DOI: 10.2436/20.2003.02.45 http://scq.iec.cat/scq/index.html

ISSN 2013-1755, SCQ-IEC Educació Química EduQ número 6 (2010), p. 30-36

Talking Chemistry in Zanzibar: Probing Pupils' Chemistry Knowledge Using Videos of Local Pedagogies

Parlant de química a Zanzíbar: sondeig de coneixements de química dels alumnes utilitzant vídeos de les pràctiques pedagògiques locals

Sibel Erduran / University of Bristol, United Kingdom

abstract

The article describes a group interview with two boys and two girls around some video clips of teaching and learning in Zanzibar schools in Africa. The study is part of a larger project called SPINE (Student Performance in National Examinations) funded by the Economic and Social Research Council and Department for International Development in the United Kingdom. The project was a collaboration between University of Bristol and the State University of Zanzibar. The study provides evidence that pupils in Zanzibar face significant difficulties with English language which contributes to their difficulties with subject knowledge of chemistry as well. However when the pupils are immersed in interesting and motivating contexts with links and referents to local culture and schooling, they are willing to and are able to contribute to discussion. Such discussions in this study illustrate how sophisticated pupils' understanding of chemistry and pedagogy can be along with the exposure of some misconceptions about some key chemical ideas.

keywords

Acids and bases, English as a second language, Zanzibar, education in low-income countries, group interviews

resum

L'article descriu una entrevista amb un grup de dos nois i dues noies sobre alguns viídeos d'ensenyament i aprenentatge a les escoles de Zanzíbar, a l'Àfrica. L'estudi és part d'un projecte més gran anomenat SPINE (Rendiment dels Alumnes en els Exàmens Nacionals), finançat pel Consell de Recerca Econòmic i Social i el Departament de Desenvolupament Internacional del Regne Unit. El projecte va ser una col·laboració entre la Universitat de Bristol i la Universitat Estatal de Zanzíbar. L'estudi proporciona l'evidència que els alumnes de Zanzíbar s'enfronten a dificultats importants amb l'idioma anglès que contribueixen a les seves dificultats amb els coneixements de química. No obstant això, quan els alumnes estan immersos en contextos interessants i motivadors, amb enllaços i referències a la cultura local i a l'escola, estan disposats i són capaços de contribuir al debat. Les discussions en aquest estudi il·lustren com pot ser de sofisticada per als alumnes la comprensió de la química juntament amb l'exposició d'algunes idees prèvies sobre alguns conceptes químics clau.

paraules clau

Àcids i bases, anglès com a segona llengua, Zanzíbar, educació en països pobres, entrevistes de grup.

Introduction

Chemistry is a difficult subject for many students worldwide. On top of the conceptual challenges posed by chemistry, consider the scenario where the students have to learn it in a foreign language. Furthermore, imagine that the dominance of the foreign language, English in this case, persists despite the fact that a majority of students cannot gain access to education because they have little fluency in English. The scenario I am painting exists in Zanzibar, among other places on the African continent. In this article, I will review some of the

challenges of learning chemistry in Zanzibar in the context of a research project that aims to understand how language plays a role in achievement in national examinations. The project is collaboration between University of Bristol in the United Kingdom and the State University of Zanzibar with involvement by key policy makers in the Ministry of Education and Vocational Training, Zanzibar. The project was funded by the Economic and Social Research Council and Department for International Development in the United Kingdom. One of the questions guiding the project has been how proficiency in English influences the learning and assessment of subject knowledge, primarily mathematics, biology and chemistry. To this end, several studies have been conducted. In this paper, I will focus on interviews conducted with secondary pupils to elicit their understanding of some chemical concepts such as acids, bases and neutralisation, and to explore their ideas on the links between chemistry learning and the role of the English language.

