原著論文

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南アフリカ・ムプマランガ州のモカツ高等学校における理科教師の実践活動の事例研究

A CASE STUDY ON SCIENCE TEACHERS IN HANDS-ON ACTIVITIES AT MOKATSU SECONDARY SCHOOL IN MPUMALANGA PROVINCE, SOUTH AFRICA

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抄録：教育省による理科教師の育成とその強化に対する積極的な貢献は，決して否定するものではない。そしてこれを仲介するプログラムが導入されてきている。しかし以前から成績不振の学習者に，特に改善がなされたという報告はほとんどない。残念ながら，そのような知見は，南アフリカの学校における真の理科教育に結びつくものではない。この論文は，学校における真の理科教育に迫るもう一つの気がかりを追求しようとしたものである。ムプマランガ州の公立モカツ高校の５人の理科教師に口頭面接を行った。この調査により，教師が基本的な技能から離れ，無難な目的だけで実践活動を行っていることが明らかになった。それゆえ，その学校のレベルの適切なモニタリングと評価が緊急に必要とされる。

キーワード：実践活動，カリキュラム実践者（CIs），理科教育

Abstract：The positive contributions made by the Department of Education towards the development and empowerment of science educators are undeniable. Several intervention programs are conducted through out the year. However, very little improvement has been reported especially amongst previously disadvantaged learners. Unfortunately, such information does not enable one to make access to the reality of science teaching in South African schools. This paper aims at pursuing an alternative way to approach the reality of science teaching in schools. An oral interview was conducted with five science educators at Mokatsu secondary school, a public school in Mpumalanga Province. This survey reveals that, apart from lack of fundamental skills, educators perform hands-on activities (science experiments and projects) for moderation purposes only. There is, therefore, a dire need for proper monitoring and evaluation at the school level.

Keywords：Hands-on Activities, Curriculum Implementers (CIs), Science Educators.

1. INTRODUCTION

The Trends in International Mathematics and Science Study (TIMMS) conducted in 1999 revealed that South Africa's grade 8 learners were the worst performers, in Mathematics and Natural Sciences, out of 38 countries surveyed (1).
Such alarming statistics are worrying and indicative of the tough challenge faced by all stake holders in education. The Department of Education and other interested organizations have come up with several strategies aimed at the empowerment of Mathematics and Science educators. This paper reports on a case study of science teaching in a public secondary school in Mpumalanga Province, South Africa. The DINALEDI project and the Mpumalanga Secondary Science Initiative (MSSI) are the most prominent projects at this school.

1.1 MPUMALANGA SECONDARY SCIENCE INITIATIVE (MSSI)

The MSSI project is an initiative of the Mpumalanga Department of Education in partnership with the Japanese government (through the Japanese International Cooperation Agency, JICA) (2). Three tertiary institutions are involved in the academic training of educators, the University of Pretoria in South Africa as well as Hiroshima University and Naruto University of Education in Japan. The MSSI project aims to improve the quality of teaching, in mathematics and science, by enhancing educators' teaching skills and subject knowledge (3, 4). Each year, a group of Curriculum Implementers (CIs) and educators (CLs) are offered an opportunity to receive content knowledge and other strategic training in Japan. The knowledge acquired is then shared, through the guidance of the University of Pretoria and JICA experts, with all educators in the province. Figure 1 shows the flow of knowledge and skills in the MSSI project.

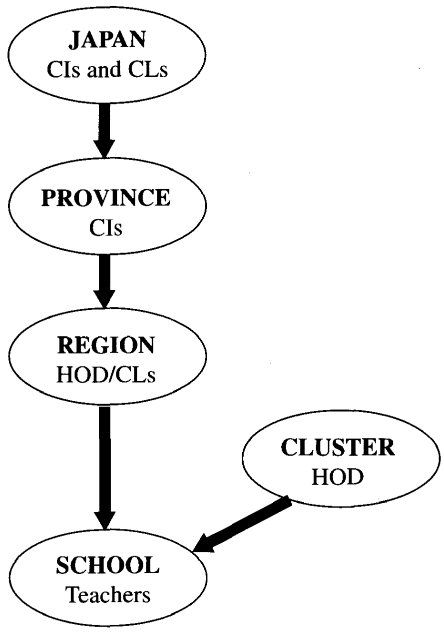

Figure 1: Diagrammatic representation of an ideal training system in MSSI

Schools have been grouped into clusters, the cluster leaders (CLs) are normally selected for the overseas training (3, 4, 5). Usually, the Head of Department (HOD) or senior educator from each of the participating schools is invited for a cluster meeting, and the HOD in turn train the affected educators at his/her school. This is aimed at sustaining a year long school based In-service Training (INSET).

