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RESEARCH REPORT

Effects of In-service Education on Improving Science Teaching in Swaziland

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This paper discusses the findings of an evaluative and interpretive study into the potential of in-service education to improve science education in Swaziland. Short-term and long-term effects of an in-service intervention are evaluated in terms of changes in classroom processes. The teaching approach of participating teachers has been monitored and analysed before, during and 1 year after the in-service intervention, to assess whether changes occurred. The study revealed the subjective interpretations of teachers about those changes, also in relation to contextual factors. Recommendations are put forward to enhance the potential of in-service education in comparable contexts.

Introduction

Science[1] education plays a decisive role in human resource development, which is indispensable to the sustained development of nations (Caillods, Göttelmann-Duret, & Lewin, 1997). Many initiatives have been undertaken over the past 30 years to adapt the science education programs of the developing world to the needs of modern societies, although often with disappointing results (Caillods et al., 1997; de Feiter, Vonk, & van den Akker, 1995). Assistance from the industrialized world has often taken the form of simply transferring forms of science education that were seen as "ideal" in the western world, without considering the feasibility, desirability, and sustainability of these efforts in the local context (Guthrie, 1990; Ogunniyi, 1996; Walberg, 1991).

In recent years, in-service education[2] has come to be considered an important means for improving the quality of science education in developing countries, even though little is known about the effectiveness of such courses in these contexts

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(Caillods et al., 1997; de Feiter et al., 1995; Farrell, 1993; UNESCO, 2000; Ware, 1992). A common criticism of science in-service courses is that the realities of schools and students have not been taken into account and that their effect on teachers' actual practice has rarely been demonstrated on a long-term basis (Caillods et al., 1997; de Feiter et al., 1995; Ware, 1992).

In Southern Africa, the small Kingdom of Swaziland has also undertaken several initiatives over the past 30 years to improve its education programs through In-Service Education and Training (INSET), with special attention to science education. INSET organized by the Science and Mathematics Advice & Regional Training (SMART) programme for science teachers in senior secondary education in Swaziland serves as the context for the study described in this article. The SMART programme started as part of a cooperative link between the University of Swaziland (UNISWA) and the Free University of Amsterdam. The programme had the long-term goal of improving the quality of science education in Swaziland high schools. This was to be achieved through strengthening of local structures, improving conditions in the schools and, teacher guidance and support.

The strengthening of local structures entailed capacity building in the provision of science in-service education. Institutionalization of the SMART programme has now taken place. A science education centre has been established at UNISWA, staffed with well-trained local in-service educators. Furthermore, a regional in-service network has been set up, consisting of eight well-equipped regional INSET schools, staffed with four mentor-teachers each. Improvement of conditions in schools has been realized by provision of science equipment to a number of schools and by setting up resource centres.

The focus of this study is on the third component of the SMART project; namely, teacher guidance and support through development and implementation of ongoing in-service courses for science teachers throughout the country.

The SMART team started with gathering information on successful INSET strategies in comparable contextual situations and conducted an in-service needs assessment among science teachers in Swaziland. This information formed the basis of a new tailor-made in-service approach for science teachers in Swaziland taking into account the boundaries of the SMART programme and the realities of Swaziland's educational system. In this approach the focus was on improving basic teaching skills (e.g., lesson preparation) as well as modestly promoting more learner-centred teaching approaches.

The study described in this article investigated the short-term and long-term effects of the new SMART–INSET approach on classroom practices and the factors that influence those effects. For this purpose an in-service course for biology teachers has been selected, the design of which was fully based on the design principles agreed upon by the team.

Building on Kirkpatrick (1959), Guskey (2000) proposes a model for the evaluation of professional development courses, distinguishing five levels of effect: participants' reactions, participants' learning, organization support and change, participants' use of new knowledge and skills, and student learning outcomes.[3]

An important assumption for this model is that effect on a certain level can only be obtained when effects occurred at preceding levels.

Guskey (2000) considers teachers' use of new knowledge and skills (Effect Level 4) to be the most relevant outcome of in-service courses; that is, the primary factor influencing improvements in student learning. This is also the main level on which the effect of the selected biology in-service course has been evaluated.

This article will introduce the design principles for the in-service approach, followed by a description of the framework, questions, and procedures of the study. It will then present the results and subsequently discuss the findings of the study.