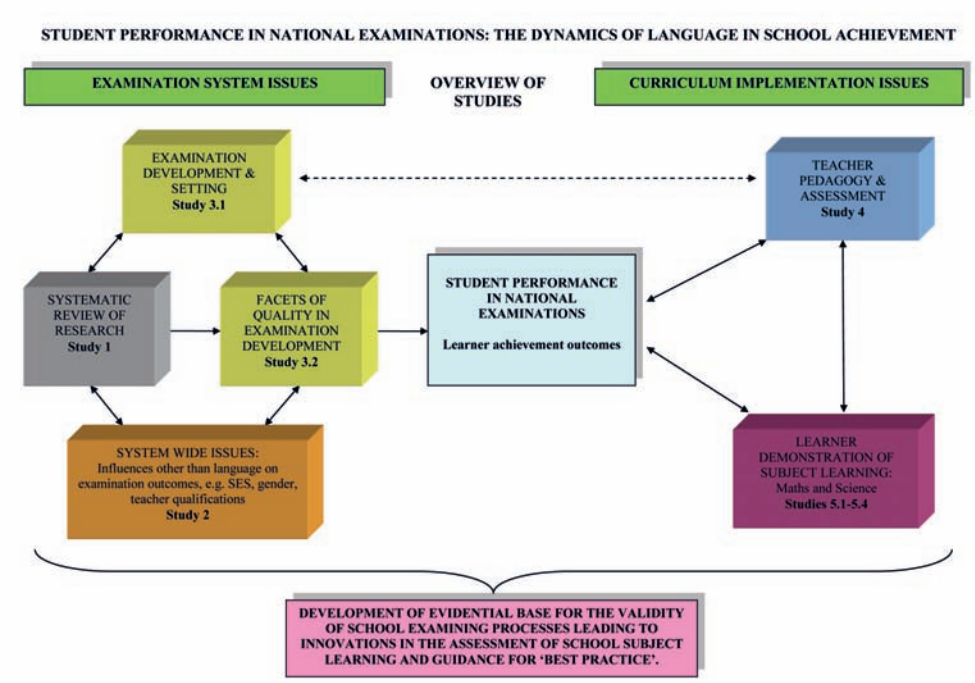


Figure 1. Project overview.

Student Performance in National Examinations (SPINE) Project

The SPINE project is about the study of teaching, learning and assessment in sub-saharan Africa where children have to demonstrate their subject learning through formal examinations that are administered in English. Rea-Dickins, P., Yu, G., & Afitska, O. (2009). Secondary school pupils learn their mathematics, science and other school subjects through two languages, that is their first (home) language as well as their second language. Incompetence in English has been mentioned as a significant factor contributing to low examination performance and some researchers (e. g. Roy-Campbell, 2003) have argued that the language of examinations should be in the children's first language. The research reported in this paper was conducted from 2007 to 2010 in Zanzibar situated off the coast of Tanzania in east Africa, and investigated the dynamics of languages (English and Kiswahili) in formal school examinations through which children attempt to show how much they have learned in school. On transition from primary to secondary school in Zanzibar, the medium of instruction switches from Kiswahili to English, with the first formal examinations entirely in English in the second year of secondary schol. The research focused on various facets of the education system in Zanzibar including examination system issues and curriculum implementation issues (figure 1). In terms of curriculum implementation, different aspects of the examination process in three curriculum areas: Science (Biology and Chemistry), Mathematics, and English were studied. This research links directly to language policy development in education and aims to: *a)* develop insights into the extent to which language factors contribute to poor examination achievement, including gender as a key variable, and *b)* identify factors that will raise the quality of examining processes thereby enhancing students' potential to demonstrate fully their conceptual understandings through formal examinations (SPINE Working Paper, 2009).

