MAKING SENSE OF SCIENCE THROUGH TWO LANGUAGES:
A SOUTH AFRICAN CASE STUDY

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Context

Mzamo Senior Secondary School[1] looks like any typical township school in South Africa: modern face-brick classroom blocks which conceal a serious lack of resources – material and human. Under apartheid the disparities in spending on white and African students[2] meant hugely different teaching and learning contexts - including infrastructure, teacher training, pupil: teacher ratios and teaching materials. Today, 10 years into the new democracy and despite government's efforts to equalize spending, the historic inequalities persist. The school is surrounded by township houses and shacks that reflect the high poverty levels in the Eastern Cape Province[3].

Students at schools like this face an additional but less obvious problem – that of the language medium. Although in the Eastern Cape, Xhosa[4] is the home language of 83,8% of the population and English speakers comprise only 3.7%, the official language medium in schools is English from the beginning of Grade 4 in the majority of schools (see Figure1).

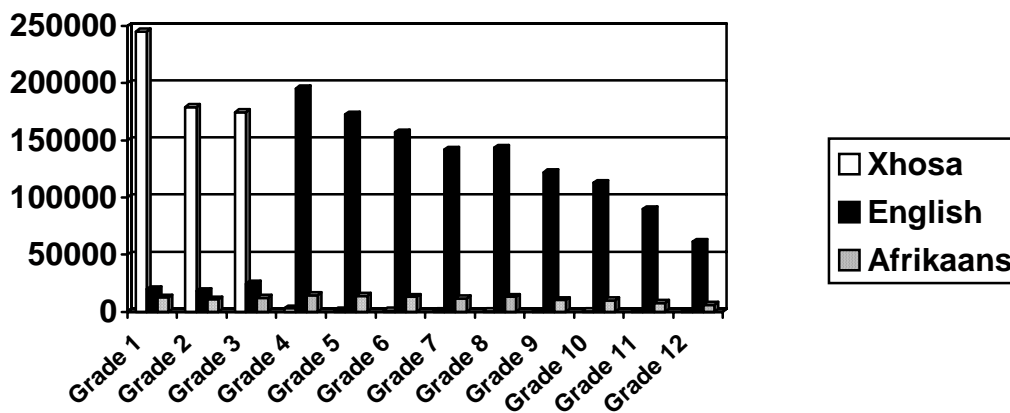**Learners' Language of Learning and Teaching Eastern Cape 2001**

Figure 1 (EMIS, 2001)

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[1] Fictitious name

[2] For example, in 1984 the per capita expenditure on white students was R1 926 and for African students R294.

[3] It is estimated that 75% of households in the Eastern Cape province live in poverty (Bot, Dove and Wilson 2000).

[4] Xhosa is one of the 11 official languages recognized in the South African Constitution (1996).

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South Africa is a multilingual country with 11 official languages recognized in the Constitution of 1996 – 9 indigenous languages (list them) and the two colonial languages, English and Afrikaans.

Official Languages	Home Language Speakers
Zulu	22, 9%
Xhosa	17,9%
Afrikaans	14,4%
Sepdi	9,2%
English	8,6%
Setswana	8,2%
SeSotho	7,7%
Xitsonga	4,4%
SiSwati	2,5%
Tshivenda	2,2%
IsiNdebele	1,5%
Other	0,6%

Figure 2 (Census 1996 in Statistics South Africa, 2000)

The demographics of South Africa are such that apart from in the melting pot of Gauteng province where historically speakers of all the languages have converged to work on the mines, the indigenous languages are still largely concentrated in particular geographic areas, so that the majority of learners mix largely with speakers of their own language in their homes and communities (Heugh 2002: 185).

The Language–in-Education Policy (Department of Education, 1997) allows schools to choose their language of learning and teaching (LoLT) and the languages to be learnt as subjects. However, for a range of reasons that reflect the relative power of English in the social, political and economic life of the country, the majority of schools have opted for the introduction of English as the language of learning and teaching from the beginning of the fourth grade. This is despite the fact that demographics dictate that most learners have little contact with English speakers (less than 9% of the population) and little exposure to the written language outside the classroom: a national survey[5] found that only 10 percent of parents bought newspapers and magazines; more than 50 percent indicated they had access to fewer than 10 books (Strauss, 1999:25); and 83 percent of schools have no libraries (Bot and Shindler, 1997: 80-81).

