The effect of an integrated strategies approach to promoting scientific literacy on grade 6 and 7 learners’ general literacy skills

Abstract

This study investigates the effects of a scientific literacy strategy which focuses on reading, writing, talking and doing science on the development of grade six and seven learners’ general literacy skills, both in their home language (isiXhosa) and the language of classroom instruction (English). A mixed method design was used. Quantitative data were generated via baseline and post-testing of learners’ language skills and qualitative data were generated by interviews and classroom observation. The sample comprised of seven grade six and seven (multigrade) classes in seven primary schools (five experimental schools and two comparison schools) in the deep rural area of the Tyumie Valley in the Eastern Cape. Mean score differences between the experimental and comparison groups for the reading, writing, listening and speaking aspects of the literacy test were analysed using Analysis of Co-variance (ANCOVA) techniques. Qualitative data generated were used to gain insights into the statistical findings. The data suggest that the scientific literacy strategy statistically significantly improved the learners’ reading skills in English, their listening skills in both English and isiXhosa, and their writing in isiXhosa over the course of one academic year.

Keywords: scientific literacy, general literacy, reading, writing, talking, code switching

Introduction

It has been recognized for decades that there is widespread underachievement in science education in South Africa (De Lange, 1981; Taylor & Vinjevold, 1999), and that this situation is not improving to any marked extent (Asmal, 2000; Howie, 2001; Reddy, 2005; Fleisch, 2008). Local and international research point to issues of language as important contributors to low
achievement and high failure rates in the subject (National Centre for Curriculum Research and Development, 2000; Reddy, 2006; Yore & Treagust, 2006). Norris and Phillips (2003) argue that, just as scientists extensively read, write and discuss ideas to develop and defend their claims and arguments, young learners need to be able to read, write and talk about science at a much higher level than they currently do if they are to develop meaningful understandings. Lemke (1990) and Hagen, Huber, Kahlert and Hemmer-Schanze (2005) point to the necessity of well developed listening and talking skills if children are to engage actively in scientific investigations, discuss their data, develop argumentation skills, draw conclusions and report convincingly on their findings. Yore, Florence, Pearson and Weaver (2002), Wallace, Hand and Prain (2004), and Marlow (2005) echo these sentiments and emphasise the importance of reading and writing in developing scientific literacy.

Cervetti, Pearson, Bravo and Barber (2006, p 2) built and tested a curriculum that put literacy instruction to work “…in the service of acquiring knowledge, skills and dispositions of inquiry-based science” and their findings pointed to learners making significant gains when exposed to their literacy-based (Seeds and Roots) science teaching approach. Klentschy, Garrison and Amaral (1999), in a large-scale study amongst mainly second-language learners in California’s El Centro district, found that children who participated in a district-wide combined kit-based and science writing programme scored significantly higher pass rates on sixth grade science, numeracy and literacy proficiency assessment tests than to those who did not participate in the programme.

In the South African context, an integrated strategies approach to promoting scientific literacy, which includes the reading, talking, planning, doing, writing, arguing and presenting aspects of scientific investigations, has been developed for local use by a team of South African and American science education researchers. An intervention based on this approach was introduced in a sample of deep-rural primary schools in the Eastern Cape and researched in terms of the intervention’s effect on the participating teachers’ ability to use the approach, the ability of their learners to interact with the expectations of the approach, as well as possible effects on their learners’ problem solving abilities and general literacy skills. This report specifically focuses on the effects of the intervention on learners general literacy skills.

**Background**

The new South African National Curriculum Statement, which places a greater emphasis on specific learning outcomes and the competencies that the learner must achieve, was developed to replace the previous traditional and content-based curriculum that was in existence in South Africa prior to universal franchise in 1995 (Department of Education, 2002, 2005). Overall, the new curriculum purports to be highly supportive of the development of scientific literacy, but it appears that the changes that have been brought about on paper have not equated to transforming or improving maths and science education in the classroom (Christie, Butler & Potterton, 2007). Additionally, in countries such as South Africa where teaching and learning most often takes place officially in a second language, poor performance in national and international tests of science achievement and in national systemic evaluations of literacy and numeracy (Department of Education, 2003) suggest that there is an urgent need to focus on broader issues of scientific literacy and literacy in general.

