention, and as a result, we are failing to prepare them for the rest of their lives.

This paper therefore reports on an oral assessment intervention in Biological Sciences at two higher education institutions in South Africa based on “practical activities and first hand experience” emphasized by The 1975 Belgrade and Tbilisi international agreements (UNESCO-UNEP 1976, 1978). The oral assessment intervention discussed in this paper focuses on formative assessment or “assessment for learning” (Qualifications and Curriculum Authority, 2004: 10) as thoughtful questions, careful listening, reflective responses, and high quality interactions are essential to clarify prior learning, explore current mis/understandings or to guide future improvements (Young, 2005: 3).

Grounded in a social-constructivist framework, this qualitative study located learning and assessment in Biological Sciences within the framework of situated learning which focused on the construction and assessment of knowledge within the learner’s community of practice.

### **Situating Learning within a Community of Practice**

Researchers (Carragher and Schliemann, 1982; Lave, 1988, 1993; Lave, Murtaugh and de la Rocha, 1984; Lave and Wenger, 1999; Rogoff, 1990, 1999; Rogoff and Gardner, 1999; Roth, 1994; Scribner, 1986, 1999; Wenger, 1998) have found that there are many discrepancies between what is taught at school and the real practice in everyday life. In other words, the culture of practice at schools does not correspond with the culture of practice in everyday life. To this end, Lave and Wenger (1999: 100) argue that “rather than learning by replicating the performances of others or by acquiring knowledge transmitted in instruction, we suggest that learning occurs through centripetal participation in the learning curriculum of the ambient community”. This implies “participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities”.

Parker (2009: 45) concurs that learning is a social activity in which knowledge and meaning are constructed through shared and joint practices between members of a community that share a common culture or language, codes and ways of seeing the world. If we are training our learners to take their place within the health science community, then we must ensure that their construction of knowledge takes place within the appropriate contexts and that their training and their assessments must be situated within these contexts, because as Lave (1988: 14) explains, knowledge constructed in practice is the locus of the most powerful knowledgeability of people in

the lived-in world. Vygotsky (Wertsch, 1985: 166) agreed that the thinking abilities of children develop as a result of attempting to communicate with other human beings.

In social-constructivism, language and dialogue are critical to the development of knowledge, for it is through dialogue that the community is able to construct common knowledge, and it is through internal language that individuals construct their idiosyncratic expression of the community's knowledge (Mandeville and Menchaca, 1994: 320). This "dialogue" should be carried forward into tertiary education, where learners are grappling with their medium of instruction and the content of the various courses they are studying. Since assessment determines whether a learner is ready for the job market or not, we should be placing more emphasis on this crucial deciding factor in a learner's life. So, while it is necessary for teaching and learning to be situated within the reality and experiences of the learner, so too must assessment be situated within the locus of everyday practice.

This paper extends Lave and Wenger's "situated learning" to include situated assessments within the learner's "community of practice" which means that assessments too must take place in the context of learner's everyday lives. Interaction and problem solving in real life does not occur in writing only, it involves dialogue, working within a community and thinking on one's feet. Oral assessment incorporates all of the above and the interactive nature of these assessments also means that participants can consult with each other, explain themselves, clarify issues, ask questions and work together to solve problems. As Schusler, Krasny, Peters and Decker (2009: 124) point out, environmental action is a process of co-creating environmental and social change while building individuals' capabilities for further participation contributing to personal and community transformation.

### **Research Design**

A total of two hundred and eighty three learners and six educators from two higher education institutions in Durban, South Africa formed the sample for this study. The learner sample was made up of second and third year learners doing the following subjects: Microbiology, Air Pollution, Environmental Pollution, Plant Biochemistry and Plant Physiology. One lecturer, two senior lecturers, one professor and two associate professors made up the assessor sample. In terms of years of experience at higher education level, one assessor indicated experience of between one and five years, two had between six and ten years, and one had between eleven and fifteen years and two had more than fifteen years. The assessors' participation in this study was voluntary.

