
Out-of-school experiences in science classes: problems, issues and challenges in Botswana

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This paper sets out to identify some key problems, issues and challenges relating to out-of-school experiences of learners in science teaching that emerged during classroom observations in schools in Botswana. Generally, there is evidence suggesting weak incorporation of learners' experiences into teaching. The experiences seemed to have a lower teaching priority than did formal universally accepted canonical science concepts. The study revealed that the relative merits of the science curriculum also appeared undermined by lack of teacher preparedness to handle the learners' out-of-school experiences. This paper also considers some of the implications of the research findings to science education in Botswana.

Introduction

The issue of out-of-school personal experiences of the learners in science teaching is an important one, both in Botswana and elsewhere internationally. Studying science concepts in contexts involving out-of-school experiences of learners is consistent with the notion of humanizing science and promoting meaningful learning in culturally and cognitively appropriate ways (see Ingle and Turner 1981). This helps promote the 'relevance' of science to both learners and society – a 'contextualist' approach to science teaching (Matthews 1990). As Newton (1988) states, incorporating out-of-school experiences into teaching is 'commonly seen as having a strong motivational value and to hold promise for enhanced learning, retention and recall of what has been taught' (p. 8). Moreover, there is a high political value and appeal of teaching science that does not alienate learners from their experiences, socio-economic environment, culture, norms and societal values (see, for instance, George 1999, Jegede 1995, Nganunu 1988, Yoloye 1998).

The aforementioned factors have in recent decades led to the development of various science schemes in America and Europe sharing some common philosophical assumptions about science teaching, science and technology in society (STS), with some schemes overtly emphasizing the teaching of science in social contexts (e.g. SISCON; Solomon 1985). Some developing nations followed suit (see Knamailler 1984), including Swaziland in Southern Africa where a contextualized science curriculum was developed and implemented (see Campbell and Lubben 2000, Lubben et al. 1996). Botswana apparently implements a weak version of an adapted STS program in line with those in the UK (Rollnick 1998).

Nonetheless, the perceived and theoretical advantages of implementing such programs appear illusive and inconclusive in practice (see Mayoh and Knutton

1997, 1998, Peacock 1995). As Cajas (1998) notes, sadly some STS programs have had little or no impact in promoting relevance of science in society. And, as Lubben et al. rightly observe, 'little is known about student's responses to science curriculum content and teaching methods designed to be locally relevant' (1996: 311). Peacock also notes the dilemma posed by the regimented and testable knowledge dictated by the selection examinations, which might include 'topics which most rural children are unlikely to utilize in their daily lives' (1995: 154), as well as being remotely related to their experiences. The situation is a vivid and fitting reminder of Ingle and Turner's (1981) classic paper 'Science curricula as a cultural misfit'. The origins of the problems are perhaps explained away by Cajas (1998), who notes that the lack of research on how teachers connect learners' out-of-school experiences with science and how learners actually use science in their everyday lives. Furthermore, Mayoh and Knutton (1998) have noted in the UK context that there was a dearth of episodes in which out-of-school experiences were sought, discussed and/or formed the basis of science teaching.

The observations are of relevance to this study as science taught in lower secondary schools in Botswana serves a multiplicity of purposes including, among others, preparing the youths (age 14 + years) over a 3-year period, both for further education and adult life. The latter is the social rationale for science teaching in Botswana, a middle-income country with a relatively un-diversified economy and high unemployment rates. As Kahn (1990) notes, lower secondary education is no longer a stepping stone to senior secondary school education: those who fail to proceed to senior secondary school 'would have to seek paid employment in town or return to rural areas'. The education system as well as some key aspects of the science curriculum is discussed in the next section.

Context

Botswana offers a tripartite co-education system comprising 7-year primary school education, followed by 3-year lower secondary, terminating with a 2-year senior secondary school education. The latter stage of secondary education is equivalent to the University of Cambridge 'O-level' education. Collectively the primary and lower secondary education comprise a 10-year Basic Education cycle, after which learners sit selection terminal examinations. Learners move from primary to lower secondary education through automatic promotion, irrespective of their performance at the Primary School Leaving Examinations. Within the lower secondary school education, a host of vocational electives comprising Art, Design and Technology, Business Studies, Home Economics, Religious and Moral Education are offered alongside traditional core subjects including English, Mathematics and Science, among others. Tuition-free education is offered from primary to senior secondary schools and this has resulted in wide access to education, high pupil retention rates and mixed ability classes, particularly within the 10-year Basic Education cycle.

