

Teachers' Conceptions of Teaching Physical Science in the Medium of English: A Case Study

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KEYWORDS Code Switching. Innovations. Language Competency. Abstract Concepts. Examinations

ABSTRACT There are still many teachers who are daunted by mandates of language policy in South Africa. In historically Black schools some continue using the medium of indigenous languages although the official language of teaching is English. English still dominates the society despite the proclamation that there are 11 official languages. This article draws from a qualitative study conducted in the Province of KwaZulu-Natal where four Physical Science (Black African) teachers were participants. These participants were observed and interviewed as the researchers investigated their conceptions of teaching Physical Science in the medium of English language. The results show that Black African teachers do not always use English in the facilitation of learning in classrooms. They sometimes code switch or at times use the indigenous languages to ensure that learning does take place. Furthermore, frequently, overwhelmed by the thought of examinations and understanding, teachers might use the pupils' first language instead of English to enhance meaning and understanding.

INTRODUCTION

Ayon (2012) points out that a number of factors will always affect the teachers' conceptions of teaching Science in second language. The teachers' prior language learning experiences as pupils and experiences in teacher education are major influences on the teachers' conceptions. These conceptions or beliefs affect the teaching approach as well as the teachers' professional development. Canbay and Berecen (2012) also concur that the teachers' conceptions shape their instructional decisions in the classroom. "In other words, what teachers do in their classrooms is oriented by their conception of teaching which are derived from their beliefs including a teacher's prior experiences, school practices, and a teacher's individual personality" (Canbay and Berecen 2012: 71). Teachers form conceptions consciously and these guide their teaching throughout their careers.

The debates around the teachers' conceptions highlight the notion that teaching is a cognitive process and the teachers' beliefs impact immensely on their instructional decisions in the classroom (Farrell and Particia 2005). Furthermore, these authors cite Johnson who points out that research on the teachers' conceptions and beliefs share three basic assumptions; (i) Teachers' beliefs influence perception and judgement; (ii) Teachers' beliefs play a role in how information on teaching is translated into classroom practices; and (iii) Understanding teachers' be-

liefs is essential to improving teaching practices and teacher education programmes. The teachers' conceptions are also crucial to investigate, especially in an educational environment that is constantly changing. Teachers have a role in determining what is needed or what works best with their pupils (Eslami and Fatahi 2008). Moreover, the teachers' conceptions have an influence on pupil success.

This study reports on the findings of teacher conceptions of teaching Physical Science in the medium of English from four KwaZulu-Natal practicing teachers. The following research questions were posed in the study:

- How do Physical Science educators select their language of teaching outside the policy mandates?
- How do they view the utilisation of strategies such as code-switching in their classrooms?
- What challenges do teachers experience in balancing English proficiency and content mastering in the pupils?

Objectives of the Study

This study seeks to explore the following objectives:

- To investigate the rationale for teachers to select alternative ways to teach without using English language although the latter is the official language of teaching;
- To examine the potential of alternative ways of teaching such as code switching;

- To explore how teachers attempt to use English 2nd or 3rd language effectively while facing the challenge of presenting the Science content.

Literature Review

The challenge posed by English to non-native speakers appears to be common in a number of countries. Vizconde (2006) contends:

The attitude of teachers comes to the fore as they reflect upon the language that they use in teaching. Consciously or unconsciously, their attitudes play a crucial role in languages' growth and decay, restoration or destruction (Baker 1988). Their attitudes, too, as part of their cultural orientation, influence heavily their young students. What kind of attitudes towards English should teachers have in order for them to teach Science and mathematics concepts successfully.

The value of investigating teachers' conceptions in relation to their instructional practice is strongly supported in the literature. Brown (2003:1) provides a compelling argument; that all pedagogical acts "are affected by the conceptions teachers have about the act of teaching, the process and purpose of assessment, and the nature of learning". As noted by BouJaoude (2000) and Zuljan (2007), all teachers possess conceptions that influence their thinking, instructional decisions and classroom management. These personal constructs can also serve as lenses of understanding classroom events (Jones and Carter 2007).