Therefore the English language proficiency of the majority learners frequently does not meet the demands of learning through the medium of English. As a result, where teachers

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[5] The Monitoring Learning Achievement survey (Strauss, 1999) tested the literacy, numeracy and lifeskills proficiency of Grade 4 learners in 400 schools in all nine provinces and collected baseline indicators of the learners' socio-economic backgrounds.

and learners share a common home language, teachers tend to switch to the learners' home language to achieve a number of pedagogic purposes.

Wong-Fillmore (1986) refers to the tension between content and language learning in a bilingual classroom. As a teacher put it in an interview:

> "They must understand English … so that they can express themselves; but the problem again, they have to understand what you are actually teaching them, the content, so somewhere, somehow, you have to weigh this ....". (Probyn, 1995)

Wong-Fillmore suggests that 'it is possible to accomplish both goals at the same time but to do so requires that the competition between these two sets of instructional objectives be recognized and resolved' (*ibid:* 653).

Currently there is little official recognition of the language problems faced by teachers and learners and the practical tension for teachers between communicating content in the language most easily understood by students and the obligation on them to stick to the official language of instruction. As a result code-switching is largely covert and not recognized as a legitimate strategy: a teacher referred to "smuggling the vernacular into the classroom" (Probyn, 2001) (see also Setati et al 2002); nor is there training for teachers to equip them to deal with teaching through the medium of an additional language.

The 2001 report of the Third International Mathematics and Science Study[6] focused attention on these problems when it found that " …the majority of South African pupils cannot communicate their scientific conclusions in the languages used for the test (i.e. English and Afrikaans which were the medium of instruction and are the languages currently used for matriculation examinations). In particular, pupils who study mathematics and science in their second language tend to have difficulty articulating their answers to open-ended questions and apparently had trouble comprehending several of the questions" (Howie, 2001).

Research study

Given the apparent need for training for teachers to deal with the challenges of teaching science through the medium of English as an additional language, it seemed useful to research what teachers actually do in their classrooms and to draw on the expertise of experienced teachers, to inform the development of appropriate training. Grade 8 science classrooms were selected to tie in with the TIMSS results.

The resulting small scale research into the language practices in six Grade 8 science classrooms revealed wide range of patterns of language use: for example in the number of

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[6] Third International Mathematics and Science Study-Repeat was an international survey of the mathematics and science proficiency of Grade 8 learners. South African learners came last out of the 38 participating countries (Howie, 2001).

words spoken by teachers and learners over three consecutive lessons and the proportion of English and Xhosa words used (see Figure3).

Teachers' classroom language
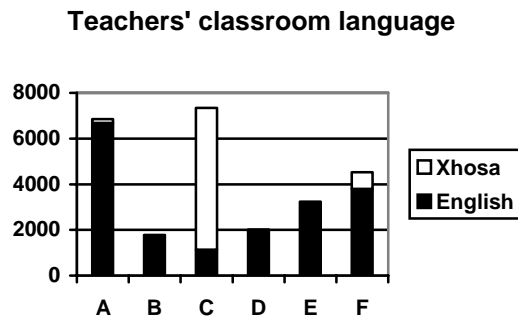
The lessons were also analysed in terms of the language used by learners and the kinds of questions asked by the teachers in order to obtain a rough picture of the cognitive challenge of the lessons and the relative use of home language and English (see Addenda A and B)

Teacher A at Mzamo Senior Secondary School stood out as an excellent teacher, in terms of the skillful way he used both English and Xhosa in the classroom and in the kinds of linguistic and extra-linguistic support he gave learners in helping them to develop science concepts and language skills.

It therefore seems useful to examine the practice of this experienced and expert teacher to make explicit the ways in which language is used to achieve both conceptual understanding and development of English language skills.