The current science curriculum was enacted in 1996 following the recommendations of the country's second National Commission on Education of 1993 and the subsequent publication of the Revised National Policy on Education of 1994. The latter commission built upon the work of its predecessor (Republic of Botswana 1994: 2), which had advocated for education that should 'orientate young people toward social, cultural, artistic, political and economic life of their unique

society' (Republic of Botswana 1977: 12). The statement was significant in that it marked not only the beginning of consolidation of the independence in Botswana through appropriate education, but also marked a shift in paradigms and values on education through provision of locally relevant curriculum.

The history of science curriculum changes in Botswana prior to and after 1977, the year the country's first National Commission on Education made its findings public, is widely documented, particularly as it marked the beginning of some independence from curriculum models from the UK (see, for instance, Kahn 1989, Nganunu 1988, Prophet 1990). However, the adaptation of the already modified version of the 'Science for 70s' Scottish Integrated Science Scheme (discussed thoroughly by Hamilton 1982) to suit the local context appeared inevitable due to the relatively weak curriculum development in Botswana (see Kahn 1989, Nganunu 1988). The practice appeared consistent with that in other developing nations (see, for example, Lewin 1990) where context-dependent and context-driven curricula with themes, perspectives and examples drawn from learners' immediate environs are modified versions of curricula from Western metropolitan nations. The introduction of the first distinctly 'localized' curriculum in schools in Botswana was done in 1986. The current curriculum materials introduced in schools in 1996 have upheld the philosophy of their predecessors and have not brought about any radical changes.

The current integrated science curriculum, an amalgam of Biology, Chemistry and Physics topics, developed in 1995 by a 20-member Task Force, has seven detailed aims. Three aims relevant to this study state that: 'At the end of three years of Junior Secondary Science Programme, students are expected to have developed:

1. an understanding of the basic principles and concepts of science as they are experienced in everyday life.
 2. positive attitudes towards scientific skills such as curiosity, open-mindedness, creativity, objectivity, integrity and initiative.
 3. an awareness and appreciation of the interrelationships between science, technology and society in the context of science and everyday life.'
- (Ministry of Education (Botswana) 1995: ii-iii)

The aims of the syllabus reflect concerns with contemporary debates in science education and how science can enhance the quality of life of learners. The aims are also consistent with the spirit of national development through the creation of a scientifically literate society that can bring science to bear, where possible, in various areas of human endeavor. Nonetheless, a major weakness of the curriculum aims seems to be that they give no specific recognition of the context in which the curriculum is situated, given the disparate socio-economic contexts of Botswana.

The foreword for the science syllabus document makes clear assertions on the position of out-of-school experiences in science teaching. It is stated that 'the content has been selected from the students' immediate environment to facilitate understanding and ease of transfer of skills and knowledge to real life situations' (Ministry of Education (Botswana) 1995: foreword). Furthermore:

Science learning . . . should draw from and apply to living experiences in an effort to give children practical, relevant, and meaningful experiences in preparing them for living in a changing world. (Ministry of Education (Botswana) 1995: i-ii)

The statement aligns the curriculum well with one of the recommendations of the National Commission on Education of 1976, which stated that education should aim to:

... provide all children with: ... an understanding of scientific and technical subjects, based on examples from their own environment; a sense on nature of their society and their role in it; ... an orientation toward work in the real world. (Republic of Botswana 1977: 6)

Furthermore, consistent with pronouncements on linking the science curriculum to everyday lives of learners and empowering them for the twenty-first century, a whole new module on information technology/computing was introduced. There is also an overt campaign to conscientize learners and educate them on the contemporary topical issues impinging on mankind such as HIV/AIDS, Drug Abuse, Conservation of Natural Resources, and Pollution. As Reid (1975) says, it appears it had become:

... apparent the critical task of educators was to equip children for an uncertain future and, consequently, that the central concern of curriculum planning must be to foster and facilitate change and not to refine instruments which tended to perpetuate the status quo. (p. 242)