Design of the In-service Intervention

The SMART programme followed earlier INSET initiatives in Swaziland in which a lot of emphasis was put on promoting a more student-centred teaching and learning environment. This was attempted while the actual situation in most schools in Swaziland resembled the picture in many other African nations. Classroom processes can usually be characterized as: teacher-centred; content-driven; examination-oriented; emphasis on lecturing, note-taking, memorization and recall; whole class approach with minimal individual student involvement and chorus answering; and strict discipline (Chapman, Snyder, & Burchfield, 1993; de Feiter et al., 1995; Fuller, Snyder, Chapman, & Hua, 1994; Macdonald & Rogan, 1990; Prophet & Rowell, 1994; Stuart, 1991; van den Berg, Lunetta, & Finegold, 1994).

Experiences from earlier INSET projects in both Swaziland and other parts of the Southern African region (Ogunniyi, 1986; Rogan & Macdonald, 1985; Prophet & Rowell, 1994; Walberg, 1991) revealed that any effort to change teaching approaches through in-service programmes had to take teachers' teaching abilities and daily practice fully into account. Only with a full appreciation of these factors can realistic aims be set. It is against this background that the SMART team decided to put more emphasis on improving conventional teaching methods than promoting innovative teaching methods in its programme. The improvement addressed shortcomings in basic teaching skills, such as preparation of lessons, guidance of students through homework assignments, adequate textbook use, and questioning skills.

Yet the pursuit of more student-centred ways of teaching had not been shelved because eventually more student-centred forms of learning and teaching were seen as preferable, as is documented for other projects in similar situations (Avalos, 1993; Caillods et al., 1997; de Feiter, Macfarlane, Stoll, & Van den Akker, 1998; Dekkers, 1997; Guthrie, 1990; Harvey, 1999a; Ottevanger, 2001; Rowell, 1995; Shaeffer, 1993; Thijs & Van den Berg, 2002). An important argument is that science teachers are supposed to facilitate the development of higher cognitive skills, which is inadequately addressed by more formalistic teaching approaches (Tobin, 1998; Tobin, Tippins, & Gallard, 1994). The science syllabuses in use in Swaziland indeed put more emphasis on higher cognitive skills. From this perspective it is important to find realistic middle ground between the extremes of formalism and constructivism to help facilitate development of higher cognitive skills. Of course, there are many

more compelling arguments for making educators promote more student-centred forms of teaching in classrooms all over the world (Kyle, 1999). Most of these arguments emphasize that a more active role of students in the teaching–learning process prepares them better for life after secondary school, both in continued studies as well as in jobs. Thus, although the SMART team initially directed its in-service training towards improving conventional teaching methods, it also modestly tried to infuse more student-centred elements in the dominant instructional patterns.

A number of principles were applied in the design of the in-service approach.

Continuous In-service Education

The in-service training organized by projects preceding SMART was mainly of the one-shot 1-day type. At the advent of SMART, research evidence had been accumulating that these types of workshops were ineffective and that INSET had to be a more long-term commitment organized on a continuing basis (Fullan, 1991; Jennings, 1993). Within the means available, SMART created more continuity in the in-service training in two ways. First, a kind of sandwich-structure was adopted for the SMART in-service courses, which contained the following three units: an initial workshop of 2 days, a practice period of 3 months at schools, and a follow-up workshop of 1 day. Second, these types of in-service courses were organized twice per year and contained certain continuous elements (i.e., attention to lesson preparation, note-giving, textbook use, homework, and student involvement).

Addressing Change Concerns

In order to effectively educate teachers in mastering and implementing changes in teaching, teachers' primary concerns related to these changes must be addressed. It appears that teachers, when confronted with a change, potentially go through similar phases of concerns (Burden, 1990; Hall & Loucks, 1978; Hall & Rutherford, 1990; Bell & Gilbert, 1996):

- *Awareness phase*: informational and personal concerns dominate in relation to the change.
- *Implementation phase*: management concerns become more intense.
- *Impact phase*: teachers become more concerned with the consequences of the change, the collaboration that might be required for this, and the implementation of the change in their contextual situation.

These "change concerns" can be addressed in INSET training that focuses on acquiring or improving instructional skills through skill acquisition models (Showers, Joyce, & Bennett, 1987; Yeany & Padilla, 1986). In-service courses, based on these models, are composed of all or some of the following elements:

- *Information* on theory, skills, and strategies, and *demonstration* of new skills and teaching strategies to address informational and personal concerns.