Patterns of talk

As can be seen from the graphs, Teacher A spoke a lot in his lessons – only 6.5% less words than Teacher C, who spoke the most, and 37% more than the average number of words spoken by all the teachers over the three lessons. In addition, 98% of his talk was in English by contrast to teacher C's lessons where 85% of her talk was in Xhosa.

Although both Teacher A's and Teacher C's lessons were both teacher fronted with high proportions of teacher talk, their lessons were fundamentally different: Teacher C's lesson consisted of exposition – reading a chunk of English from the textbook (only she had a copy), and translating and explaining in Xhosa with some relatively low level questions that required learners to recall information. Teacher A was also engaged in

whole class exposition but his approach could perhaps be best described as Socratic – the lesson content was collaboratively constructed through a process of whole class oral question and answer with the teacher explaining, questioning and probing. Concepts were illustrated through demonstration, analogy and practical work; and consolidated on the chalkboard which served as a reference point throughout the lesson.

As can be seen from the graphs in Addenda A, the learners in teacher A's class spoke more overall and produced more extended responses (categories e, f and g) than learners in other classes. The critical difference lay in the kinds of questions asked by the teachers that directed classroom discourse. As can be seen in Addendum B, Teacher A asked more higher order questions: the discourse frequently followed the pattern of a question requiring a short answer from the whole class, followed by a question requiring elaboration from an individual.

Examples of classroom discourse

Teacher A used a range of linguistic and extra-linguistic strategies to support learners' conceptual understanding and linguistic development. These strategies included whole-class question and answer; code-switching at times for a range of pedagogic and affective purposes; repetition of new words; practical work; demonstration; analogy; role-play; use of examples from learners' own experiences and environment; use of the chalkboard for diagrams, for summary notes to consolidate new concepts and at times as an interactive resource to involve learners in explanations.

In some cases though, code-switching was unconscious. For example most teachers in the study used Xhosa question tags and reflected that these were 'habits' rather than conscious strategies. One teacher offered the explanation that question tags in the learners' home language served to get the learners' attention – 'to hook them' – and to elicit a confirmation check.

Teacher A's strategies are illustrated in the following annotated transcripts. The explanations for particular strategies were provided by Teacher A in post-lesson interviews which were based on video-tapes and transcripts of the lessons.

Extract 1: Teacher A asks a question that requires learners to apply the concepts about electricity that they have learnt. When they hesitate to answer, he rephrases the question and gives a clue. When the students still seem hesitant he switches to Xhosa to encourage them to participate. He translates their initial responses and having elicited the correct response, helps the student to rephrase his response in English. He code-switches to Xhosa to teach an unfamiliar word (metal) and repeats it several times for emphasis.

T: <u>Do you think the bulb will really light up there now</u>?   *Inferential question*
Ls: Yees.
T: Why? Why? Because look (*pointing to diagram on chalkboard*)   *Probing*

                                                                          Uses chalkboard

This part of the wire inside the bulb is not connected to the wire coming to the negative and positive. Why do you think the bulb will actually light? Try. Think. Think hard. Think, think
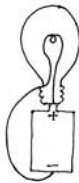
T: Think about, think about, think about, think about, <u>think about this part</u>. Think about this part now right. Think about the <u>metal</u> part of the bulb. Who got it right? Who can explain it?

Gives clue

T: Okay. Suppose I do it this way (*rubbing off wire on diagram and redrawing it in different position*)

Rephrases and calibrates question – scaffolds thinking
Uses chalkboard

You agree that way, <u>ne</u> [*okay*]? That the bulb will light up?

Xhosa question tag

Ls: Yees.

T: (*tracing on diagram*) Because the current will have to move from the positive, right up there through the bulb and into the negative, right across there.

But now I've changed the connection you know there (*rubbing out wire on diagram and redrawing it*).

Uses chalkboard

I've made it this way. You said the bulb will now light up?

<u>Teta isiXhosa</u> [*Speak isiXhosa*]. Yes? (*pointing to learner*).

Code-switches to encourage participation

L1: IBulb ayizokulighter [*The bulb will not light.*]

T: <u>He says the bulb will not light</u>. He says the bulb will not light. Oh I've got some hands up now. Yes (*pointing to another learner*)?