1.2 DINALEDI PROJECT

The DINALEDI project is a collaboration between the National Department of education and South Africa's business sector (6). DINALEDI is a Sotho word for stars. The project started with 102 schools around the country, 7 in Mpumalanga Province, which were chosen as centers of excellence. All the schools are in rural areas and are among the so called 'previously disadvantaged schools'. They were selected because they were considered to be hard-working schools, and were able to compete with adequately resourced schools, particularly in mathematics and physical science.

As a result, the National Ministry of education committed itself to adopt these schools and supply them with necessary resources. The schools, in turn, undertook to be centers of excellence, exemplary and of service to the community. The theme of the DINALEDI project is: 'creating tomorrow's stars today'.

2. MOKATSU SECONDARY SCHOOL

Mokatsu Secondary School (pseudonym), the school that was visited for this research, combines both projects (DINALEDI and MSSI). DINALEDI is bringing in resources and MSSI is providing science content knowledge and skills. The two projects compliment one another very well; this is undoubtedly a dream combination for every school. Already, the school has computers and science equipments from DINALEDI project (see appendix).

In this research, discussions were held with science educators from Mokatsu secondary school. The discussion was mainly on 3 topics: logistics of running a laboratory session, laboratory instructions and science content. Data were collected by use of electronic devices (digital camera, video camera and tape recorder). The main problem encountered was that educators were sometimes reluctant to talk in the presence of a camera or tape recorder. In some cases there were requests of responding 'off record'.

3. RESULTS

3.1 Are there any problems, in the teaching and learning of science, at this school?

This question was posed as an ice-breaker. After a long silence and hesitations:

"Mmm, sometimes if there is no activity running, it is difficult to say there are problems. I'm not saying teachers are doing nothing in the lab. I'm saying the truth is we have no idea on how to go about, say ordering of chemicals. If I come to the lab and find that we don't have a particular chemical, then I have no other option except to discontinue the idea of doing the intended experiment. That's why I'm saying there are no problems because minimal work is happening."

It became obvious from the first response that there might be serious teaching problems at the school. However, it was encouraging to note that the educators were cooperative and prepared to give honest answers.

Improvisation seems to be a big challenge. When there is a shortage of one chemical or component, performing an experiment becomes impossible.

"Jaa..., may be to add on that. In inorganic chemistry, I use the micro science kit. I never used the big equipments; I solely rely on the micro science kit. Another thing, there are other experiments that I failed to do, like the one on Boyle's law, there is no bicycle pump in this lab, so I can't do it.".

The idea of getting help from other schools or students does not immediately come. This apparatus can also be operated by using a syringe. Moreover, the school has a budget for the laboratory; and a bicycle pump can be purchased from any supermarket.

The major reason given for the failure to perform science activities was that the school's equipment is not user-friendly. The mobile lab or big equipment is shown in the appendix.

"I can't use the electricity kit in the mobile lab; the kit makes the connections more complicated. Unlike the conventional kit, the new kit has everything (cell holders, bulb holders, switch, etc.) fixed. It becomes very difficult for, say, series and parallel connections."

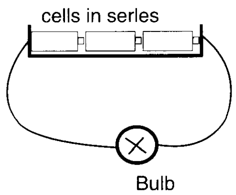

Figure 2a: Conventional electricity kit

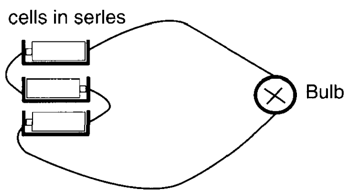

Figure 2b: New electricity kit

The conventional electricity kit consists of a single cell holder that can accommodate up to four cells in a series connection. Cells are simply inserted as shown in Figure 2a. The mobile kit has, instead, four cell holders. To arrange three cells in series, further connections are necessary, as illustrated by Figure 2b. Figure 2a and Figure 2b illustrates what cognitive researchers call declarative knowledge (facts) and operative knowledge (reasoning), respectively (7). Learners need the conventional kit as an introduction to circuits, and the mobile kit for some basic operational skills. Mastering both connections may lead to better understanding of more complex circuits.

"The experiments on kinematics..., we never performed them."

For kinematics, the problem is not on equipments. Educators revealed that they cannot do them, whether using the conventional or the new equipment. This is a kind of problem that should be dealt with at the cluster meeting, and may also require the intervention of the Curriculum Implementers (CIs). Students produced by this school, therefore, enter the tertiary level with very limited knowledge on kinematics.

"I think this discussion is not helping us. If we identify a problem, let us tackle it. I for one, I would like that we even talk about the content. You talked about titration; let us do the experiment and the related calculations, because personally I have a big problem with chemistry."

Educators were very enthusiastic; they wanted to be engaged on activities than discussions. However, for the sake of the research, the interviewer was allowed to proceed with the discussion.