The concept, *English Second Language* (ESL) is used to describe individuals whose main language is any language other than English. According to Rollnick (2000), ESL Science teachers can be grouped into two broad categories. *Category 1* is made up those who are citizens in a given country and from a language background other than English, but who teach Science in English. While *Category 2* comprises of those who have come to a given country having received part or all of their schooling in a language other than English, but teach Science in English. The majority of the teachers in South Africa fall under *Category 1*. This is because majority of South Africans, Black South Africans in particular, speak one or more indigenous African language as their mother tongue. This study focuses only on these Black African teachers.

Language has far reaching effects on educational quality hence critics usually link achievement to language of learning and teaching. Fleisch (2008) writes about the challenges that rural and historically Black schools encounter frequently. This author points out that the quality of education is affected by five main factors:

- (i) Many teachers are not literate and have poor subject knowledge;
- (ii) Pupils receive less instructional time because of poor punctuality, absenteeism;
- (iii) Teachers have low expectations of pupils;
- (iv) There is poor utilisation of existing materials; and
- (v) There are inadequate methods of instructions used.

All the above factors result in poor teaching and learning. Poor teaching has the obvious negative impact on pupils' success. Furthermore, the above have far reaching effects on the pupil learning in any class.

There is also research that shows that the self perceptions of teachers who are non-native speakers of English (sampled from 20 countries) acknowledge the challenges they encounter in the second language classrooms. They are aware of their different nature to English first language teachers and affirm that this lower proficiency in English exerts negative effects on their teaching (Braine 2006). Some educators though cite the absence of parental involvement in education as among the most common reasons for struggling pupils.

Theoretical Underpinnings

The study reported here is underpinned by the constructivist theory (Vygotsky 1978). From the constructivist perspective, knowledge is not directly transmitted from one knower to another, but constructed within individual minds "based upon the interaction of what they know and believe, and the phenomena or ideas with which they come into contact" (Richardson 1997: 3). Science as a learning area is practiced based hence the construction of knowledge therein is knowledge for practice. Borg et al. (2012) point out that issues such as who is involved in knowledge construction, with what objectives and for which audience are very crucial to be touched upon. It is then crucial to look at these when looking at the teachers' conceptions and the classroom practice.

Borg et al. (2012) argue that knowledge for practice is embedded in knowledge-in-practice, and that knowledge construction needs to be generated to what actually happens in actual practice. The pupils need to be involved when generating new knowledge in the classroom. Hedges (2012) writes about the way in which pupils are motivated to explore their experiences from their surroundings. She opines:

Within cultural-historical approaches, temporality, motive, culturally-valued knowledge and pursuits are central to understanding children's thinking. During children's inquiry into their worlds, their thinking is dynamic and involves theorising and developing ideas, often in creative ways that relate to their current, albeit limited, experiences. In general, theories are viewed as ways to seek patterns, meanings and explanations about phenomena.

In line with Vygotsky's theory pupils need to be supported to achieve development in Science learning. Pupils need support in their cognitive development and this is what is referred to as scaffolding. The construct of teachers' conceptions in the study is explored within tenets which assert that scientific knowledge is tentative, intuitive, subjective and dynamic. Such knowledge originates from observations, experimentation and abstraction using senses (Abd-El-Khalick et al. 2000). Part of the South African trend to constructivist and information processing has been concerns for the Black African pupils, bringing to the fore questions of language and culture. In Jegede's (1995) words African students have to "cross border" as move in and out of Science. ESL teachers of Physical Science need to facilitate this "border crossing" process for effective learning to occur. Effective teaching involves equipping pupils with conceptual understanding of the process skills that enable them to individually or collectively develop a repertoire for constructing powerful constructions that concur with viable scientific knowledge.

METHODOLOGY

A qualitative research approach was employed since the purpose of this exploratory case study was to describe the four participating teachers' conceptions of teaching Physical Science in the medium of English (Creswell 2009; Fair-brother 2009; Ivankova et al. 2008). The participants' conceptions of teaching Physical Science in the medium of English, was informed by data from four participants, it can be thought as a collective case study (Stake 1995). The rationale for using a multiple participant design was to inform the case by producing "potentially contrasting results for predictable reasons" (Yin 1989). A purposive and convenience sample of four teachers from KwaZulu-Natal was used. All the participants teach Physical Science at the Further Education and Training (FET) Band. Within the context of South African education the FET Band includes grades 10 to 12. It also includes career-oriented education and training offered in other Further Education and Training institutions – technical colleges, community colleges and private colleges. Table 1 illustrates the characteristics of the participants. The researchers are aware that this sample cannot be regarded as a representative of all the Physical Science teachers in KwaZulu-Natal Province; the findings may nevertheless be substantively applicable to other teachers in similar settings.