In recent years there has been increasing international research and recognition of the central role of language in learning science (Norris & Phillips, 2003; Yore & Treagust, 2006). These
researchers, amongst others, believe that for someone to be judged scientifically literate they must be proficient in the discourses of science, which include reading, writing and talking science. Hand, Prain and Yore (2001) and Norris and Phillips (2003) draw a distinction between the fundamental and derived senses of scientific literacy. Scientific literacy in the fundamental sense requires proficiency in science language and thinking. Being proficient in the fundamental sense is a pre-requisite for being able to operate within the derived sense, i.e. being able to make informed judgements on scientific societal issues (Hand, Prain & Yore, 2001; Norris & Phillips, 2003). In the South African context, where teaching and learning most often takes place in a second language, promoting scientific literacy in its fundamental sense in the language the learner is best able to engage in cognitively, as well as the official language of learning and teaching, is likely to be a prerequisite requirement for providing the necessary framework for learners to engage in the derived sense of scientific literacy.

A common challenge that is encountered when attempting to effect curricular change in science education is that of insufficient qualified educators, whether it be in developing countries, countries in transition, or in developed countries (Earnest & Treagust, 2007). As such, a teacher development intervention strategy, viz. the integrated strategies approach to promoting scientific literacy, was developed and tested in the Eastern Cape in an attempt to investigate the effectiveness of the strategy in terms of teacher implementation and effectiveness.

Integrated teaching strategies model for developing scientific literacy

Yore and Treagust’s (2006) call for attention to be paid to the fundamental sense of scientific literacy resulted in the development of an approach that not only specifically includes classroom discussion, argumentation and writing to learn science, but which provides teachers with ideas and techniques to stimulate their learners to develop their own investigable questions, plan and execute an investigation in the classroom, and present their findings to an authentic audience. As noted earlier, the approach models what scientists do, viz. read, talk, identify a problem, plan an investigation, do experiments, read more, argue their findings, and present them in a number of ways depending on the audience.

Put simply, the strategy aims at enhancing reading to learn science and learning to read for science; improving classroom discussion and exploratory talk towards investigable questions; facilitating planning and doing an investigation in the classroom; scaffolding writing to learn science, and scaffolding argumentation and critical thinking. In terms of reading, learners are encouraged to read and listen to carefully selected stories that can be used as a starting point towards formulating investigable questions. These stories are in the form of big books with enlarged prints and illustrations. The teacher reads the book aloud, builds language support to help learners develop the language and the story serves as a vehicle for thought and discussion. After guidance in formulating an investigable question, planning an investigation and implementing the investigation, the learners engage in scaffolded writing using the Science Notebooks approach (Villanueva & Webb, 2008) and a modified Toulmin argumentation frame (Webb, Williams & Meiring, 2008). They are then expected to present their findings to an authentic audience, e.g. their peers, teachers, parents, etc.

The basic tenets of the model are illustrated in Figure 1.
From Figure 1 we see that the stimulus (the reading material, discrepant event, concept cartoon, etc.) not only provides the stimulation for discussion, but can also help access some of the prerequisite information needed for meaningful discussion towards raising investigable and researchable questions. The discussion that ensues and the investigable question generated, enables the planning and execution of the investigation. Once the line of learning is drawn in the children's science notebook, i.e., they have drawn all the conclusions that they can from their classroom investigation by using the data they have generated, further reading and research allows them to go beyond the limits of their investigable question. This means that they can explore through other forms of information gathering the non-investigable but researchable questions that were raised as part of their earlier discussions. Finally, getting learners to record their arguments within a writing framework not only improves their argumentation techniques, but provides opportunities to improve their understandings of the nature of science, scientific processes and procedures, the notion of audience and presentation requirements.

Although the integrated teaching strategies model approach has been designed to result in an overall better understanding of scientific literacy, there are a number of implications and obstacles for teachers, and for teacher education. Firstly, for science teachers there may be issues in terms of reading techniques to be considered, particularly if the students are second-language learners. Practicing teachers must be *au fait* with current practices and science-teacher educators must ensure that they introduce their students to effective language and literacy strategies. Secondly, teachers also need to become competent and at ease in terms of promoting classroom discussion amongst their learners and must ensure that there are ample materials available for their learners to use to promote reading and researching to extend their line of learning. Thirdly, they must also be thoroughly acquainted with understandings of the nature of science and the processes and
procedural knowledge that need to be developed if their learners are to develop their scientific literacy in an authentic sense.