Translates

L2: Izakulighter, mfundisi [*The bulb will light, teacher*].

T: <u>The bulb will light</u>. Okay. <u>Why? …Why? Why</u>?

Translates; asks probing question

L2: Ngoba la gas uthe nca ecangcini [*Because the wire is stuck to the metal*.].

T: Because … okay try that now in English. Because… this … yes … follow me. This …

Scaffolds rephrasing in English

L2: This …

T: This wire …

L2: This wire …

T: is …

L2: is …

T: (*makes circular gesture with hand to class*)

L3: (*calls out*) is connected

T: Good, good! Is …

L2 & class: is connected

T: Is connected to (*learner sits down*) … to the …

Class: cell

T: To the …noo to the... This wire is connected to the (*pointing to diagram*

then indicates metal on bulb at front of class)
L: (*indistinct*)
T: to the cangci [*metal*]   *Code-switches to teach*
Class: (*laughs loudly*)   *new vocabulary and for*
T: Nooo. No look here, to the … metal.   *emphasis*
Ls: Metal
T: To the metal, to the metal here (*indistinct*). Good, good, good, good! Icangci
[*Metal*] to the metal. So the whole of this metal, the whole of this metal here   *Repeats new word*
conducts electricity. So no matter where you put the … no matter where you
put the wire, as long as this wire is connected you know to these (*indicating on
bulb*) … the metal outside here. Then the current of electrical energy will light
up.

Extract 2: In this extract Teacher A consolidates a concept with repetition and elicits
synonyms ('becomes small', 'decrease', 'drops', 'goes down'); code-switches to Xhosa
for emphasis and to ensure understanding; and writes down the concept on the
chalkboard. The key concepts are written on the chalkboard as the lesson unfolds and
provide a record of the lesson and a reference point.

T: So, so what happens when you increase the number of bulbs in series?   *Consolidates concepts with*
What happens to the current when you increase the number of bulbs in   *repetition and use of*
series? Heee… (*pointing to learner*) Yes?   *synonyms*
L1: The current becomes small.
T: The current becomes small. So we can therefore now say, when we
increase the number of bulbs in series the current becomes
T&Ls: small.
T: Good. (*writing on chalkboard*) So when we increase the number of bulbs
in series the current becomes small or we can say what - one word? We can
say … (*pointing to learner*) Yes?
L2: The current decrease
T: The current decrease - good. (*writing on chalkboard*) Decrease … or
another word … beginning with a d … the current (*pushing down with hand*)   *Uses gesture to convey*
Hm? (*pointing to learner*) Yes?   *meaning*
L3: Increase
T: Heeh!
Class: (*laughs*)
T: Huh? (*pointing to learner*) Yes?
L4: The current drops.
T: The current drops (*writes on chalkboard*) …. the current goes down, or
the current becomes small.
T: Goes down, iyehla [*decreases*].   *Code-switches for*
                                                                                emphasis and to clarify
                                                                                meaning
2. When we increase the number of bulbs in a circuit the current   *Consolidates concept on*
becomes small/decreases/drops.   *chalkboard*

Extract 3: Teacher A noted that 'compare the brightness of the bulb now with the
brightness of the bulb before' was a difficult grammatical construction for second
language learners and so he translated the instructions to make sure they understood what
to do.

T: Right. I would like you now to join in the second bulb there and compare the brightness of the bulb now with the brightness of the bulb before. Uzakujonga indlek ibulb zakho ezi lighter ngayo ngoku, ne. Uzicompare nangokuya ibulb ibinye [*you are going to look at the way the bulbs will light now and compare them to that one bulb*]. second one … right?

Code-switches to clarify difficult grammatical construction in instructions

Example 4:

The teacher frequently dropped his voice dramatically to gain the learners' attention; he refers to learners' own experiences and contexts; he develops their English language skills by modeling and scaffolding their responses; he role plays an unfamiliar word 'dim'; and code-switches when he makes a cultural specific joke about witches. He then introduces a new concept with a question; and code-switches to recap what they have just done to clarify understanding and for emphasis.