3.2 How many experiments have you performed so far?

"None": grade 8 & 9

"We performed three (3)": grade 10

For grade 10, there were three teacher's demonstrations: using the helix spring to produce waves, producing waves by dropping a stone to water and production of sound from the tuning fork. All these activities were not student centered as required by the national curriculum.

"I should have done one, but I could not, because of the lack of the bicycle pump. Last year, I performed experiments on inorganic chemistry using the micro science kit. To tell you the truth, I can't use the big equipments": grade 11

"I have done the experiment on Zn and Cu for redox reactions. We should have also done the one on momentum, but as I told you before, the lab has no 1m ruler to measure the distance": grade 12

It is possible that the educator demonstrated the reaction between zinc electrode, Zn(s), and copper sulphate solution, $CuSO_4$ (aq), or the construction of a galvanic cell.

3.3 When do you conduct experiments? During school hours, after school, on Saturdays?

"Long experiments are done after school and during school holidays".

3.4 Do the learners keep a notebook?

All educators: **"Yes"**

"For grade 11, we use the DINALEDI worksheet. It has experimental procedures and questions at the end. Learners keep this in the portfolio".

3.5 Before coming to the lab, do students research about the experiment?

"Yesss.... I tell them a day before that they will be doing an experiment, say in redox reaction".

3.6 Do you read safety rules to students?

"Normally we tell them about safety rules, we still need to write them down and make copies".

The educator assigned with the responsibility of maintaining the lab, feels that there is little support from the school management team (SMT).

"I have no control of the lab. It is a multipurpose hall. I know that the lab rules state that: students are not allowed to be in the lab without the supervision of the teacher and that no other activities, apart from science activities, may be performed in the lab. The two rules cannot be enforced without the support of the SMT".

It was agreed that educators will take a more active role in controlling access to the laboratory. Furthermore, educators realized the need to work together as a unit, assist each other and form a family-like network. It became clear that communication was a major problem, educators agreed to consult the educator in charge of the laboratory in case of any problem associated with apparatus and chemicals. The Head of mathematics undertook to help the science educators where possible.

3.7 What are the challenges of conducting a lab session?

"Students refuse to clean the apparatus after use and are not committed".

This could be a genuine management problem. From experience, too much democracy can cause chaos during a lab session. Educators need to know their learners. Research reveals that the characteristics of the learners dictate what the educators teach them (7).

3.8 How do you conduct the lab session?

- Composition of the group
- Writing and submission of reports
- Discipline

"Please advise us on what to do. We may end up saying what we think you expect to hear, not what is practically happening".

The following statement summarizes everything:

"We do experiments for moderation purposes".

The discussion was then terminated.

For content enrichment, the following topics were discussed:

- Use of the electricity kit in the mobile lab
- Boyle's law experiment, using a syringe instead of a bicycle pump.

4. DISCUSSION

Performing hands-on activities is engraved in the South African National Curriculum as learning outcome 1: Practical Scientific Inquiry and problem-solving skills (8). According to this outcome, learners should be able to use scientific inquiry skills like planning, observation and gathering information, comprehension, synthesizing, generalizing, hypothesizing and communicating results and conclusions. This advocates a paradigm shift from the traditional 'do and see' approach to an approach that requires problem solving skills. Problem solving skills involves, among other things, prior research of the problem at hand.

South Africa's education system (Outcomes-based education) regards educators as researchers and life long learners. Educators, therefore, cannot just sit back and cry **"we can't do this"**, they should seek information from books, internet and colleagues.

Experiments and projects, as shown in Table 1, together contribute 30% to the learner's continuous assessment (CASS) mark. After 52 school days, no real hands-on activity has been conducted at Mokatsu secondary school. Every learner in grade 12 needs a minimum of ten experiments and at least one project, seemingly these activities are hurriedly done for moderation purposes only. Acquiring skills to do scientific experiments is therefore left in the hands of tertiary institutions.

The Outcomes-based education defines CASS as an ongoing process (9). A process that finds out what a learner knows, understands, values and does. CASS is supposed to provide information that is used to support the learner's development and enable improvements to be made in the learning and teaching process. Teaching methods employed at Mokatsu secondary school; cannot develop a learner that is envisaged by the South African constitution: a learner who is able to identify and solve problems and make decisions using critical and creative thinking (8).

Table 2 below, reveals that the school has no adequately qualified educator (an educator with a university qualification in physics or chemistry) who can really handle high school physics and chemistry with confidence. Conducting experiments needs a lot of planning, and can be very strenuous to educators. Preparation of worksheets, solutions, apparatus, and improvisation can be a big challenge for educators.