Teachers have to assess their learners’ levels of scientific literacy in all aspects covered by the strategy. Levels of scientific literacy, i.e., the learners’ ability to read, write, discuss, plan, do, argue and present their findings, can be assessed both formatively throughout the process and summatively by assessing the whole strategy, as shown in Figure 2. What also must be remembered is that although the model presented above seems to imply that the reading, writing, talking and doing aspects of the strategy take place at discrete intervals, this is not the case. As shown in Figure 2 they take place whenever applicable. This diagram also further teases out the prediction, procedure, data collection and conclusion aspects of the inquiry process, as well as the importance of teacher directed discussion and teacher demonstration as ways of extending the line of learning. Also illustrated in this version of the model is the importance of student generated ideas and words, scientific vocabulary, new applications and questions raised during the process. The model illustrates that findings can be shared in a variety of ways, e.g. reports, publications, oral and dramatic presentations, etc. Finally, in terms of records of students’ work, each investigation with the concomitant evidence of learner output and assessment can be kept in a portfolio for presentation to their parents, peers and any other interested parties.

Figure 2: Representation of the integrated teaching strategies model for improved scientific literacy showing continuous and integrated nature of the reading, writing, talking and doing aspects of the model and opportunities for assessment.
Design and methods

The strategy was workshopped with teachers in English but at all stages it was emphasised that using home language both for teaching and learning, as well as code-switching, was both legitimate and encouraged. A simple pre- and post-test design using experimental and control groups (schools/classrooms) was used in this study. Classroom observations of the teachers implementing the process (three observations per teacher) took place at regularly spaced intervals over the course of one academic year while the scientific literacy intervention strategy was taking place. Interviews of teachers and learners took place during the implementation stage and immediately after the general literacy post-tests were administered.

Sample

The sample comprised of seven grade six and seven (multigrade) classes in seven primary schools situated in the rural foothills (Tyumie Valley) of the Hogsback Mountains in the Eastern Cape. These milieu was purposively selected in order to investigate the effect of the scientific literacy strategy in a rural setting. The schools were selected as a convenience sample in terms of an easily accessible cluster, after which they were randomly allocated to either the experimental (n=5) or control group (n=2). The teachers and the learners from all participating schools were isiXhosa first language speakers while English is the language of teaching and learning in the schools. Learners ranged between 11 and 14 years of age and both the learners and teachers were isiXhosa first language speakers.

Classroom observation

Three individual classroom observations of all the experimental teachers were undertaken at regular intervals throughout the year after the initial baseline observation made before implementation of the strategy. A four-point scale classroom observation schedule was used to determine whether learners in these classrooms were given opportunities to read, listen, write and speak during the implementation of the scientific literacy strategy. These data were used to determine how successfully the scientific literacy strategy had been implemented and to assess possible weaknesses in terms of implementation. The observer who generated the classroom observation data is an isiXhosa first-language speaker, is fluent in English, and was intimately involved in introducing the integrated strategies scientific literacy approach to the teachers.

Tests

The literacy baseline and post-tests that were used were initially designed for the British Department for International Development (DFID) sponsored Mpumalanga Primary Schools Initiative evaluation (Webb, Glover, Cloete, England, Feza, Hosking, et al., 1999). These tests were translated into the home language of the teachers and learners (isiXhosa) who participated in the research project. The aim was to test learner’s literacy levels in both their first language and the language of teaching and learning (English). The children’s reading comprehension skills, ability to make inferences based on what they have read, and their ability to complete a paragraph in the form of a writing frame based on their interpretation of diagrams, were tested. Their listening skills were tested by requiring them to listen to a story and then answer multiple choice questions based on what they had heard. They then had to follow instructions given, for example, they were asked to complete a diagram by following instructions given by the researcher. Writing skills were tested by requiring the children to write a story based on pictures provided,
i.e., to see if they could transfer information from a visual to a written mode, could write coherent meaningful sentences based on the pictures, could interpret the visuals, and could write grammatically meaningful sentences. They were then asked to discuss something the researcher presented to them, e.g., they were asked whether they thought that if a feather and a blackboard duster dropped from the same height and at the same time would reach the floor simultaneously. They were asked to discuss what they thought and explain their answers to the researcher. Their speaking ability was probed further by asking follow-up questions on what they had said.