Student Performance in Chemistry English Tests

In order to establish some baseline information about the pupils, a series of tests were performed across 8 schools including the focus school and its pupils who will be described subsequently. Original test items from the national examinations were selected. These items were representative of some key chemical concepts that may pose difficulties in terms of the English language as well (e. g. solution). Another test was constructed with a wider range of chemical concepts including classification of matter; chemical reactions; balancing of chemical equations. In this second Chemistry test, only 41.3 % (i. e. n=19) of the learners have scores above the mean of 26.9 %, and only 4 learners achieved a score of 50 % or above. Data from the pilot studies revealed frequent pupil comments about «not understanding the words» For example, in some cases learners reported not knowing the majority of the content

words of the English Reading Comprehension passages. Finding reported in Spine working paper nº 2 (2000) http:/bris.ac.uk/spine) included the following. Further interviews with the original test items revealed similar difficulties with vocabulary. Across all the subjects, learners reported difficulty in understanding words or phrases in the instruction rubrics for the examination items as well as within the test items themselves. When learners were asked to provide synonyms or to provide Kiswahili equivalents, they often failed to do so. In addition, words that learners reported «knowing» were also investigated and it became clear that for some of the learners the meanings they attributed to a word or phrase were also incorrect. For these reasons, it was decided to probe further whether the hypothesis (that learners were inhibited from answering the examinations through low levels of vocabulary) was valid. Sections from Nation's Vocabulary Level Tests were administered (general vocabulary, 1000, 2000, 3000, academic list) to a select group of learners. Among these 31 learners, a significant correlation between their English test performance and the vocabulary levels test was observed ($r = 0.798$, $p. < 0.01$). Several simple regression analyses were conducted to understand how English language abilities (as measured by the vocabulary levels test and the English test using the original examination items) affected the learners' performance in other subjects. The resulting data analyses indicate that there are strong correlations between the learners' English language abilities and their performance in other subjects. The learners' performance in the vocabulary levels test can predict around 28 % of their Biology performance, 50 % of Chemistry performance and 55% of Mathematics performance. Their performance in the English test using some original items can predict 42 % of the learners' performance in Mathematics test, 65% in Biology and 66 % in Chemistry.

Figure 2. Group interview in an urban school in Zanzibar.

Videos of local pedagogies

Given the baseline studies on the relationships between English language and subject knowledge, we wanted to gain a more in-depth understanding from a more qualitative perspective of how the children are talking and reasoning about the subject knowledge. In this case, I will present a study that I conducted with 4 pupils in a primary school in an urban setting in Zanzibar (figure 2). Two boys and two girls were put into a group and were engaged in a group discussion around a set of video clips. The video clips were from other schools in Zanzibar collected as part of the project data set. The main aim of using video clips (demonstrated on a laptop) was to create a motivating context for pupils by viewing video clips of familiar school environments (in the sense that they were Zanzibar-based scenes), and yet unfamiliar in terms of the content of the videos.

The video clips were selected to explore several issues: *a)* science in school versus out of school contexts (Informal Learning); *b)* involving girls in demonstrations (Gender); *c)* connecting symbolic language of chemistry to experimental evidence (Chemical Language). All of these clips are some rare instances in the data of such themes. For instance, inclusion of girls in science demonstration and doing experiments outside of the classroom are not commonplace activities in Zanzibar schools. Inclusion of these types of activities in the instructional approaches in project schools were motivated by the aims and contexts of the project activities. It should be noted that the use of videos was a novel approach in the context of Zanzibar considering that Zanzibar is a low-income country and there are limited resources in schools, even basic resources such as pencils and paper, let alone videos and laptops. The novelty factor in children's experiences of the use of the technology should be kept in mind in interpreting the results. The video clips were from other schools from the children's own. This was to ensure that the children could dissociate from any potential personal associations with their teachers and peers, and concentrate on the issues that were being represented in the videos.

Video I: Taking chemistry out of the classroom

In this video, the teacher takes the class into the school garden in order to demonstrate how sodium reacts with water (figure 3). The children get into a big circle and the teacher uses a bucket to throw a big chunk of the metal into water. This video was intended to stimulate the children's discussion about the context of science learning.

Figure 3. Demonstration out of the classroom in the school yard.