Implementing a curriculum with a pronounced social rationale is also important in Botswana due to the high attrition rates of learners as they move from lower secondary to senior secondary school education. School drop-outs (age 16 + years) start adulthood too early as they face a bleak future with no prospect for meaningful employment (see Tournas 1996). The National Commission on Education of 1993 noted that of the about 21,945 16 + year olds who sat their terminal selection lower secondary school education examinations in 1991, 11% were absorbed into vocational training institutions; 27% enrolled into senior secondary schools while 62% became school-drop outs (see also Republic of Botswana 1994, 2001, Tournas 1996). The progression rate to senior secondary school education was expected to decline to 25% by the end of 1997, following the construction of more lower secondary schools (Republic of Botswana 1994: 167). However, contrary to the expectation and due to the unprecedented expansion of senior secondary schools, the progression rate has increased to 49% as 18,068 out of 36,562 learners enrolled into senior secondary schools in 1999 (Republic of Botswana 2001: 13). The justification for a relevant science education program that fosters links between science and the lives of the learners cannot be faulted, given the high attrition rate. It has therefore become imperative to investigate and seek an understanding of the problems, issues and challenges in implementing the locally relevant science curriculum in Botswana.

Purpose of the study

The purpose of the study is to seek an understanding of teaching episodes in science lessons as science teachers attempt to incorporate into the formal science the appropriate out-of-school experiences of the learners. Consequently, the following research questions guided the study:

- (a) What are the observed classroom transactions in teaching episodes involving out-of-school experiences of learners?
- (b) What problems, issues and challenges arise from the teaching episodes?

- (c) What are the implications of the findings to science teaching in Botswana?

A qualitative case study methodology was adopted in attempting to answer these research questions. It is envisaged that the findings of the study will contribute to knowledge on the incorporation of the out-of-school experiences into science teaching particularly from a developing country perspective.

Methodology

The data in this paper are drawn from a study involving 26 science teachers in eight lower secondary schools, also known as Community Junior Secondary Schools, in one semi-urban location 50–60 km from Gaborone, the capital city of Botswana. The main qualitative case study (see Merriam 1998) focused on the implementation of the new science curriculum. According to Yin (1994: 1), case studies are used when the ‘investigator has little control over events, and when the focus is on contemporary phenomena within some real-life context’. The year-long study, conducted between July 1997 and June 1998, enabled teachers to be observed over many hours of teaching. The main modes for data collection were participant observation, interviews and document collection (see Koosimile 2002).

Data collection was inspired by ‘process perspective’ (see Fullan and Pomphret 1977) in which case the concern was with the ‘operational curriculum’ the actual instructional process in the classroom (Goodlad et al. 1979) and seeking explanations from the contexts and users of the formal curriculum. Through participant observation (Denzin 1978, Goetz and LeCompte 1984, Spindler and Spindler 1992), classroom observations at Form 1, Form 2 and Form 3, corresponding respectively to first, second and third years of lower secondary school education, involved a week-long contact with different science classes. Through systematic observations, the cross-section of classes facilitated data triangulation (Anderson and Arsenault 1998, Denzin 1978, Knupfer 1996). The ‘open-ended’ and ‘unstructured’ observations (see Delamont 1975, Delamont and Hamilton 1975, Hargreaves 1998), recorded chronologically on blank sheets of paper, encompassed teacher and learner activities, and some complementary and/or explanatory notes meant to preserve the integrity of the various teaching situations.

This approach was legitimized by the exploratory nature of the study, enabling the researcher to pick up important features in various teaching situations. Through a progressive focusing strategy (see Stephens 1990), systematic identification of instances of data saturation (Bogdan and Biklen 1998, Denzin 1978), systematic deductive and inductive data analysis involving data coding and theme identification (see Tesch 1990) during fieldwork, it became possible to identify some key aspects of curriculum implementation, including those that received relatively little attention from teachers. The incorporation of the out-of-school experiences of the learners into science teaching fell within the latter category. The latter area was then designated one of the significant lines of enquiry in the main study, focusing on the implementation of the science curriculum (see Koosimile 1999). This paper reports on the research findings and their implications to science teaching in Botswana in particular, and developing nations in general.

Research findings

The presentation of findings with respect to the first research question briefly highlights trends noted in the observational data, with examples provided to illustrate various aspects of teaching episodes with out-of-school experiences and contributions from learners in science lessons.