The quantitative data generated by the tests were treated statistically and as the experimental and control groups pre-test mean scores were not the same analysis of co-variance (ANCOVA) techniques were applied. Analysis of covariance is a more sophisticated method of analysis of variance (ANOVA) as it allows for the inclusion of continuous variables (covariates) into the ANOVA model. In this study the covariates were the initial scores of the participants. In other words the result of the treatment alone could be statistically evaluated between the target and control groups by eliminating the possibility that one class was inherently more able than another.

**Interviews**

The teachers and learners were interviewed individually and in focus groups respectively to gain insight into their perspectives of the general literacy aspects of the intervention including why they choose to communicate in the language most used in their classroom and if they felt that the scientific literacy strategy made any difference in terms of their understanding of science. All interviewees were asked the same open-ended questions in the same order and the interviews were conducted in English, the language of learning and teaching, but as the interviewer/researcher is a first language isiXhosa speaker, she assisted with translations where necessary.

**Data analysis**

The classroom observation data were generated manually and simple tables were created to provide overall visual access to teacher behaviour in terms of the strategy in the lessons observed. The data generated by the general literacy study pre- and post-tests were analysed using Analysis of Variance (ANOVA) and Analysis of Co-variance (ANCOVA) techniques. This was done to interrogate differences between the experimental and control groups mean scores for the reading, listening, writing and speaking aspects of the literacy tests; gains made during implementation of the strategy; and differences between the scores dependent on the language used. The interview data were inspected and themes were identified inductively.

**Results**

The data generated by classroom observation, learner tests and teacher and learner interviews revealed the following:

**Classroom observation**

Classroom observations revealed that in general the teachers chose to teach in their home language and code-switch into English, the official language of learning and teaching (Table 1).
Table 1: Teachers’ use of language while implementing the scientific literacy strategy used in this study

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Home language and switch to English</td>
<td>✓</td>
</tr>
<tr>
<td>Discourages home language</td>
<td></td>
</tr>
<tr>
<td>Use English and switch to home language</td>
<td>✓</td>
</tr>
<tr>
<td>Uses English only</td>
<td></td>
</tr>
</tbody>
</table>

All of the lessons observed suggested that the teachers had an adequate understanding of the scientific literacy strategy, but that they provided no planned activities where learners listening skills were tested. It was also apparent that teachers’ had difficulty implementing the classroom discussion aspect of the strategy and that the participating learners’ struggled to share their ideas when opportunities were provided for classroom discussion. It was noted that the learners used isiXhosa exclusively during classroom discussion. Their science notebooks were often incoherent and in most cases they struggled to read the material presented to them by their teachers.

**Literacy tests**

The differences between mean scores of the experimental and control groups for the reading, listening, writing and talking aspects of the literacy tests (English and isiXhosa) were analysed using Analysis of Co-variance (ANCOVA). A positive score indicates a higher score for the experimental group than the control group, a negative score vice-versa. An asterisk indicates that the difference between the experimental and control group mean scores is statistically significant at the 99% confidence level. For example, in the case of the reading scores in Table 2 the control group scored higher in both the English and isiXhosa pre-tests, with a statistically significant difference in terms of the English reading pre-test. The control group scores were also better in the post-tests, but the data indicate that the degree of difference between the experimental and control group mean scores was reduced.

Table 2: Differences in the mean scores of the experimental and control groups for the English and isiXhosa pre- and post-tests in reading, listening, writing and speaking. A positive score indicates a higher score was attained by the experimental group than the control group.

<table>
<thead>
<tr>
<th>Differences in mean</th>
<th>Pre-tests</th>
<th>Post-tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>English</td>
<td>isiXhosa</td>
</tr>
<tr>
<td>Reading</td>
<td>-11.7*</td>
<td>-2.17</td>
</tr>
<tr>
<td>Listening</td>
<td>-19.62*</td>
<td>-9.21</td>
</tr>
<tr>
<td>Writing</td>
<td>0.62</td>
<td>-4.51</td>
</tr>
<tr>
<td>Speaking</td>
<td>3.38</td>
<td>-2.78</td>
</tr>
</tbody>
</table>

* = statistically significant at the 99% level of confidence.
The effect of an integrated strategies approach to promoting scientific literacy ...

In the pre-test, the control group performed significantly better than the experiment group in reading and listening in English, and non-significantly better in all four performance areas in isiXhosa. The experiment group performed slightly better than the control group in writing and speaking in English. In the post-test, the difference between experiment and control groups was considerably reduced in reading and listening, although the control group still performed better than the experiment group in English reading, writing and speaking and isiXhosa reading. The experiment group performed significantly better than the control group in writing in isiXhosa, and non-significantly better in listening and speaking isiXhosa and writing English.