Data Collection

Data from the semi-structured interviews with the four Physical Science teachers were audio-taped after they granted their consent. Research ethics require researchers to ask for consent whenever their utterances are to be recorded. The duration of these interviews were between 45-60 minutes. The interviews were triangulated with lesson observations as well as focus group discussion among the four. Each participant was observed twice in a period of

Table 1: Characteristics of teachers in the study

Teacher	Academic qualifications	Subjects taught	Teaching experience	Grades taught	First language
T1	BEd* Honours	Physical Science	13 years	11 and 12	IsiZulu
T2	BEd Honours	Mathematics and Physical Science	09 years	10 and 11	SeTswana
T3	BEd	Physical Science and Technology	11 years	9 and 11	IsiZulu
T4	BEd	Biology and Physical Science	06	10 and 11	IsiZulu

*Bachelor of Education

twelve months. The first interview was conducted during the first week and the second one just before the finalisation of the study. For trustworthiness of data from interviews and group discussions transcript were taken back to the participants to verify if the transcriptions reflected their intended views. A few semantic changes were made to the satisfaction of the participants. In case of lesson observation the contextual features as suggested by Cohen and Manion (2000) regarding learning and teaching process in relation to language of learning and teaching was used by ticking items as they happen during lesson observations.

Analysis of Data

The analysis of data, was subjected to open, axial and selective coding (De Vos 2010). Open coding was done line by line, followed by axial coding where paragraphs were compared to give precision to a category. Lastly, core categories were selected during selective coding. The analysis was done in three phases. The first phase involved, transcribing the audio-recorded data. Then the transcripts were read several times in order to get familiar with them. This was followed by coding the data. This being a case study of the conceptions of four ESL teachers, the researchers' emphasis was on the discussion and classification of their views rather than on the teachers themselves. In the second phase data from the lesson observations were grouped into categories. Lesson observations aimed at interrogating the ESL teachers' instructional practices. This approach was deemed appropriate as it serves as a way to validate and triangulate the interviews. In the third phase, the data from the focus group discussion was transcribed then coded using open coding.

FINDINGS

Results from phase 1 that explored what the ESL teachers make of the statement "proficiency in English language is a prerequisite to Science knowledge". Three out of the four participants agreed with the statement (T1 to T4 refers to teachers 1 to 4).

T1: I agree with this statement because there is a term here "proficiency" How do you expect an African child who started to learn English at his or her secondary level to be good at

English? We are brought up in these disadvantaged communities and we learnt in these miserable schools where we had unqualified teachers, some of them didn't know English, so how can you expect learner to be proficient in English in their schools?

T2: I don't believe in that...the best thing is for the learners to understand. Some teachers just teach learners terminologies not explaining the meanings.

T3: Yes; you need to know English in order to learn or teach ScienceWe were made to believe that fluency in English means intelligence; and only intelligent students were allowed to do Science. It was the system of education those days. That was the criteria so that on its own gave us recognition. It made us feel big in a small town.

T4: Yes it is, because learners will be able to understand questions in exams and have the language to answer what they have already conceptualised in their languages.

With regards to question 2, which sought to explore the teachers' preference in relation to English, three preferences were noted:

- The use of both IsiZulu and English in the teaching of Science;
- The use of IsiZulu only in the teaching of Science and;
- The use of English only in the teaching of Science.

The participants added:

T1: Perhaps if we can try to use both languages, English and the mother tongue in the teaching. At least there must be 70% mother tongue and 30% English if we want the learner to understand.

T2: My home is in the North West Province and I'm working in KwaZulu- Natal Province. Now that means each and every teaching is in English because here I cannot speak IsiZulu. So I prefer English. I don't want to use the home language in teaching Science as it is going to make those learners not to be able to read and understand question papers. But using English language is going to make them get used to the language of exam papers, that's why I prefer English.

T3: I would love to teach Science in IsiZulu, because we spend most of the time trying to interpret what is in English and then back to IsiZulu, and for these learners if there was an IsiZulu Science book maybe things were going

to be simpler, because even at home parents were going to be able to help their learners during their study time.