Video 2: Involving girls in chemistry demonstrations

In this video, the teacher invites a girl to come to the front of the classroom to drop a piece of sodium into water as part of his demonstration on teaching about the reaction of acids with metals (figure 4). The mode of teaching that dominates Zanzibar school is the transmission model where there is little participation by the pupils in classroom talk and activities more widely. There is also considerable issue with the inclusion of girls in science given gender inequity persists across much of the sub-Saharan African region. In this respect, the clip was intended to promote an image of gender diversity and inclusion in science.

Figure 4. Girl participating in the demonstration activity.

Video 3: Verifying chemical equations

In this video, the teacher is building up the chemical equation of the reaction whose demonstration was conducted with the help of the girl in video 2 (figure 5). The primary aim of this clip is to forge a context for discussion of the link between experimental evidence and the symbolic representation underlying this evidence.

Figure 5. Teacher constructing the chemical equation for the sodium and water experiment.

Results

The group in figure 2 watched the video clips in sequence with pauses to probe their understanding of what was going on in each video clip. I asked the pupils to elaborate on the key issues on out-of-school learning, gender and linking experimental data to the chemical language of the equation. Here the results of the conversation will be thematically organized with respect to four emerging themes: *a)* attitudes towards language, *b)* coordinating experimental evidence with theoretical knowledge, *c)* pupils' inclusion in lessons and gender, and *d)* pedagogical approaches.

Attitudes towards language: English versus Kiswahili

After watching video clip 3, the group was probed to indicate whether or not it would have been easier for them to understand the chemical equation had the language of teaching been Kiswahili. Here the overall sentiment in the group was that the use of Kiswahili might sometimes be useful in chemistry but not always. In the particular example of the chemical equation, they indicated that the language would not have made a difference. They were also quite adamant about their preference of English as the language of instruction due to the international nature of English and its use, as illustrated in the following conversation:

I: There was no Kiswahili in this clip so I understood everything but do you think if the teacher talked in Kiswahili you could understand the equation better?
B: Yeah.
I: Yes? Tell me why how.
G: … what the teacher
I: When the teacher wrote the equation on the board, in Kiswahili do you think it would be easier to understand the equation?
G: No it would be not easier because … example. I mean it was too difficult with usual language and…. example…
I: Ok so it is not always, sometimes it's easy to understand in Kiswahili.
G: … for someone especially in chemistry.
B: … especially in chemistry.
I: So would you rather the teacher spoke more in English in the class or in Kiswahili in the class?
Gs/Bs: More in English this is an international language this why possible to understand so much … because every country whether USA or..so I mean the international language … language everyone can understand.
G: Also the teacher has to speak more English in the class because even the books are written in English.

Coordinating experimental evidence with theoretical knowledge

The pupils' discussion exposed some of the difficulties experienced in school science in coordinating the results from experimental or laboratory work with theoretical information introduced in class. Firstly, when the pupils were challenged to consider the nature of evidence and the claims around evidence (e. g. do you believe this has happened?), they did not seem to have understood the question because they have conflicting answers. Second, even though they had already covered the pH scale and the use of litmus paper in the testing of acidity/alkalinity, they could not see the link between the use of this instrument and the validation of acidity until they were probed through a leading question which resulted in correct chemistry knowledge about the pH scale. These instances, exemplified in the following conversation, illustrate that chemistry remains a conceptually difficult subject for pupils, irrespective of the language of instruction and learning given they were rather verbal and proficient in English during the interview.