No first year learners/courses were considered for this study because as an educator myself, I am mindful of the problems of adjustment, acculturation and language difficulties faced by first year learners (*see also* Penny, 1980). I did not want to add on the burden of a different type of assessment to their list. The population identified for this study was one hundred percent of the learners taking a subject (*see* Sekaran, 1992, 2003). I had to be present at the oral assessments to ensure that everything went according to the schedule, so the study had to be limited in terms of the population (Biological Sciences) and the geographical location (Durban, South Africa). Gipps (1995: 173) maintains that to pretend that we can generalize widely is to delude ourselves and others. Moss (1992: 250) and Gipps (1995: 173) agree that "transferability" which involves a description of the context in which the assessment took place, is far more important than "generalisability". Any significant results emerging from this study therefore may not reflect the situation at all higher education institutions but will undoubtedly prove useful in beginning to understand and address the assessment needs of learners at higher education level.

Ethical clearance had to be gained from both institutions before their learners could be involved in this study. Written consent was obtained from all the participants to allow the audio-taping of the assessment sessions and focus group discussions. All participants were guaranteed anonymity in the reporting of results, correspondence and write-up regarding this study.

Data was gathered by means of questionnaires and focus group discussions from all participants. The questionnaires provided me with biographical data as well as candidate perceptions of the assessments conducted. The focus group discussions allowed me to discuss issues related to the assessment sessions with the participants more candidly and in-depth. Data triangulation was used to determine validity by triangulating the five main sources of data generated, *viz.*: transcriptions of the audio-tapes and field notes of the assessment sessions; transcriptions of the audio-tape recorded focus group discussions with the learners and the assessors; and the written responses from the learner questionnaires and the assessor questionnaires (*see* Guion, 2002: 3). Collaboration with the assessors ensured the design of a rigorously debated assessment rubric or grid. The assessors were trained to conduct the assessments and to score learners on the oral assessment grid. These mock oral assessments were conducted before the learners were sent out into the communities to conduct their research so that they would know how the oral assessments would be structured. The assessors were mindful of the fact that learners would have to concentrate on writing up their project and then prepare for the orals, and that time was of the essence as examinations were looming. The mock orals were a simulation or trial for the actual oral, so all learners were present when members of their group were answering. All groups were asked the same questions but as it pertained to their particular topic. The topics were selected from their notes.

### **Structure of the Oral Assessments**

Learners were assessed in groups of six because a smaller number would have negated the purpose of conducting group orals. They were asked to choose the members of their own groups. As learners had to work on a project as a group, they could decide who they wanted to work with. As such, they were allowed to use their own method of selecting their groups. Many chose to work with their friends, while others chose to work with learners in their class that “*come to class everyday*” or those who “*get good marks*”. Each group was tasked with researching a particular aspect of their syllabus, within their own communities. The research areas included among others: water pollution, eutrophication, air pollution, pathogenic bacteria, environmental pollution and community development. Learners had to identify and research a real or actual problem which affected their particular community. Working as a group, this topic or area of research had to be confirmed with their lecturer.

Learners were given time frames within which to hand in their written projects to their lecturers.

They were then assessed orally on the written project they had completed. The duration of each oral assessment session was twenty five minutes. After a pilot study and careful deliberation of the breakdown of the time required for the assessments, with the assessors, it was decided that twenty five minutes per group was sufficient.

The assessors felt that “*since it is our first time with the orals, we should not intimidate the students with long assessments. Let’s first see if this whole thing is a success, then we can extend or shorten the time as required*”. The allotted twenty five minutes gave each group *four minutes* to discuss the questions as a group, *three minutes* for each learner to answer the questions in any order that they preferred (this was the total talk-time allocated per learner, it did not mean that the learner had to talk

for three minutes in a stretch) – this time had to be guided by the assessor, and *three minutes* to recap, ask questions or to address unanswered questions. This meant that a class of twenty four learners could be assessed in one hundred minutes (ten minutes over one double period).

The questions (based on their task) were typed and handed to the learners so that they could make reference to the question if necessary and they did not have to ask the assessors to repeat the questions. After the pilot study which followed an exclusively oral format, learners had complained that they “*need to write down what I am thinking*”. So, for the assessments, learners were given writing material to make notes or to jot down their thoughts and ideas which they could refer to during their assessment.

Each session was assessed by two assessors to ensure fair play and to improve reliability. The assessors scored the learners as individuals on separate assessment grids. Assessors were able to assess each learner individually as they were assessed or scored on their contribution to the discussion. Each learner was scored separately on an assessment grid or rubric which contained the name and student number of each learner. In essence therefore, each learner was scored as an individual even though they were part of group. This individual assessment within the group context was also possible because the assessor acted as facilitator of the discussion, drawing the quieter learners into the discussion thereby controlling the participation of the learners. The learners were scored as individuals because the assessors and learners felt strongly that if some learners performed badly, “*this should not affect the marks of those who did well*”.