T4: I would prefer teaching Science in IsiZulu, reason being I believe that classroom science can only be useful to my learners if they are able to apply it in their lives. And they can only be able to apply it after they have already conceptualised it in their languages. It is easy if we start with let's say IsiZulu, then, after understanding the aspects in IsiZulu, we bring in English.

Results from lesson observations that is, phase 2, formed the second set of data. Table 2 provides a summary of all the contextual features as suggested by Cohen and Manion (2000) of the learning and teaching process in relation to Language of learning and teaching. The three main languages for the participants and their pupils are English-E; IsiZulu- Z; SeTswana- T.

Table 2 findings indicate that T1 and T4 in the study demonstrated a one-to-one relationship between their conceptions and the use of English in the teaching of Science. This was evident in the three themes; *pupil-teacher discussion, classroom regulation of pupil activity and linking pupils' experiences and interests to the world outside school*. This showed consistency between participants' espoused theories and instructional practice.

There was also evidence of consistency in the *Concept Development* theme for participants. T2 showed a one-to-one relationship between his conceptions and the use of English in the teaching of Science. He uses only English throughout his teaching. What is exciting here is that all participants in the study use English for *classroom regulation of discipline and management*. In general, the findings from the observed lessons revealed that the ESL teachers'

espoused theories informed their instructional practice to a great extent. There is no tension or dilemma between what the teachers say or profess to believe and their classroom practices, namely, the use of English in teaching Science.

Findings from phase 3: Contrary to the findings of the individual interviews which pointed to three preferences, the analysis of the focus group interview reflected two preferences, namely:

- The use of both mother tongue and English is seen as a vehicle for accessing scientific knowledge; and
- The use of English only is seen as a vehicle for accessing scientific knowledge.

In general, analysis of data collected findings from the interview schedule and focus group interview allude to the following. ESL teachers preferred the use of:

- Both English and mother tongue as vehicles for accessing scientific knowledge; and
- English only as the vehicle for accessing scientific knowledge.

However, these preferences suggest a dichotomy of socio-economic and examination issues. Social issues include their disadvantaged milieu characterised by under-qualified teachers, while examination issues include English as a language of examination. Furthermore, it was observed that the teachers' conceptions depended on what they foregrounded. When understanding is foregrounded, teachers tend to opt for IsiZulu together with English as the medium. When examinations are foregrounded, however, English is seen as the suitable medium for teaching. Therefore, it can be argued that the teachers in the study perceive understanding in Science to be achievable through other means or languages other than English. How-

Table 2: Themes that guided lesson observations

How is language used in the classroom in terms of:	T1			T2			T3			T4		
	E	Z	T	E	Z	T	E	Z	T	E	Z	T
Concept development		X			x			x			x	
Classroom-led group discussion		X			x		x			x	x	
Teacher-learner discussion		X			x		x				x	
Learner-teacher discussion	x	X			x		x	x		x	x	
Classroom regulation of learner activity	x	X			x		x			x	x	
Classroom regulation of discipline and management	x				x		x			x		
Linking learners' experiences and interests to the world outside school, that is, in- and -out of school experiences	x	X			x		x			x	x	
Percentages	40	60	0	100	0	0	71	29	0	50	50	0

ever, they draw a clear distinction between teaching for understanding and teaching for examination.

DISCUSSION

The idea of considering personal conceptions of teaching Physical Science in the medium of English was novel to the participants in the study. All of them indicated that they found it useful to reflect on their own conceptions of teaching Science using English as a second language. As indicated in the study, the findings from the case interviews reflect that some teachers prefer the use of:

- Both English and mother tongue as vehicles for accessing scientific knowledge; and
- English only as the vehicle for accessing scientific knowledge.

Discussion around these preferences, however, has two qualifiers, that issues of language acquisition or proficiency in English cannot be divorced from the socio-economic issues of learning Science and issues of English as a language of examination.