I: Do you think the chemical equation shows what happened in the experiment that you saw? You know when the teacher wrote equation do you think it is do you believe that this has happened?
Bs/Gs: No.
I: Why?
G1: Because we already saw it and we believe it.
I: But how do you know that it's not sodium oxide?
G: Sodium reacts with water. It goes to the water and oxide and gives hydrogen.
G1: Hydrogen oxide.
I: Where does hydrogen oxide go? Where is it?
G: Um…
I: In this experiment where is sodium because I am just thinking about the pop. It was hydrogen what about sodium hydroxide?.
B: It remains.
I: It remains in the beaker, ok.
G2: You can't see it with your own eyes just imagine it.
I: Yeah can we prove that sodium hydroxide?
B: By experiment.
I: What can you do? He said basic, alkaline so if it is a basic oxide what chemical can test it?
B: Oxide.
I: have you done pH?
G: Ah, ok.
I: How do you test for…
G: You prepare something, ok liquid, so you try to, no no no you put is, once the number is from 1 to 6 it mean that your mixture have got more acid than… but if

it is from 7 to 14 which mean less… but more…
I: Ok, so here basic, sodium basic oxide so we can test that.

Pupil inclusion in lessons and gender

The pupils were reflective of the way in which the pupils in the video clips participated in the lessons. When the issue of gender was probed with respect to video 2, one of the girls pointed it out that liking a subject will dictate whether or not a person is good at it, not necessarily the gender. An interesting aspect of this discussion was that the children were keen on proposing some potential strategies for including more pupils in classroom activities. For example, one of the boys proposed that the class could be put into groups and each group gets a piece of sodium to experiment with at home. Doing an experiment yourself was considered to improve memory of the subject. This observation by the pupil is particularly striking given that group activities are very rare in Zanzibar due to various reasons such as overcrowded classrooms and insufficient pedagogical knowledge in coordinating group activities.

I: Anything else that you thought was different apart from this because it is also about sodium.
B: … experiment…
I: what about the girl who was doing the experiment.
B: … experiment by the teacher, the teacher only directed the girl.
I: Ok, the students do themselves.
B: Yeah to get more experience, they want to…
G: … to remind what was done, more memory about that.
B: … and there is a question… that experiment, it's easy to understand.
I: They will actually remember it for the exam.
Bs/Gs: yeah
I: What about I mean imagine you were in this classroom so you did it but your friend didn't do this.
G: It should be good but it's not good.
B: …so we had to choose one of us…for all but not all.
B2: …so the teacher maybe select one of them, you know.
G2: Do you think … ok give an example… at home … sodium at home … maybe two, other one too.
B: Two people…teacher …and by piece of sodium provide time … that experiment.
I: so you got it… so at least you got a small piece.
B1: The teacher would select one of them…That's good.
G2: But it's no more good.
G1: If you take one, others want too.
B1: It would be good if the teacher.. I mean made stories, provide a piece of sodium in each group. Then provide a beaker…or any surface, I mean for the ones doing the experiment and in time, they will understand..Then there is no boy or girl.
G: yeah
I: Excellent idea ok what about the fact that the student was a girl there are some people who say that girls are not good at science?
G2: I am going to disagree, it depend I mean … example myself, I like science so much. Alright, so because I like it I am going to be good at it so…

Pedagogical approaches

When questioned about the use of English, participation in learning and the use of pupils in demonstrations, pupils were able to discern the key issues involved in these segments of the videos. For example, they conjectured that the teacher used Kiswahili in the context of a potentially explosive chemical experiment so as to ensure that the pupil understands what to do, not leaving it to chance to guess the meaning of the English.

I: Ok… small piece and the teacher talks in Kiswahili.
G: Of course he was saying putting in the water… staying for the experiment.
I: Ok that what he was saying in Kiswahili why do you think he was saying this in Kiswahili?
G: Because we said maybe because students do not understand English that's why.
B: Maybe…
I: It is really important. Why was it important?
B: Because of explosion.
I: Well in this clip there is something else is different from what we saw in the garden. What are some of the differences?
G: Of course. Experiment was done in the class.
B: Experiment and students. A small tiny piece, it was quite different.
G2: … it was quite different.
B2: It is also…
G: Small bits.
B: … experiment
I: Anything else that you though was different apart from this because it is also about sodium?
B: … experiment…
I: What about the girl who was doing the experiment?
B: … experiment by the teacher the teacher only directed…
I: Ok the students do themselves?
B: Yeah.
B: Yeah to get more experience… they want to …
G: … to remind what was done, more memory about that.
B: … and there is a question… that experiment, it's easy to understand.
I: They will actually remember it for the exam.