Learners were briefed that they would have to answer the questions based on their research project and from their notes and discussions in class. The questions therefore revolved around: an explanation of how the problem occurred or the causes thereof, the effects of the problem on the community, their intervention and possible solutions to the problem. These questions were then broken up into sub-questions which allowed the examiner to elicit the desired response from the learners, like for example, when a learner was asked, “*what are the nutrients in eutrophication?*” Her response was, “*nitrates and phosphates*”. The assessor then asked, “*ok, but what nutrients give rise to the nitrates and phosphates?*” acknowledging the learner’s response, but delving deeper to get the answer to the original question posed. The oral examination also alleviated the pressure of thinking of the correct word or expression as one student found out, “*... the bacteria causes , er, some, er problems in the water. Ooh, I don’t know how you say it, um, contain, er, it makes the water not to be pure*”, to which the examiner responded, “*Do you mean, contaminate?*”. “*Yes, that’s the word I am trying to say,*” said the relieved student.

When learners answer in a very general manner, marks cannot be awarded because the assessor is uncertain as to whether the learner knows the correct answer. In the oral assessment, the assessor can pose further questions to determine whether the learner does in fact know the answer, as illustrated by this excerpt from an Epidemiology oral:

*Learner: I don’t think they can penetrate into the body*  
*Assessor: What do you mean ‘into the body’? Be more specific, where in the body?*  
*Learner: Into the lungs ...*

Or this excerpt from a Microbiology oral:

*Assessor: What happens inside the bacterium in an anaerobic environment?*  
*Student: In an anaerobic environment, it copes with um, er, formation of spores?*  
*Assessor: Sometimes, yes, but, I mean ...*

*Student: Metabolic pathways?*

*Assessor: Correct, yes. And what does this switch consist of mostly?*

*Student: Er ... [silence]*

*Assessor: If there is no oxygen ...?*

Another example is taken from a Microbiology oral where a student was responding to a question on water contamination with, *“it does contain some bacteria, but these bacteria are present to stop contamination from, er, other bacteria making it safe to drink”*. The examiner had to intervene and ask the candidate to clarify what she was saying, *“... but that depends on many things. So, what are you telling me then about the level of contamination of the water?”* The student then rephrased her answer to, *“that potable water is not absolutely sterile or pure”*. The assessor was not satisfied and said, *“but we live, we drink it, we live ...”*. The student interjected with, *“yes”*, but the examiner wanted more information and added, *“the presence of these bacteria ... What kind of bacteria are they and where would they come from?”* Still the student did not follow and asked, *“which bacteria?”* To which the examiner replied, *“the ones in the potable water”*. It was only then that she was able to discuss the bacteria present in potable water. Agreeably this student had problems structuring her answer and had to be helped along by the assessor, but imagine what this student would have written in an essay without the guidance of the examiner – most likely an unintelligible essay or one that would not have answered the question.

It must be borne in mind that the above are just excerpts from the oral to demonstrate how the assessor posed further questions to the learner to get clarity on a response so that a mark could be awarded after the learner and the assessor understood each other. They were also not the main questions for the assessment as this would have entailed pure rote learning. Learners were asked among other questions about their intervention regarding the situation and possible solutions to the problem. They were required to apply the lessons learned in class to the real life situations.

### **Encouraging Thinking through Dialogue**

Analyses of the questionnaires, focus group discussions and my observations of the oral assessments revealed that the assessors and learners were very pleased with the *“level of interaction”*, *“dialogue”* and *“camaraderie”* provided by the oral assessments. Assessors were excited that the orals *“encouraged the students to think on their feet”* and *“we could probe student’s thinking. We didn’t just have to listen to learned off answers. We were engaged in dialogue”*. The learners responded that *“we had to study very differently for the oral. My friends and I learn off our notes by heart, but for the orals, we had to read and understand our notes, sheesh that was tough!”* It must be borne in mind that this was the learners’ first experience with actually going out into their communities to research problems that affect them, and situated cognition and communities of practice are not the norm. It was also the first time that the assessors had engaged in such a task with their learners. This was also the learners and the assessors’ first experience with oral assessment.