The study further reveals that the existing conceptions held by some Physical Science teachers play a major role in shaping their instructional practices, that is, that what teachers foreground form the basis of their views and conceptions. For instance, when understanding is foregrounded, teachers tend to opt for both IsiZulu and English as the language of teaching and learning. When examinations are foregrounded, English is seen as the suitable medium for teaching. The findings of the study also provide support for the idea that Physical Science teachers in the similar contexts to those participants under study hold uncomplicated conceptions of teaching, at least when compared to Hewson and Hewson's (1988) ideas about "an appropriate conception of teaching Science". Similar to the findings reported by Aguirre et al. (1990), the majority of English second language teachers emphasise a transmission approach to Science teaching. It can be argued that this has been influenced by the current language policy which gives authoritative powers to School Governing Bodies to determine their respective language of teaching policies while failing to recognise educators' inputs in the implementation of the language policy. This result in styles of teaching that emphasise teach-

ing factual knowledge about scientific concepts and principles, as opposed to practical applications of scientific knowledge described in both; the Outcomes Based Education and the recently launched Curriculum and Assessment Policy Statement (DoE 2010). These findings are reasons for concern, especially when viewed against the teacher's role as that of a learning mediator. In agreement with Hewson and Hewson's (1988) "appropriate conception of teaching Science", Curriculum and Assessment Policy Statement have called upon teachers to conceptualise learning as a constructive endeavour that enables conceptual change and to conceptualise teaching in a way that mediates this type of learning.

In terms of promoting multi-lingualism in South African classrooms, however, some of the observed teachers' conceptions seem to be in line with national language policy. The majority of the English second language teachers in the study preferred the use of both English and the pupils' main language(s) as medium of teaching; though many Black South African parents, through School Governing Bodies, prefer English use in the classrooms. As mentioned earlier, ESL teachers' conceptions in the study have their roots in the secondary education institutions they attended. This is coupled with the perceived teachers' role in the learning of Science. It is these experiences that, in Nespor's (1987) words, influence and frame ways in which one uses what has been learned. ESL teachers who opt for the use of both English and the pupils' main language as LoLT perceive potential insights about the use of the two languages. Likewise, the ESL teacher who opts for the use of English only as language of learning and teaching perceives potential insights about its use. In both cases, the impact on the teaching and learning of Physical Science within the context of the language policy is considerable.

In case of the former, ESL teachers who have foregrounded understanding of Science would have taken their own initiative in the promotion of multilingualism in their Science classrooms. In the later case, a teacher who has foregrounded an understanding of instructions in examination papers would unknowingly be promoting inequality in languages, and this is contrary to the aims of the language policy in that only black South African pupils would be expected to communicate with pupils from other linguistic background (English), and is never the other way round.

According to Jegede (1995) communication in a language requires not only a language structure, but also the propagation of a culture and values embedded in that language or border-crossing. This would mean that black South African pupils assume a foreign culture as they learn and communicate Science in English. It is therefore recommended that as much as many might embrace the diverse cultural backgrounds, Science teachers who employ English second language and other roleplayers need to explore a variety of conceptions of teaching and learning of Science. This has to be approached in a way that ensures that the aims of language policy are attained, moreover, to ensure that Science teachers become effective through the use of effective use of language.

CONCLUSION

This study focused at various ways in which teacher conceptions influence teaching and learning. It is clear from the participants that teaching should utilise aspects that would make it easy for the pupil to grasp the content and be able to apply it in different situations. The participants' conceptions also show that there is a need to see the pupils' point of view; that teaching approaches should take the pupils into cognisance at all times. The participants had empathy with the pupils whose first language is not English. Among others, the participants used their own experience as pupils to teach. Code switching that the teachers used was a way of ensuring that the pupils followed the content well. The use of IsiZulu in teaching was to make sure that the pupils did follow the conceptual understanding in Science classrooms. However, the importance of the examinations which are in English also made the teachers adjust their teaching to be suitable for this purpose. Language in ESL classes will always be crucial but this can be positive if the teachers' conceptions take the pupils' worldview into consideration. Effective teachers who use language effectively will be able to demystify Science and ensure that their pupils succeed.

RECOMMENDATIONS

The following recommendations were drawn in an attempt to contribute to address some of the apparent challenges in teaching second language pupils.

- Science teachers should continually improve their language use in classrooms. Science deals with aspects such as kinetics, audio-visual aspects as well as the sense of smell and touch. Effective teachers should be able to explain these in the language simple to pupils;
- Linked to the above is that teachers should try and be bilingual. It helps the process of learning when teachers can speak more than one language including the first language of the majority of the pupils.
- Pedagogic tools such as journal writing might also help teachers understand their conception and their practice in Science classrooms;
- More research needs to be conducted in this area. When effective teachers can use language effectively, many schools can attain success.

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