Conclusions

The study described in this paper provides evidence that pupils in Zanzibar face significant difficulties with English language which contributes to their understanding of chemistry as well. However when the pupils are immersed in interesting and motivating contexts with links and referents to local culture and schooling, they are willing to and are able to contribute to discussion. Such discussions in this study illustrate how sophisticated pupils understanding of chemistry and pedagogy can be along with the exposure of some misconceptions and lack of understanding of key chemical ideas.

The use of the video has been powerful in eliciting some of the results. The video acts as a deflecting point where pupils do not consider the conversation the probing questions as being targeted to them personally. When the same pupils were interviewed individually, they had barely contributed to the conversation, feeling shy about their English and giving the impression that they did not understand the questions. The format of the video viewing and probing around video clips acted as a way to distance the focus on the pupils themselves.

In terms of chemistry knowledge, the pupils demonstrated some understanding of acidity and alkalinity but could not necessarily connect this knowledge to the understanding of the «nature» of chemistry. For instance, how pH could be used as a tool to validate chemical knowledge from experimental data. The pupils were able to propose some pedagogical strategies to facilitate learning. For instance, considering group discussion is not a key strategy used in their classroom (on the basis of our observations of teaching in these classrooms), they were able to imagine and propose that grouping of pupils could be a way to help learners have more direct experiences with experiments.

Overall, the study highlights some of the challenges facing learners in low-income countries particularly where issues of language politics might hinder effective access to science education. The pupils described in this article were from a middle-class urban school where the pupils are relatively more privileged. However even such learners demonstrate difficulties with both English and Chemistry knowledge.
Improvement of science education in Zanzibar will necessitate more than a language reform: it will require that a series of coordinated actions take place to equip teachers with innovative pedagogical strategies (such as group discussions and gender inclusion) to facilitate meaningful learning of chemistry. The teachers captured in the video-clips are forerunners of the initial stages of such reform by initiating links between formal and informal schooling and promoting active participation of all pupils in lessons.

Improvement of science education in Zanzibar will necessitate more than a language reform: it will require that a series of coordinated actions take place to equip teachers with innovative pedagogical strategies to facilitate meaningful learning of chemistry

Acknowledgments

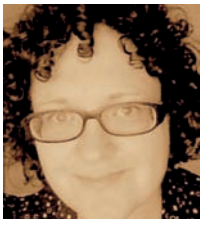
I would like to acknowledge and thank the pupils and teachers involved in the study reported in the paper as well as the wider SPINE project for their contributing to understanding language and subject knowledge issues in Zanzibar. I am grateful to Pauline Rea-Dickins for her leadership in the project and for fruitful discussions around the data. The data collection reported in the article was facilitated by Mohamed Abeid Mbaraok and the transcription of the video data was performed by Oksana Afitska.

References

Rea-Dickins, P., Yu, G., & Afitska, O. (2009). The consequences of examining through an unfamiliar language of instruction and its impact for school-age learners in sub-Saharan African school systems. In Taylor, L & Weir, C (ed), *Language Testing Matters: the social and educational impact of language assessment*. Cambridge: Cambridge University Press.

Roy-Campbell, Z. M. (2003). «promoting African languages as conveyors of knowledge in educational institutions». In: Makoni S., Smitherman G., Ball A.F., Spears, A.K. (ed.), *Black Linguistics: Language, Society and Politics in Africa and the Americas*. London: Routledge, p. 83-102.

Spine Working Paper (2009). *Investigating the language factor in school examinations: Exploratory studies*. Bristol: University of Bristol.



Sibel Erduran
is Professor of Science Education at University of Bristol, United Kingdom. Her interests include the nature of chemistry, argumentation and scientific reasoning. She is the International Coordinator for NARST and an Editor for *Science Education* Journal
E-mail: sibel.erduran@bristol.ac.uk