In order to test the hypothesis that the literacy programme resulted in improved literacy skills, a measure of ‘improvement’ was calculated. Improvement was calculated as the difference between post-test score and pre-test score in each literacy variable. Improvement was then compared between the experimental and the control groups. The prediction made was that the experimental group should show greater improvement than the control group. Comparisons were made of the changes in pre- and post-test experimental and control group scores in all literacy categories, viz. reading, listening, writing and speaking. The mean differences in the pre- and post-test scores for the experimental and control groups in terms of reading are shown in Table 3. Again a positive figure indicates a higher score for the experimental group than for the control group.

**Table 3:** Improvement between the experimental and control groups for reading ability. A positive figure indicates a greater improvement in the experimental group than the control group.

<table>
<thead>
<tr>
<th></th>
<th>Mean change</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>7.65*</td>
<td>0.007</td>
<td>0.47</td>
</tr>
<tr>
<td>isiXhosa</td>
<td>-0.93</td>
<td>0.714</td>
<td>n/a</td>
</tr>
</tbody>
</table>

* = statistically significant at greater than the 99% level of confidence (p≤0.01); n/a = not applicable

Improvement in the experimental group was significantly greater than the control group in terms of English reading and the Cohen’s d score suggests a medium effect size (0.2-0.5 = small effect; 0.5-0.8 = medium; ≥0.8 = large), i.e., it had a medium effect in practical terms on the experimental group as a whole. Although the control group scores improved marginally more than the experimental group when reading in Xhosa, this result is not statistically significant. Differences in improvement in listening are shown in Table 4.

**Table 4:** Differences in improvement between the experimental and control groups for listening ability.

<table>
<thead>
<tr>
<th></th>
<th>Mean change</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>9.16*</td>
<td>0.01</td>
<td>0.60</td>
</tr>
<tr>
<td>isiXhosa</td>
<td>11.48*</td>
<td>0.005</td>
<td>0.62</td>
</tr>
</tbody>
</table>

* = statistically significant at greater than the 99% level of confidence (p≤0.01)

Improvement in the experimental group in English and Xhosa was statistically significant and the Cohen’s d score indicates that there was a medium effect in practical terms on the experimental group as a whole.
Differences in improvement for the experimental and control groups in terms of writing are shown in Table 5.

**Table 5: Differences in improvement between the experimental and control groups for writing ability**

<table>
<thead>
<tr>
<th></th>
<th>Mean change</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>0.56</td>
<td>0.810</td>
<td>n/a</td>
</tr>
<tr>
<td>isiXhosa</td>
<td>13.48*</td>
<td>0.005</td>
<td>0.78</td>
</tr>
</tbody>
</table>

* = statistically significant at greater than the 99% level of confidence (p≤0.01); n/a = not applicable.

There was no statistically significant improvement in the English writing category for either the control or experimental group whereas the experimental group’s isiXhosa improved significantly. The Cohen’s D figure indicates that there was a medium effect (approaching large).

There were no statistically significant improvements in speaking between the pre- and post-talking tests in either English or isiXhosa.

In order to test the hypothesis that learners performed better in isiXhosa than in English, scores on each literacy measure was compared in the two languages. Comparison was not made as matched pairs, but each learner was evaluated in both languages and the group scores compared. We predicted that learners would perform better on the pre-test in isiXhosa than in English.

The mean differences in scores between the learners’ English and isiXhosa abilities in reading, listening, writing, and speaking are shown in table 6 where a positive number indicates a higher score for the Xhosa test than in English.

**Table 6: Mean differences in scores between English and isiXhosa abilities in reading, listening, writing and speaking**

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean diff</td>
<td>n</td>
</tr>
<tr>
<td>Reading</td>
<td>9.53*</td>
<td>88</td>
</tr>
<tr>
<td>Listening</td>
<td>10.41*</td>
<td>88</td>
</tr>
<tr>
<td>Writing</td>
<td>-3.89</td>
<td>88</td>
</tr>
<tr>
<td>Speaking</td>
<td>-6.16</td>
<td>15</td>
</tr>
</tbody>
</table>

* = statistically significant difference at greater than the 99% level of confidence (p<0.01); n/a = not applicable

Results that support the predictions are those for reading and listening in the pre-test, where learners performed significantly better in isiXhosa than in English. In the post-test, learners performed significantly better in listening and writing in isiXhosa than in English. There were no statistically significant results where performance in English was better than that in isiXhosa.