T: (*softly*) Now I want you now to give me

Uses voice tone to attract attention

(*normal voice*) two things you hate about bulbs connected in series. … Things that you think, mna [*me*], I do not like bulbs connected in series because one, they do this thing; two, they do this thing. Think, think, think Yes boy, try boy … huh?

Inferential question related to own experience
Code-switches[mna] for emphasis

(*high tone*) Look you have it there (*pointing to chalkboard*), you have it here. Hmm? Think, think, think, huh? Talk, talk, talk! (*pointing to learner*) Yes?

Gives clue - uses chalkboard

L1: I don't like …

T: … bulbs in series. Why?

Models and scaffolds learners' responses

L1: because it makes … it makes … it makes other bulbs not light.

T: I know what you are saying but … please correct her please. (pointing to another learner) Yes?

L2: I do not like bulbs …

T: … connected in series …

L2: … when … because when you take one out …

T: … or …

L2: … or when you fuse one bulb …

T: … one bulb …

L2: the whole house will not light.

T: the others, the whole house will look like …

Everyday example

Ls: (*giggling*)

T: I mean how can you make the electrician to come to your home and say please I want you to make me a nice (*indistinct*) here and he arranges all the bulbs in series. Then in the middle of the night you put off the switch ... your lights in the back … in the back room - I'm sorry - in the kitchen and all the lights in the whole house are off. I wouldn't like that! Huh? Right?

So I also agree with you, I don't like bulbs connected in what, in …

Consolidates concept

T & Ls: … series

T: because one bulb has a fault, is wrong, has a fault, the other bulbs will not light.

Number two? Another thing that you wouldn't like about bulbs in series? (*pointing to learner*) Yes?

Inferential question

L3: I hate bulbs connected in series because in the house will be dim.

T: When you increase - yes he is good! - when you increase the number of bulbs, if you put one bulb in at the kitchen, put another bulb in the TV room, put another bulb in the bathroom, put another bulb in the loo … they all become … hm? (*stoops with limp hands*)

Role plays word 'dim' - and for humour

Class: (*loudly*) Dim!

T: Dim. Who wants to live in a dim house? Heh? Amagqwirha! [*witches*]
Class: (*laughs*)

Cultural reference - it is believed that witches live in dim houses

T: Okay, good. Now so that's what we know about bulbs connected in what, in series. Now think, I'm going to ask you something now, please think here, ne? Please think here. (*softly*) Why do you think bulbs connected in series make the current come smaller?

Xhosa question tag
Inferential question - uses soft tone to attract attention

Now remember you had (*indistinct*) you did not change it, ne? Awukange uyitshinthse [*you did not change it*]. Right? Kodwa qho usongeza umbane, usihla, usihla, usihla [*But if you add (bulbs) all the time, it goes down, it goes down, it goes down*].What makes the current to drop all the time when we increase bulbs in series? Huh?

Recapping - code-switches for understanding and emphasis

Think, think, think. Something begins, it's a word beginning with 'R'. It's a word beginning with 'R' … it's a word beginning with 'R'. Re … yes? (*high tone*) Huh? Yes, yes, yes? Yes, yes, yes, yes? Talk! Yes, yes, huh?

Gives clue

L: (*calls out*) Resistor.

Elicits new term

T: (*to learner*) What's that? Yes? Resistor? No? What's that? It's re-sis-tance! Resistance.
(*to class*) So when you increase the number of bulbs in series what are you increasing? The ntoni [*the what*]?
Class: Resistance

Code-switches for emphasis

Discussion

South Africa introduced a new outcomes-based national curriculum in 1997 and the training for this has tended to cast teacher-centred practice as 'traditional' and to be abandoned in favour of 'learner-centred' approaches. This apparent dichotomy has not been helpful to teachers as it has undermined existing good practice and has left many teachers under the impression that the new curriculum requires group work activities to the exclusion of whole class teaching.

In a research study in the United States that compared classes that worked well for language learning with those that did not, Wong-Fillmore (1985) found that, contrary to the popular belief that more 'open' (learner-centred) classrooms are best for language learning, in fact the most successful classes for language learning were those that made the greatest use of teacher-directed activities. Classes that were open in their structure were least successful for language learning, as learners did not get enough English input and English language practice. When students are learning through the medium of an additional language that they have little access to outside the classroom, the teacher is frequently the main source of language input.