When learners are engaged in conversation about their learning, it enhances their critical thinking skills as they engage with other’s perceptions and opinions. The group oral assessments encouraged learners to listen to, think about and assess each other’s answers. They also listened to the answers and discussions provided by their assessors. *“It was a very new experience”* said one learner, *“in class we never get to speak one-on-one to our teachers, and in the orals, which is an exam, we were chatting to each other - it was so weird, but also cool”*. While there were complaints about *“nervousness”* and *“having to think on our feet”*, learners were unanimous that

*“the greatest benefit of the orals”* was *“the learning that took place”*. Situating the assessments within the learner’s community of practice, did not only lead to learning for the individuals in the group, but it also led to them sharing their learning with their communities. One learner said, *“our notes came alive. For the first time I understood what eutrophication means because we were talking about things in our communities and we were using real examples that we understand”*. Another member of the group added, *“when I went to the park with my friends after that, I was teaching them about the pond and what caused the problem. They were looking at me very strange like with ... er ... respect. My friend wanted to be smart so he told his father when he went home. And his father said that he will talk to his cousin who works in the eThekweni Municipality to look at the situation”*. While there was no formal feedback to their communities, learners were encouraged to share information about their research by liaising with residents, key members of the community, stakeholders and others who could assist with dealing with the problem identified. Such sharing of information and learning can only lead to improved awareness and education about one’s environment.

Another group who had engaged the ward councilor, local residents and the refinery in the Merebank community (in the Durban south basin) while researching their task, were very excited that *“we are now going to work with our lecturer on an Air Pollution project about the Southern Basin. We’ll be working on a problem that affects our community. We are so excited”*. An assessor said, *“it was a valuable learning experience for us too, because we learned about how our students think. From the numerous questions they were asking regarding the application of legislations to their own communities and regions, it is clear that we need to focus our teaching and assessments to their realities so that it will make sense and have value for them”*.

Regarding the structure of the assessments, participants agreed that the group format was a good way to *“get students thinking”* and to *“share ideas”* but that the duration of the assessments should be extended to *“about one hour”*. Given the fact that educators complain about class sizes and the amount of time that oral assessments take to conduct, this recommendation came as a surprise. They quickly added though that that these assessments should be programmed into their time-tables so that they would not have to use up additional time to accommodate these assessments. As the oral assessments promote learning and enable educators to *“establish individual starting points in terms of knowledge, understanding and skills”* and allows them to *“later determine whether individuals have been helped to move on from those starting points”* (Qualification and Curriculum Authority, 2004) it would make sense to incorporate these assessments into the educators’ and learners’ syllabus or schedule.

Commenting on the emerging challenges of situating and assessing Biological Sciences within communities of discourse, assessors commented that cost could be a major stumbling block. Given that classes are large and that many of the learners live in remote rural areas, while others live in different provinces and still others live abroad, the cost of funding such projects could pose a huge problem. Of course, assessors would have to monitor the research projects, so the cost of their travel would also have to be taken into account. Referring to the oral assessment itself, learners were concerned that working in groups meant that they had to *“carry”* learners who were weak and did not contribute. They were also concerned that *“some students in the group talk too much and others don’t get a chance to say everything they want”* and *“I felt I had to answer quickly because the others were just beating about the bush instead of getting to the point and answering the question”*. The assessors remarked

that the assessments were facilitated and controlled so that any one learner is not allowed to dominate the discussions, but that they would need thorough training in this area.

## CONCLUSION

This study brought “dialogue” and the “learner’s reality” or “community of discourse” into the assessment of Biological Sciences. Learners were engaged with and were involved in live interaction with members of their communities in their projects. They were involved in real life situations and were using their knowledge in the field. By doing so, they involved the greater community in their learning while contributing themselves toward learning by encouraging others to become aware of environmental issues in their community. During the oral assessments, they were able to learn from each other and from the assessor.

Given that higher education institutions globally are now registering greater numbers of foreign students, one has to look at the problems associated with language and medium of instruction. The dialogue afforded by the oral assessments allows face-to-face interaction between learner and assessor so that each can seek clarity from the other. The content of the subject and not the language of interaction therefore becomes the focal point of the assessment. These assessments can be tailored to suit the subject and the participants.

This paper does not contend that the incorporation of oral assessments will solve all problems in our classrooms or that thinking in Biological Sciences will improve dramatically. This paper also acknowledges that oral assessment is just one innovative method of assessment and that many educators use other successful methods of assessment in Biological Sciences such as learning logs, portfolios, projects and essays among others. However, this paper will hopefully help educators to get an insight into how communities of practice can be used as a possible learning approach in Biological Sciences using oral assessments as they can be structured to encourage thinking through dialogue.

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