Generally there prevailed a situation where the examples were used loosely and solely to demonstrate aspects of daily applications and/or manifestations of given science concepts. Here the examples served a restricted purpose, including expediting teaching. As one teacher said:

. . . I do not use that [i.e., out-of-school experiences] a lot . . . whenever there is a problem, like when I introduce something to them . . . if I realize that they are lost, I just come up with a real-life situation, taking them home a bit so that they can think of what happens at home and try to relate that to what I am going to teach. (Interview, File 5)

One teacher cited 'oversight' as a reason for failing to link science to the experiences of the learners in the six consecutive lessons taught on Digestion. He explained:

Sometimes it is just overlooking that aspect. It is unfortunate that you came in at the time when I did not have any experiences from learners' side or mine! (Interview, File 6)

Nonetheless, there were some cases where teachers could not easily create links between the learners' out-of-school experiences and science. Evidence for this came in different forms. In one case, when asked about the objectives of an activity on First Aid, the science teacher said:

I wanted them to realize that there is science in the home and in school. So, even though we do things differently but somewhere they link together . . . I know they have an experience . . . For the First Aid techniques at home there are no explanations on how they work but at the end we can realize that even though there is no explanation . . . but . . . they help. (Interview, File 1)

The activity had been inspired by the syllabus document and not by the teacher's own initiative, ingenuity and creativity. In such situations the examples given in class occupied somewhat ambiguous positions because it was not clear whether they were covered as a mere formality as part of the requirements of the curriculum, or whether they were meant to be of any educational value to learners. However, in commenting on the observed segregation in teaching between non-science and science, one teacher succinctly pointed out that, learners

. . . have certain fixed ideas which I think are related to upbringing and it is very difficult to make them see that it is not scientific . . . They find it difficult to relate it [i.e. formal science] to reality: it is something in the book and done in school. It is not something that relates to home. That is how I see it. To learn it, it does not stay because it is something artificial, not related to reality which can become part of them. (Interview, File 6)

However, the difficulty is also recognized in the curriculum rhetoric:

In teaching the syllabus, it should be realised that when children come to school, they come not with blank minds, but with some knowledge, skills, attitudes and beliefs. Some of the experiences may become useful or inhibitive during the teaching process, and so teachers have to be aware of these earlier experiences to more effectively communicate understanding through recognizing individual abilities, interests and needs . . . (Ministry of Education (Botswana) 1995: i)

However, there is no pretense or guidance as to how teachers should recognize the experiences from learners and how the experiences should or could be infused into the learning of science.

Related to the foregoing observation is the manner in which the out-of-school experiences and contributions from the learners were elicited and handled. The question-and-answer strategy was used predominantly, although there was occasional use of pictorials in science textbooks. Teachers generally assumed that the learners were prepared for the tasks and nothing was done to ascertain and subsequently facilitate the readiness of the learners to engage in the activity. Through the approach, it appears teachers hoped that the teaching episodes would not only naturally stimulate thought, interest and learning in learners, but also that the episodes will enhance knowledge transfer, application and abstraction. This resulted in the weak provision of learning guidance, with relatively little or no prospect of learners achieving the desired competencies of linking their personal experiences to science taught in schools. The latter observation is readily evidenced by the observational data from the study as now illustrated.

The following recounted episode relates to discussion on water vapor as one of the constituents of air. The lesson was at a stage when the teacher had asked: 'when can we have little water in the atmosphere?'

One learner said water vapor is low in the atmosphere when it is 'cold', an answer the teacher accepted. However, in reality it appears that the vapor is possibly low when the land is hot and dry but high when it is cool, as in the morning or at night. Another learner, answering the same question, said water vapor was low 'when there is sunlight'. The teacher responded:

Sunlight, is it? I think you are guessing. What is water vapor, if I may ask? [Observation, File 5]

In fact, the latter's response probably contradicted the earlier response in that the sunlight could be, or is, associated with hotness (warmth). On the question of what water vapor is, the following verbal exchange occurred:

John: sometimes we get it after rain
Teacher: I did not say *when* but *what* is water vapor!
Kef: It is a moisture of a water droplet!
Teacher: Is it? Yes! . . . [signaling to another learner to make an attempt at answering the question]
Moses: [remained silent]
Teacher: . . . water vapor is the gaseous state of water. When it is very hot, there is very little of it in air but when humid you get loads of it in air . . . [Observation, File 5]

This explanation is noteworthy in that it appears consistent with the view that water vapor is low 'when there is sunlight'. The responses from learners were clearly framed within their everyday experiences and modes of self-expression, which are seemingly devoid of formal scientific terminology. There is a clear mismatch between teachers' scientific conception and the learners' everyday language. On the contrary, the responses reflected the ingenuity by learners attempting to answer questions framed within the context of their daily experiences, but whose explanations seemed to be only confined to formal science.

