

# SCIENCE NOTEBOOKS: A USEFUL STRATEGY FOR SCIENTIFIC INVESTIGATIONS?

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*This study investigated the use of science notebooks to promote science investigations in Grade 6 classrooms. Teachers were trained on inquiry-based techniques and activities, as well as the strategies for implementing science notebooks. Classroom observations, analyzing learners' notebooks, interviews, and workshop and feedback sessions provided qualitative and quantitative data to support findings. The study found that teachers were able to change their classroom practice and learners were afforded the opportunity for critical thinking, inquiry and scientific writing.*

## SIGNIFICANCE OF THE STUDY

### Theoretical Framework

With the publication of the South African Revised National Curriculum Statement (RNCS), science investigations have become a critical part of the Natural Sciences Learning Areas. According to the RNCS, investigations require that learners examine problems which call for “conceptual knowledge of science, as well as creative thought and systematic testing of ideas.” (Department of Education, 2001: 9). Research suggests that this ‘testing of ideas’ can be promoted by inquiry-based learning whereby learners formulate their own questions, develop their hypotheses, design investigations, test the hypotheses and answer the questions proposed (Edwards, 1997).

Although science curriculum in some countries have focused on inquiry-based learning strategies within the last decade, research in South African education reflects traditional teaching strategies which focus on the mastery of content, facts and basic skills (Taylor & Vinjevold, 1999). Current studies in science teacher education suggest that this conventional form of teaching can be attributed to a lack of pedagogic content knowledge (Shulman, 1999). And while the RNCS promotes investigations, teachers may not be equipped with tools, resources or training which supports the use of process skills required for investigations such as, formulating questions, observing, making measurements, classifying and recording data, interpreting information and making inferences.

Campbell and Fulton (2003), along with other researchers, advocate the use of Science Notebooks as a tool to promote investigations. As notebooks are a place to record data, observations, illustrations, understandings, questions, reflections while working (Campbell & Fulton, 2003), researchers also contend that science notebooks have the potential to build content and process skills, while serving as a context for developing literacy. (Hargrove & Nesbit, 2003; Miller & Calfee, 2004.)

Scientific investigations are an important core aspect of the science curriculum in the Intermediate Phase (Grade 4-6) of the South African Revised National Curriculum Statement (RNCS). Scientific investigations, as described by the RNCS, are based on the principles of inquiry-based learning

whereby learners seek truth, and gain knowledge and information through the process of questioning. (Melber, 2004; NSTA, 2005; Nesbit, 2003; Thirteen, 2004;) Science investigations also incorporate practical activities for which detailed instructions are not given and ones in which the learner does not know the result before the investigation (Huber & Probst, 1995).

Our current situation in South Africa reveals that the investigations which many teachers conduct in schools are comprised of traditional experiments which simply verify a scientific principle or concept that have been known for years (Huber & Probst, 1995). This traditional approach to learning places a greater focus on the mastery of content and less emphasis on the development of skills and the nurturing of inquiring attitudes. (Maree & Fraser, 2004.)

As such, scientific investigations at school level in South Africa have been criticised as something that learners see little point in carrying out as they already know the results and are just expected to follow instructions to reach that end. This may possibly be attributed to the fact that many science teachers finish their pre-service training without having completed a science investigation (Webb & Glover, 2004) and, therefore, have minimal skills in conducting inquiry-based activities or strategies to promote them. (Cheong, 2004.) Now these very same teachers are charged with teaching the RNCS's Learning Outcome 1 (LO1): 'Scientific Investigations' to their learners in an inquiry-based manner.

The primary question in this study is:

*Can the use of science notebooks be used as a strategy to promote scientific investigations in Grade 6 classrooms?*

Secondary questions underpinning the primary question are:

- Can teachers be developed professionally to use a strategy focusing on the use of science notebooks successfully in the classroom?
- What effect does the use of a strategy involving scientific notebooks have on the way children effectively utilise the processes and procedures required for scientific investigations?

## **STUDY DESIGN**

This study utilized a mixed-method design for the collection of data with both qualitative and quantitative methods being utilized in order to gain the most accurate insight into the training and use of science notebooks and inquiry-based teaching. Quantitative data were collected from the observation instruments, namely the inquiry-based science observation scale and the science notebook checklist. In an attempt to obtain deeper insight into, and deeper understandings of, the quantitative data, qualitative measures such as interviews and observations were performed.

In Qualitative thought and human understanding, Eisner (1998) states that schooling needs to be known by 'direct, intimate contact'. Through classroom observations and interviews, one can attempt to understand what educators and learners do in the settings in which they work. This approach provides qualitative data which enhances the researcher's insight into the participants' thinking processes. In this study detailed descriptions are recorded in terms of the observations, interviews, and intervention process, as well as of the interaction between the teachers and the researcher.

Qualitative information from classroom observations, interviews and processing sessions with teachers following observations of their practice in the classroom, plus examination of 15 randomly selected learners' science notebooks, was used to support and triangulate the quantitative findings. The data collection techniques in this study include: baseline information, in the form of interviews and classroom observations; professional development workshops, classroom observations and reciprocal feedback, i.e. responses from the researchers in terms of what had been observed their classrooms and possible strategies to improve their teaching strategies and also discussions between the researchers and the teachers to discuss the context of the events that took place in the classroom.

There are, however, certain limitations to conducting such a study. The external validity of the study may be in question as the small sample of schools from the Nelson Mandela metropolitan area cannot be considered to be representative of all classrooms in South Africa and therefore cannot be generalized to the South African education system as a whole. However, this research may provide some insight to various factors which contribute to the success or challenges of using a 'science notebook' approach in the classroom.