Educator A, being the most experienced, is an appropriate candidate to teach grade 12 physical science. However, due to certain reasons, educator E has been allocated to grade 12. The less experienced educator is teaching the most critical class, hence the reported decline in students' performance. This calls for an extensive intervention program. Presently, the education system does not provide formal induction or mentoring programs for new teachers. As evident from Table 2, with the exception of educator A, all educators are new and may still need guidance from more experienced colleagues. [In describing educators, personal pronouns were not used. This was intentionally done to eliminate the assumptions that one sex does better in science than the other.]

The department is delivering, but there is no proper monitoring and evaluation at school level. There seems to be a brake-down of communication between the intentions of the department and the reality on the ground. The department dreams of a Culture of Learning, Teaching and Services (COLTS), but this cannot be successful without involving the most important link, CIs. Figure 3 shows that CI's occupy a very critical position; they are the carriers of 'science' from where it is developed to where it is implemented. They are the important link between the policy makers and schools.

No project or initiative will ever succeed without their

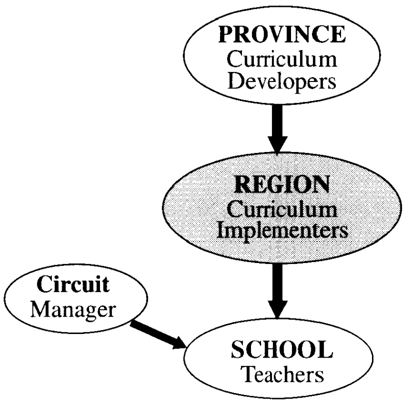

Figure 3: The path for the implementation, monitoring and evaluation of science curriculum.

Table 1: Composition of Continuous Assessment (CASS) for grade 12 Physical Science

	Class work	Home work	Short tests	Tests	Project	Practical	June exam	Trial exam
Number of written items	12	12	6	3	1	10	1	1
%	7.5	7.5	5	20	15	15	15	15

Table 2: Educators' qualification and teaching experience (Physical Science)

Educator	Highest qualification in P. Science	Experience of teaching P.Science (in years)
A	STD	15 +
B	STD	2
C	STD	2
D	PTD	2
E	STD	1

STD = Secondary Teachers Diploma PTD = Primary Teachers Diploma involvement. A school like Mokatsu secondary school needs the intervention of CIs.

5. CONCLUSION

Despite the government's efforts to improve the teaching and learning of physical science, South Africa's education system is result oriented. More emphasis is on teaching for examination rather than teaching for understanding, resulting to a situation where experimental results are being assumed for moderation purposes. For educators, it appears teaching for examination is the key. This is true, because a best teacher is considered to be one who produces 100% pass.

> **"I proved myself of being a good teacher as my pupils passed with flying colors. This helped me to develop self confidence"** (Former teacher) Ridge News 12/12/2003

To obtain a high pass rate, science educators feel compelled to concentrate on theory work. Theory work requires less time and effort, and is the work that is examined at the end of the year.

To work towards the attainment of outcome 1, and for the school to be a centre of excellence and of service to the community as intended by the department, educators at Mokatsu secondary school need to be 'smart and sharp'. Moreover, there should be proper monitoring and evaluation by both the SMT and CIs.

Educators do attend INSET at the cluster level, but none is evident at the school. Armed with content knowledge from MSSI and equipments from DINALEDI, science educators at Mokatsu secondary school are not supposed to be having problems with conducting of experiments. It seems the efforts from the two projects have little impact, if any. Questions on the relevance of the activities to educators and their classrooms, and readiness of educators to implement these activities in the classroom, could be the key.

> Teaching should be **"a profession that attracts to it the brightest and best of our youth - dedicated people who want to share their knowledge"**. Prof. Kader Asmal (Minister of Education) The Cape Times, 21/04/2004

REFERENCES

1. http://www.nces.ed.gov/timms/results.asp # mathscience1999
2. MSSI Project Document (Phase I). (1999). (published by JICA)
3. Ndlalane, T.C., et al. (2003). "Toward Establishing In-service Teacher Training System In South Africa." Bulletin of Research Center for School Education, Naruto University of Education, No.18, 2003, **35-44**.
4. Dlamini, S., and Kita, M. "The development of "Study Guide" as a unit planning for secondary science teachers in South Africa." Bulletin of Research Center for School Education, Naruto University of Education, No.18, 2003, **45-57**.
5. MSSI Booklet No.2. (2002) "Peer Teacher Learning." (Published by JICA).
6. http://www.info.gov.za/speeches/2002/020408946a.htm
7. Herron, J.D. (1996) "The Chemistry Classroom." American Chemical Society, Washington, DC.
8. National Curriculum Statement Grades 10-12 (General); Physical Sciences. RSA.
9. Outcomes Based Education, generic concepts grade 4 & 8. (2000). Mpumalanga Department of Education.

APPENDIX

THE NATURAL SCIENCES LAB	THE STORE ROOM
	
THE BIG EQUIPMENT/MOBILE LAB	THE COMPUTER LAB