With the majority of learners in South Africa involved in learning through the medium of a second language, it would seem that more skilful front of class teaching might be necessary where the teacher can extend the learners' understanding and language skills; and provide a model and source of input of the target language.

Cummins (2000) claims that second language learners will acquire language and content most successfully when they are challenged cognitively but provided with contextual and

linguistic supports. This is what Teacher A appears to do: skillfully utilising a wide range of teaching strategies that appear finely tuned to the language competencies of the learners, while extending them cognitively.

Teachers need to be helped to work effectively within current constraints – linguistic and material. The learners at Mzamo Senior Secondary School are fortunate to have an experienced teacher who is able to balance language and content in the classroom. There is much that can be learned from the practice of such teachers. For example, teachers need to develop whole class questioning skills to promote higher order thinking, while providing linguistic and contextual support. The chalkboard is often an under-utilised resource that can be used to record the main points of the lesson and serve as a reference point; it also provides written language input and support; and can be used interactively with learners. In addition, all teachers need to understand the role of language in learning (including the importance of learner talk to tease out and consolidate conceptual understanding), how to develop learners' proficiency in the language of learning and teaching, and the importance of reading and writing in developing the academic language skills needed for learning so that they are able to plan for lessons that meet the need for cognitive challenge and language support. This training of course should not be confined to science teachers. It is needed for more effective teaching across the curriculum and to seriously address the question of access to the curriculum for the majority of learners in the country.

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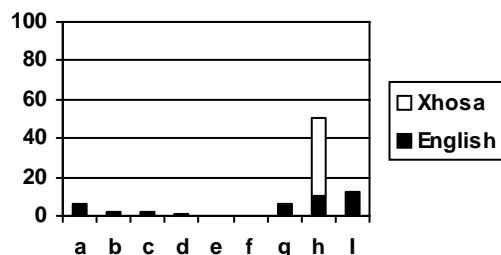**LEARNERS' CLASSROOM LANGUAGE**

Learners' language class A
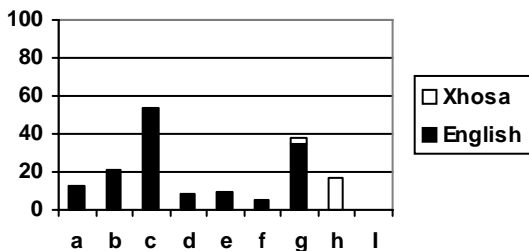
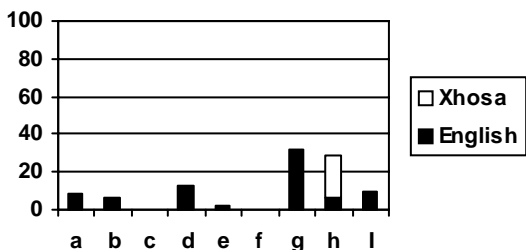**Learners' language class B**
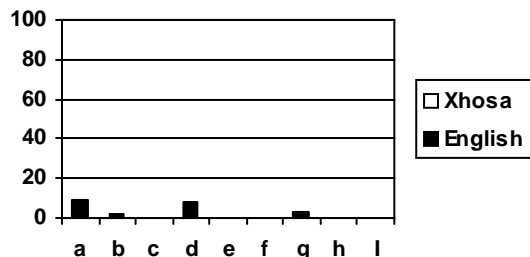
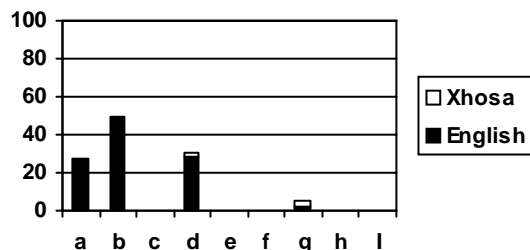**Learners' language class C**
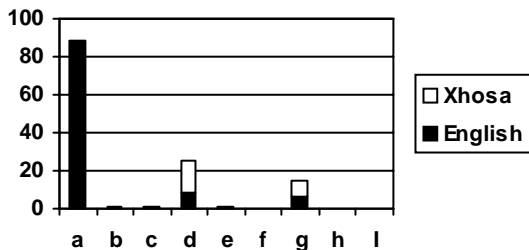
Learners' language class D