Table 1. Components of the SMART in-service approach

SMART in-service course units	In-service components
Initial workshop	Theory Demonstration Practice
Practice period in schools	Practice (with guidance and support through curriculum materials)
Follow-up workshop	Follow-up Feedback

- *Practice* of the new skills and teaching strategies with immediate *follow-up and feedback* to address management concerns.
- *Guidance and support* during the process of transfer to the real classroom situation to address implementation concerns (e.g., through curriculum materials, and/or coaching).

This approach has empirically proven impact on instructional practices of teachers and student achievement (Joyce & Showers, 1988), although long-term effects are less evident.

SMART utilized the following elements of the model to address change concerns: information, demonstration, practice (with guidance and support through curriculum materials), follow-up, and feedback. These elements were incorporated in a sandwich structure (see Table 1).

Integration of Clear and Validated Materials in In-service Courses

The SMART project was aimed at facilitating a more effective implementation of the existing curriculum by improving the teaching abilities of the teachers. Exemplary curriculum materials can play an essential role in this process by clarifying to teachers what a certain change or improvement implies, and by specifying how this could be implemented (Roes, 1997; van den Akker, 1988; Voogt, 1993). The assumption is that teachers benefit from these materials, especially in the first steps towards implementation, because the materials enable them to explore and extend their "zone of proximal development" (Vygotsky, 1978). In order to assist teachers in improving the implementation of the curriculum, the integration of exemplary curriculum materials into in-service courses seemed to be a promising approach (van den Akker, 1994). The materials can reduce early implementation concerns of teachers by providing procedural specifications for essential but vulnerable lesson elements (Doyle & Ponder, 1977–78; Fullan, 1991; van den Akker, 1988).

A sample of an exemplary SMART science lesson is provided in Table 2.

Improvement of the Educational Environment for Teachers in Schools

The "R" in the acronym SMART stands for regional INSET training (including more school-based support). This has only been realized to a certain extent, in the

Table 2. Sample of an exemplary SMART science lesson

Lesson 4	Investigating Pulse Rate
Objectives	This lesson is focusing on a practical investigation related to pulse rate. Its objectives are that pupils are able to: —Locate a pulse point and count pulse rate —etc.

Lesson plan

Time	Phase	Teacher activity	Pupil activity
10	Introduction	—Discusses homework	—Check/correct
		—Introduces title of topic	—Copy title
		—Asks for students ideas	—Respond
		—Tells what will be done in this lesson	—Listen
25	New content		
	Pupil activity	—Gives instructions	—Listen
		—Monitors/guides activities	—Do activity
5	End of lesson	—Evaluates work of group	—Listen
		—Gives homework	—Write down homework
		—Tells what will be done in next lesson	—Listen

Preparation	—Make copies of the worksheet "Investigating Pulse Rate" for each pupil —etc.
Material/equipment	—Chart of circulatory system if available —etc.
Learning problems	Pupils might have problems with: —recording in tables —etc.
Lesson progress	
Introduction (10 min)	—Return checked/marked notebooks Ask pupils: "what is meant with pulse?" —etc.
New Content	
Pupil activity (25 min)	—Hand out the worksheet "Investigating Pulse Rate" to each pupil —Let someone read aloud the first sentences of the worksheet, explaining the relationship between "pulse" and heart beat —Check whether this is clearly understood and explain if necessary; you can use a chart for this if available —Divide them in groups depending on the number of (stop) watches available —Let each group allocate the following tasks to members: person who's pulse rate is going to be measured —Now instruct the "measurers" to locate and feel the pulse of their group member as explained in their worksheet under a). —etc.

Note: This a sample from the exemplary lessons on the theme "Transport in Man" of the COSC Biology Syllabus in use at that time in the high schools in Swaziland. The worksheet "Investigating Pulse Rate" was an element of the student material on this theme that was made available to teachers participating in the SMART workshops against cost prize.

sense that the provision of in-service has been expanded from one centre (at the university) to eight regional centres meant to reach out to the schools in their region. Seven schools spread over the country were selected and fully equipped for this. Four teachers (one for each of the science subjects) were selected and trained to become a mentor at their regional centre, responsible for organizing INSET activities at their centre under supervision of the SMART team. Because the mentor-teachers were expected to shoulder extra tasks without extra compensation, the organization of the regional in-service activities met with considerable problems, many of which have yet to be resolved.