Because of the small size of the sample used for the speaking test, no statistically significant differences could be detected, but it appears that their talking abilities changed from being better in English in the pre-test, to better in Xhosa in the post-test.
The above findings are summarised in Table 7.

**Table 7: Overview of the differences between the experimental and control groups for the reading, listening, writing and speaking pre- and post-tests**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Overview</th>
</tr>
</thead>
</table>
| Reading      | • The experimental group’s mean scores for reading in English improved statistically significantly more than the control group’s did after the treatment (at the 99% level of confidence)  
• The mean difference between the English and isiXhosa reading scores was significantly different in favour of isiXhosa in the pre-test, but there was no statistically significant difference in the post-test |
| Listening    | • The experimental group’s English and isiXhosa mean scores improved by a statistically significant amount (9.2 and 11.5 points respectively) over the control group’s changes in scores  
• The mean difference between the English and isiXhosa listening scores was significantly different in favour of isiXhosa in both the pre-test and in the post-test |
| Writing      | • There was no statistically significant change in the experimental group’s writing skills in English over the control group after the intervention but there was a statistically significant improvement of their scores over the control group’s scores in writing in isiXhosa (13.5 points)  
• The mean difference between the English and isiXhosa writing scores was significantly different in favour of English in the pre-test, but changed to being statistically significantly different in favour of isiXhosa in the post-test |
| Speaking     | • There were no statistically significant differences noted between changes in scores between the pre- and post-test scores of the experimental and control groups (small sample size)  
• There was no statistically significant mean differences between the English and isiXhosa speaking scores in either the pre- or post-tests |

**Interviews**

The teachers indicated that they preferred to use both Xhosa and English. One of the teachers said “my learners do not follow instructions clearly when I use English only because their home language is Xhosa so it is easy for them to understand better when I mix the two”. The other teacher’s responses were that translation and code switching are the best ways of communicating
in the classroom, for instance, one teacher indicated that “my students do not understand at all when communication is done only in English and they only hear when translation takes place”. It was interesting to note that some of the teachers believe that English should be used for giving instructions, asking questions, giving feedback and asking learners to clean the board, because they feel that this helps their learners to function in English and “that would help the learners to understand English since their textbooks and exams are in English”.

Regarding the language used when implementing the science literacy strategy, most responses were that they (the teachers) find it easier to give learners instructions in isiXhosa when they are doing the investigations. One teacher mentioned that “my learners have not reached a level of understanding in English; as a result I give them instructions in Xhosa”. At the same time teachers acknowledged that it is difficult to explain the science terms in isiXhosa as they don’t have enough vocabulary as a result they try to explain to their learners in English “even if they do not understand the meaning”. All the teachers interviewed agreed that they mostly use both isiXhosa and English, “Xhosa for instructions and explanations and English for scientific terms which are also translated into Xhosa if possible”.

All of the teachers felt that they were not giving their learners enough writing opportunities, for example one teacher confessed that she has only given the learners two class tasks since the beginning of the year (the interviews were conducted in the second semester) and these two tasks were only one word questions as they believe it is difficult for the learners to understand meaningful sentences. They commented on the science notebooks approach as one way of providing opportunities for learners to write.

In all schools, learners preferred that their home language should be used to ask and answer questions, for group discussion, giving instructions and to be used by their teachers to ask questions in class. When asked whether they could communicate in English, they said that even though their teachers expect them to develop their English language skills since English is the language of learning and teaching in their schools, they still prefer their teachers to explain everything in isiXhosa.

Learners were asked whether they are given opportunities to listen, read, write and speak during science lessons. Most of them felt that most of the time “it is the teachers who do the talking; we only speak in groups when we are given a task to do and we always communicate in Xhosa and write in English”. They further mentioned that “following instructions is not easy when given in English; hence we like it when teachers give us instructions in Xhosa”. Their answers about reading revealed that they were not reading during the science lessons because “most of the time it is our teachers who read for us and the only chance we have is when we read from the charts and we do that aloud as a whole class”. Furthermore, they mentioned that they write mostly in their class work books after the lesson “not many times as we have 6 class works since January” and most of the writing was done ‘during the investigations on our science notebooks’.