**Learners' language class E**

Learners' language class F

LEARNERS' LANGUAGE CODES

a) whole class chorus 'yes'/'no'
b) whole class prompted cloze chorus - teacher pauses and waits for class to complete sentence
c) whole class response unprompted - one word answer to real question from teacher
d) individual response - one word answer from a learner
e) individual extended response - performance assisted by teacher
f) individual extended response - performance assisted by teacher and learners
g) individual extended response unassisted
h) group discussion - number of minutes (approximate estimation of relative use of Xhosa/English)
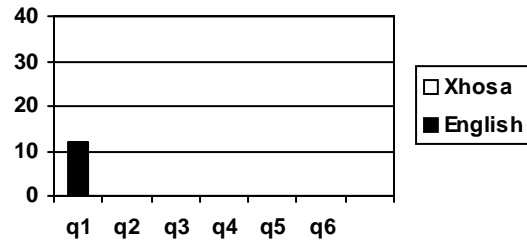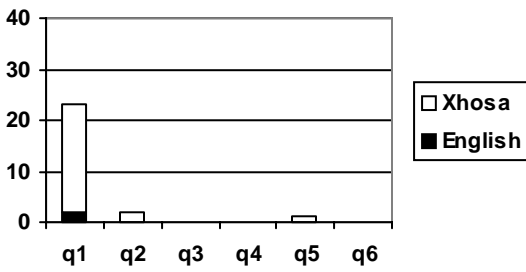i) individual sustained response - report back
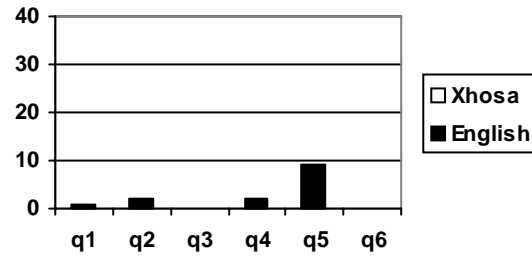
TEACHERS' QUESTIONS

Questions Teacher A
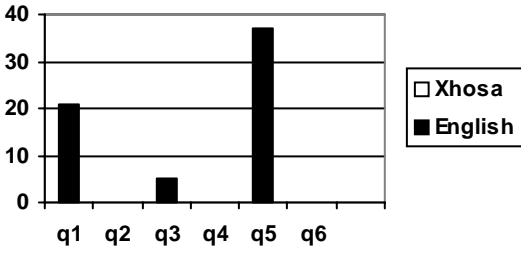
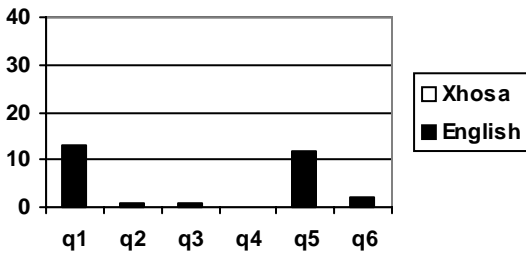### Questions Teacher B

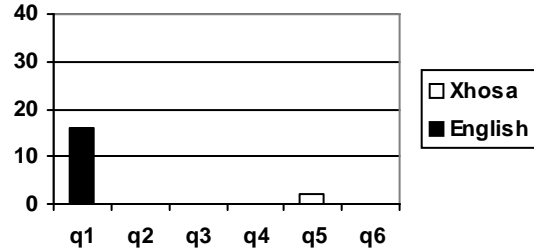### Questions Teacher C

Questions Teacher D

Questions Teacher E

Questions Teacher F

TEACHERS' QUESTION CODES

q1   recall/review/general knowledge/report
q2   collect information
q3   investigate (practical)
q4   organise information (classify,/compare/transfer information)
q5   infer/interpret/apply knowledge (induce/deduce/predict/give reasons)
q6   give own opinion