Two more examples are used to illustrate the latter point. In one case, the teacher rejected an explanation by a learner that a crocodile basking in the sun

exemplified some form of its adaptation to its environment. Another example is of a learner who said solid matter floats in a septic tank because it is *lighter* than water. The responses were rejected by the respective teachers who, in turn, were predisposed to supplying or accepting particular scientific versions and explanations of reality. There existed a content-oriented pedagogical problem, or more specifically, a 'science-centred' approach (Newton 1988: 9). Furthermore, as Prophet and Rowell (1988) also noted, the situation may lead to some form of conceptual confusion and possibly some learner insecurity particularly as teachers 'declare other ways of describing reality as less valid' (p. 29).

However, some episodes in teaching revealed teachers' lack of knowledge of the learners' environment, reducing further prospects of science teaching meaningfully linked to the learners' environment. For instance, in one class on sources of water in Botswana, learners said there were *rivers* in their locality, but the teacher denied the 'fact', adding that rivers would always have water flowing in them. This explanation was and is at variance with typical conceptions of rivers and streams, mostly ephemeral or transient in Botswana. It would seem that learners were left doubtful of the teacher's conception and interpretation of a river both as a concept and as a physical structure. In another instance, a teacher's lack of acquaintance with the environment became apparent in a lesson on the Ecosystem. The teacher expressed her surprise when learners said that frogs ate insects. The teacher thought snakes would kill but not eat frogs. This occurred as the class was attempting to construct a Food Chain comprising different living organisms drawn from the learners' environment. In all the cases cited the conceptual and/or knowledge conflicts and possible confusion that arose from different interpretations of terms and/or situations were left unattended. Science possibly remained esoteric and sterile, seemingly devoid of meaningful connections with both the teachers' and learners' out-of-school experiences and environments.

As Jegede (1995) rightly notes within the framework of 'collateral learning' and 'the eco-cultural paradigm' for explaining the ideal-real curriculum gaps noted in science teaching in Africa: 'this "good" scientist (i.e., the learner) at school can at home be a "traditionalist" without any feeling of cognitive perturbation or dissonance' (p. 350) (see also Rollnick 1998: 86). This view is similar to those findings based on constructivist ideology in which world-views of learners or alternative frameworks have both posed a challenge to teaching while proving recalcitrant to change (Driver 1989, Solomon 1987).

Nonetheless, the problems noted pose another set of challenges to the science teaching. The worlds of science and out-of-school experiences of learners have to be reconciled, but how? This is also a question of how to reduce apparent alienation between teachers and learners and find views and conceptions of science that could mediate in the learning process. The issue here also partly concerns how to encourage teachers to move away from positions of being specialist and experts in teaching science yet retaining the power to manage classrooms and to live positively within them with their learners. The other significant aspect of the issue drawn from the observational data is that while teachers and learners shared the same native language, Setswana, it was never used in pursuit of the learners' interest and the goals of the curriculum. The neglect of the language, a potentially useful medium for encouraging learners to pursue and communicate their experiences and ideas confidently and holistically, also basically raises questions regarding who the curriculum is meant for and what values it espouses, or is perceived to espouse by

teachers. This could also be a question of disparities between the teachers' and their learners' socio-economic status.