The language they preferred to be taught science with is Xhosa as “we don’t understand English well”. Others felt that “English and Xhosa are languages that help us to understand science because when we do not understand science terms or explanations in English, it always helps us when the teacher explains in Xhosa”. A minority of the interviewees said that they like English and they would like to be taught in English because “we want to understand science in English”.

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Discussion

Yore and Treagust (2006) note that learning to talk, read and write science is important as they enable learners to argue meaningfully about science issues. The influence of language is pervasive amongst first-language speakers as they grapple with what Yore and Treagust (2006) describe as the ‘three-language’ (home language, instructional language, science language) problem that exists for most science learners. However, in most of the schools sampled for this particular study an added problem exists because learners are taught in a language which is not their mother tongue, a problem that has regularly been reported in South African literature (Setati, Adler, Reed, & Bapoo, 2002). What was clear from the classroom observations in this study is that the participating learners prefer to be taught in their home language.

The fact that code switching was observed throughout the observations as a teaching strategy to support learning supports other research findings in South Africa i.e. that code switching is a common strategy used in classrooms where the language of teaching and learning is not the home language (Peires, 1994; Setati & Adler, 2000). The frequent use of this strategy suggests that the language realities of second language classrooms require a strategy that recognises the learner’s home language as well as the language of learning and teaching. As such, recognition of the role of language in learning science and promotion of writing, talking, reading, discussion and arguing by the scientific literacy approach used in this study appears appropriate.

One of the most interesting findings of this study was the statistically significant improvements in the participating learner’s home language (isiXhosa) listening and writing skills. These results are interesting as one might expect home language to be well developed at grade 6/7 level, and not easily susceptible to relatively short term interventions such as the scientific literacy strategy. However, there are a number of studies which suggest that if language is not properly developed in a child’s home language before being introduced to a second language, both will suffer (Heugh, 2000). This seems to be the case in this study because both the experimental and the control group mean scores in English and isiXhosa pre-tests reflected very low levels of learner’s performance.

Despite low levels’ of learner performance, the rigorous statistical analysis suggests that the intervention was successful in terms of improving the learners’ reading ability in English, listening in both isiXhosa and English, and writing in isiXhosa. The reading materials provided by the intervention were in English and the improvement in reading ability is gratifying. As no isiXhosa literature was provided, no improvement in this language was expected. Improvement in listening skills in both languages could possibly be ascribed to encouragement of the use of both languages in class to promote understanding. The learners’ were encouraged to write their science notebooks in the language of their choice and most chose isiXhosa. The notebook records of those who chose to write in English were often fragmented and incomprehensible. The statistically significant improvement in the experimental group’s writing in isiXhosa suggests that this approach may be a successful science strategy which contributes towards improving home language writing skills in the context of South African bilingual schools. Overall, the inferences above are supported by the comments made by teachers and learners during their interview sessions. The teachers alluded to the benefits of code switching and translating, while the learners noted that although they want to “understand science in English”, they always communicate in isiXhosa first, before trying to write in English and prefer the teacher to explain in isiXhosa. These views can be easily interpreted in terms of Heugh’s (2000) proposition that
if language is not properly developed in a child’s home language before being introduced to a second language, both will suffer.

The adoption of English as the language for second-language speakers at an early age is common in South Africa (Setati, 1998). It is therefore not surprising to find that the South African TIMMS science scores are by far the highest for children who are schooled and wrote the test in their mother tongue (Howie, 2005). However, problems of bilingualism are not confined to South Africa. Alidou and Brock-Utne (in Alidou et al., 2006) report that classroom observation studies conducted in several countries in Africa (Benin, Burkina Faso, Guinea-Bissau, Mali, Mozambique, Niger, South Africa, Togo, Tanzania, Ethiopia, Ghana, and Botswana) reveal that the use of an unfamiliar language such as English often results in traditional and teacher-centred teaching methods, e.g. chorus teaching, repetition, memorization and recall. Teachers do most of the talking while children remain silent and passive. When teachers use English mainly for explanation, rote learning of procedures takes place and opportunities for developing meaningful learner-centred scientific talk and writing are limited. These findings, and the data generated in this study, suggest that it is imperative that the influence of language be taken into account (as per Norris and Phillips’ 2003 allusion to the centrality of literacy in its fundamental sense to scientific literacy) if we are to attempt to meet Fensham’s (2008) goal of developing scientific literacy for all.

References


The effect of an integrated strategies approach to promoting scientific literacy …