### **Sample and Setting**

Eight Grade 6 science educators from the townships of Port Elizabeth were invited to participate in the research. These schools were selected based on their previous participation or relationship with the Department of Science, Mathematics and Technology Education at the Nelson Mandela Metropolitan University. The schools in which the educators teach were broadly matched as institutions that are from previously disadvantaged communities, and which are neither currently dysfunctional nor excellent. The approximate size of their classrooms consisted of 30 to 50 learners per Grade 6 science class, reflecting the average size of classes encountered during work done in schools in Port Elizabeth by members of the Department of Science, Mathematics and Technology Education.

Eight teachers participated in the study. Four teachers served as the control, one teacher did not continue with the study, and the remaining three teachers engaged in a total of 13 hours of professional development involving five sessions focused on inquiry teaching strategies and the use of science notebooks. Eight of the 13 hours involved teachers in reciprocal processing of their teaching observations. Qualitative and quantitative data were gathered from four classroom observations per teacher, four interviews and processing sessions with teachers following each of their observations and examination of 15 randomly selected learners' science notebooks.

### **Data Gathering Instruments**

The two instruments used in the study were developed and validated by the University of North Carolina – Wilmington, but were modified to support the educational context of science education as a whole. These instruments are the:

**Inquiry-based Science Observation Scale:** This instrument was designed to measure the degree of inquiry teaching used by the educators in their science lesson.

**Science Notebook Checklist:** The instrument assessed the extent to which the work in the notebooks reflected principles of Science Investigations as advocated by the RNCS.

At the completion of each lesson, each educator was also interviewed about their perceptions of inquiry teaching. An interview schedule was used to evaluate educator's perceptions and attitudes of inquiry science.

### **Ethical Considerations**

In keeping with the accepted professional ethics of research (Mouton, 2001), the aims of the study, research design and methodologies were communicated to the teachers and principals from each school. The participants' rights to privacy, including their right to refuse participation in the study were conveyed to each teacher. All the participants used in this study were informed volunteers and were aware that their responses would be used for this study. The right to seek full disclosure about the research topic and the results of the study were also guaranteed.

### **FINDINGS**

Classroom observation of the experimental group demonstrated an increase in promoting student use of inquiry skills and student construction of knowledge over the period when the Science Notebooks strategy was implemented during this study. Overall, the experimental group progressed from teachers not being able to provide a testable question in the baseline investigations, to most teachers using questioning to lead students to generate a testable question. Once the testable question was established, the teachers in the experimental group were also able to assist students in planning their procedure, collecting their data, creating scientific drawings and drawing conclusions.

The interview data suggest that the teachers' perception and attitudes regarding inquiry had strengthened and increased since the onset of the investigation. During the initial interview, teachers provided vague descriptions of inquiry science as they were just beginning to learn and practice these teaching strategies. However, during the second and third interviews, the teachers provided thorough and confident responses and commented on how much their students enjoyed problem solving and writing in their Science Notebooks. The teachers also noted that in the process they found teaching to be more enjoyable.

The usual writing activities which occurred in the participating teacher's classrooms before the intervention included test taking, writing exams and completing worksheets. These worksheets usually included mundane activities such as filling in the blanks or writing short answers to teacher-generated questions. This approach to writing activities serves to emphasize knowledge, telling and the transmission of recalled information (Holliday et al., 1994 in Levine 1997) rather than allowing learners to communicate their thought processes and how they come to their way of thinking.

Most learners and, in some cases, teachers believe that science is a learning area where facts are simply transmitted (Shepardson & Britsch, 2003). With the use of the notebooks and the structured form of writing provided by the Science Notebook approach, learners were able to follow and distinguish the various parts of the science process and come to conclusions based upon their predictions and observations. Nesbit, Hargrove and Fox (2003), however, note that drawing conclusions involve more in-depth development of science content knowledge than simply reporting findings from the investigation. They further suggest that teachers need to guide students

to extend their knowledge beyond the findings of the investigation and assist learners in incorporating scientific generalizations/concepts in their conclusions.

The data from this and other studies suggest that as students do the experiments and record their activities using the Science Notebooks approach they effectively learn the processes and procedures of investigations, but further research into how the use of how notebooks might be used to strengthen children's language skills, science content and vocabulary could possibly make a valuable contribution to greater understanding of, and wider and effective use of, the Science Notebook strategy.

## **IMPLICATIONS FOR TEACHER DEVELOPMENT**

For many science teachers, providing student's with the opportunity to pursue open-ended inquiry is not part of their current practice and, according to Edelson (1997), a shift in approach would require a significant amount of support from teacher development agencies. There has already been a considerable amount of continuous professional development support provided in South Africa for science teachers, with little return in terms of improved classroom practice (Taylor & Vinjevold, 1999). The results of this study suggest that it might be profitable to introduce the concept of Science Notebooks to South African teachers as an additional avenue in both the national and provincial departments of education plans for improving science teaching in South African schools.

However, Ruiz-Primo, Li & Shavelson (2002) caution that writings in Science Notebooks can be mechanical and its use can be neither effective nor efficient if not implemented and used properly. As such, it is important that the support given to teachers should focus on how they can engage students in inquiry so that they ask questions, describe objects and events, test their idea with what is known, and communicate what they are learning instead of merely providing teachers with specific examples of investigations in the classroom which have the prospect of becoming a conventional, recipe-type practical work (Chiappetta, 1998). Teachers need be trained to assist learners in their questioning techniques and determining what is testable in the context of the science curriculum and how to reflect on how they can use Science Notebooks to assist with inquiry-based investigations. In short, it is recommended that teachers be equipped with the theoretical and practical aspects of inquiry-based teaching and learning and helped to understand how the strategy can be used to both improve and assess their learners' procedural and content knowledge.

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