Perhaps unwittingly, the syllabus document sometimes presented examples that teachers readily identified with, but whose relevance to learners' experiences is possibly questionable (see Peacock 1995). In this case, some highly science-based examples and technological gadgets inaccessible to learners but to their teachers easily passed for authentic examples from learners' environment and experiences. A fitting illustration is that of teachers with solar water heaters at their official residences within the school bounds, while their learners in the rural setting did not have similar facilities at their homes. While one teacher concurred that learners may have had no experience with solar water heaters, the example was regarded as appropriate:

It is not irrelevant to their experiences but that is how it can be used in some cases. The same applies to the car cooling system, they are not familiar with it, but we still have to do it. [Interview, File 11]

The two (i.e. water solar heaters and cooling system in cars), in addition to a vacuum flask, had been the only examples given both in the syllabus and in class as exemplary contexts of applications of the principles of heat convection, radiation and conduction. One possible effect of the examples was to alienate the learners from both the information that was being transmitted and from the teachers themselves, with learners possibly unable to penetrate the technologically advanced worlds of their teachers. However, it is important to acknowledge that the argument for applications of science in society is that such issues have greater relevance not because they are necessarily part of the direct experiences of the learners. The point here is that teaching was devoid of long-standing indigenous applications of science and basic everyday items that could be used as exemplars. The science teachers' predisposition towards picking examples from their own technologically advanced environments while in a rural hinterland was manifest in other situations as well.

For instance, in one case one teacher gave an example drawn from a television news feature in which a man had swallowed cocaine wrapped in condoms. However, learners have restricted access, if any, to television sets due to their socio-economic status. In one school, a colored television set brought into class for showing a video on 'The Blood and the Circulatory System' stirred some excitement among the learners. Its arrival had earlier been marked by some cheering for, to learners, it was perhaps a once-in-a-while opportunity to see and come closer to this entertainment-cum-educational-audio-visual gadget.

But quite clearly, the teachers and learners were on different sides of a socio-economic and technological divide in this rural hinterland and the differences were manifest in different ways in science classes. For teachers, televisions, solar water heating panels and various other technological gadgets, as well English and scientific language, are components of both their professional and personal lives. Overall, there appears to be an unclear and undefined relationship between the positions of the teacher, the learners, their out-of-school experiences and environment, and science. What is also missing from the observational data is how the latter set of elements of the teaching situation were positioned by the science curriculum itself.

Interestingly, the observational data showed some disparities in learner participation between the Biology, Chemistry and Physics modules of the

integrated science syllabus. It is apparent from the data that it was mostly on Biology modules where learners brought forward their personal experiences, particularly on Family Health, HIV/AIDS, Drug Abuse, and Environmental Pollution. The modules have some immediate relevance to social issues that learners identified with relatively easily. The 'bias' possibly resulted in heightened participation of learners, although the teaching appeared highly teacher-controlled and contrived. In comparison, there were virtually negligible contributions by learners in Chemistry modules, while the situation appeared relatively better in Physics modules. This could be due to the fact that the technological applications relevant to Physics appeared relatively easy to pick from science textbooks. Overall, the observations probably indicate that learners were predisposed to engage in active participation in view of the usefulness and applicability in a general social context of scientific information. However, it cannot be determined, on the basis of results, whether the learners' participation resulted in enhanced intellectual returns, or presents a clear case for putting emphasis on principles and their application as opposed to factual knowledge that seemed to dominate the Chemistry and Physics teaching episodes.

Overall, and from the teachers' point of view, the incorporation of out-of-school experiences into science teaching as part of the challenges faced in the implementation of the new science curriculum is widely recognized by teachers. One teacher said:

... Experienced people should be able to come and tell everybody how to deal best with each topic because this thing [syllabus] is the first go ... we do not know a whole lot of things. There should be some sort of co-ordination that this topic should be treated this way ... you will get this type of material from here to there ... (Interview, File 6)

The teacher's plea essentially sets a stage for consideration of the second research question regarding the lessons that can be derived from the observed teaching episodes.

From the research findings it appears that the pedagogic advantages of using out-of-school experiences in science teaching may have not been realized. The situation arises due to several factors. There exists a complex question of what the curriculum stands for and the depth to which an explanation of phenomena should be taken. As some cases show, with some teachers under-prepared for out-of-school experiences, science teaching has not made in-roads into the socio-economic environs in which both the learners and the schools are located. Borrowing expressions from Hall (1977), it can be said that science teaching activities:

... stood, in essence, for value, for kinds of learning, for types of discipline and authority, it affirmed experiences altogether at variance with its natural environment ... This mismatch between where the schools stood, and what they stood for, was always a glaring one - part of a larger contradiction. (pp. 12-13)

There also appears to be a tension in a curriculum that seeks to locate its implementation in the wider social contexts, while at the same time carrying futuristic goals of preparing the youth for participation in technologically advanced twenty-first century Botswana. It is a tension between the conservative and the futuristic goals of the curriculum. But, as Newton (1988) aptly observes:

... The dilemma is that, giving consideration to the students' present and future needs would make for relevant science teaching but risks overly reinforcing class and cultural divisions. (p. 9)

Thus, the lack of complementarity between teachers' and learners' views in several instances noted in this work could be more than just a pedagogical problem: it is possibly a question of what passes for 'good and/or desirable science' in a contemporary and dynamic developing country such as Botswana. The other challenge here remains that of defining the place in the curriculum of the out-of-school experiences of the learner in harmony with the wider socio-political and socio-economic aspects of the nation. Accordingly, the challenge to curriculum developers and science educators appears clear: curriculum support materials should reflect both the generic and social rationale of the new curriculum in order to encourage and support any pedagogical innovation by teachers.

Implications for science teaching in Botswana

The manner in which teachers handled episodes involving contributions from their learners needs to be acknowledged as an issue for teacher professional development. There was an apparent lack of framework for probing in a structured, progressive and constructive manner those experiences and contributions tendered by learners for consideration in class. Given the nature of the curriculum, a teacher should have 'first, intimate, habitual, intuitive familiarity with things; secondly, systematic knowledge of things; and thirdly, an effective way of thinking about things' (Whyte 1984: 282). This appears to be a fundamental requirement for handling situations where the learners' percepts and their experiences meet Western science concepts. By extension, teacher training should also orient itself to the specific needs of the new curriculum.

Another issue for teacher professional development is that of ethics and greater respect for learners in science teaching. The cynicism, dogmatism and authoritarianism noted in some of the research findings are perhaps implicit indicators of lack of a pedagogical tool that fosters a common ground or framework for operation between the knowledgeable teachers and their learners. This is a question of ethics in teaching, hardly spoken about in the literature. By adopting a more ethically correct posture, the teacher may come to identify more with their learners' way of life, perceptions, and the contributions they make in class. The indirect implication of this to science education is that schools need to be proactive in as far as promoting positive attitudes to and links with their environments, particularly in light of the large concentration of learners in schools in rural areas in Botswana.

However, on one hand, the disparities noted in learner participation in episodes on Biology, Physics and Chemistry modules are possibly indicative of teachers laboring with conceptualizing and actualizing the curriculum rhetoric. On the other hand, the findings possibly highlight some of the attendant difficulties of the new curriculum, characterized by the 'retention of the orthodox curriculum but with an effort to introduce pupil activities and greater local relevance' (Sinclair and Lillis 1980: 173). The syllabus document – the official curriculum – itself appears to fail to advertise, publicize and make evident its links with the environment, hence possibly failing teachers in their practice.

End piece

The purpose of this paper was three-fold; namely, to state the observed teaching episodes involving out-of-school experiences of learners in science classes and to

present lessons derived from the episodes, together with their implications to science teaching in Botswana. Overall, there were relatively few and sporadic episodes in which teachers attempted to link and incorporate the learners experiences into science teaching (see Mayoh and Knutton 1998).

The fact that teachers place a lot of emphasis on universal science concepts and not on how learners know, experience and relate science to their everyday lives raises one major issue. The issue relates to defining 'relevance' or a 'contextualized' curriculum in a way that would meaningfully serve as a sustainable framework for science teaching in Botswana. Without such a framework, and with the apparent lack of clear pedagogical tools for science teaching, the goals of science curriculum may never be realized. The situation defeats the social rationale for a science curriculum whose goals are to produce scientifically and functionally literate individuals, regarded highly as a crucial element of social transformation in Botswana.

There nonetheless appears to exist a need to bridge the gap between what teachers and their learners value as worthy of consideration in science classes, rather than teachers seeking everyday exemplars that support science teaching instead of those bringing science into the lives of the learners. And, indeed, Rollnick's observation that 'relevance means more than changing content and methods of teaching' (1998: 83) but also attitudes, perceptions and other contextual or situational factors pertinent to teaching, is very incisive.

The research findings have implications for adoption of science curricula that have not taken into consideration the learners' natural disposition to experiencing and interpreting phenomena in their own way. The limited episodes comprising data for this study means that more research is needed in this area before the findings can be made fully operational in terms of instruction, learning and curriculum development.

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