Therefore, providing on-the-spot guidance and support in schools to address implementation concerns in the process of transfer to real classroom situations had to be limited to support with curriculum materials in the SMART approach. Expanding it with school-based coaching was not feasible under these conditions.

Joyce and Showers (1980) indicate that when more complex models of teaching are being introduced, the components of instruction, demonstration, practice with feedback, and school-based support (including coaching) are all considered crucial. However, they state that when the fine-tuning of teaching skills is the goal, limitation to the elements of instruction, demonstration, and (guided) practice can suffice. In short, realistic goals had to be set for the SMART in-service courses.

Evaluation of In-service Courses and Curriculum Materials

Formative evaluations of in-service courses as well as curriculum materials are essential to make appropriate adjustments for improvement (cf. Fullan, 1991; van den Akker, 1994). At the same time, it is a well-known fact that adequate evaluation of in-service interventions is a rare phenomenon (Guskey, 2000). With external support to the project, it was possible to systematically design, validate, and optimize both the exemplary materials as well as a complete in-service course (Stronkhorst, 1997).

Further details on the design and implementation of this particular intervention can be found in Stronkhorst (2001).

Design of the Study

Characterizing the Study

The study has a clear summative *evaluation* purpose. It attempts to establish the "worth of the course" (cf. Scriven, 1967) by comparing what teachers really did in their lessons before, during, and 1 year after the in-service intervention. The data collection combined short-term and long-term perspectives; it not only checked whether intended changes in behaviour occurred during "the practice period" of the intervention, but it also verified to what extent these changes had been durably integrated in the teaching 1 year after the intervention.

The short-term investigations made it clear that there were considerable differences in how teachers put curriculum materials to use in their lessons during the

practice period in schools. The investigations that followed 1 year after that were therefore not only evaluative in nature, but also aimed at insight into what made teachers integrate (or not integrate) certain elements into their teaching. In that sense the study also had an *interpretive* character (Erickson, 1998), seeking detailed information about implementation, to identify the nuances of subjective understanding that motivate various participants in a setting, and to identify and understand change over time. All three elements stand out prominently in this study.

Research Questions

The main purpose of the study was to establish to what extent the intended improvements in specific teaching skills of teachers had been achieved. Gathering evidence on effectiveness of a course in terms of teaching skills is typically done in terms of behavioural changes (cf. Posner & Rudnitsky, 1997). Also, Guskey (2000) considers teachers' actual use of new knowledge and skills the most relevant outcome of in-service courses. Therefore, information gathered from teachers who participated in the course is mainly geared toward clarifying effects of this intervention at a behavioural level. Towards this end, intended behavioural outcomes have been formulated in regard to the improvements of conventional teaching methods as well as for the promotion of more learner-centred ways of teaching. See Table 3 for some examples.

The study assesses the extent to which the teaching behaviour of teachers who participated in the course has changed in the intended direction (evaluative investigation). It also tries to uncover the nuances of subjective understanding responsible for the fact that specific teachers in specific school settings change or do not change as intended (interpretive investigation).

Table 3. Examples of intended outcomes of the in-service course

Aims	Examples of intended outcomes
Improvement of basic teaching skills	
Note-giving	Limited lesson time is spent on note-giving/copying
Textbook use	Students take their textbook to class
Homework discipline	Adequate attention is paid to homework at the start of the lesson (checking, discussing, and/or marking)
Lesson planning and evaluation	The teacher can show a lesson plan containing: objectives related to "hands-on/minds-on" activities; instructions for activities; answers to questions of activities
Promotion of learner-centred ways of teaching	"Hands-on/minds-on" activities are used in the teaching of all topics, when available

- The *evaluative* research question was: What were the short-term and long-term effects of strengthening basic teaching skills and introducing learner-centred strategies on teachers' professional behaviour?
- The *interpretive* research question was: How can the differential effects of the in-service course on teachers' professional behaviour be interpreted?

Ultimately, this study was aimed at drawing conclusions about the extent to which the in-service intervention brought about the intended change. Moreover, it was tried to relate these findings to the SMART design principles and the circumstances of the teachers in their schools.

Data Collection

The in-service intervention under investigation covered a period of 4 months. This particular course (within the biology domain) was considered a typical SMART exemplar, using findings of previous formative evaluations as a basis for its design. From the total of 52 teachers who registered for the initial workshop, 28 bought a class set of the student material, which was considered essential for practising student-centred ways of teaching during the practice period in school. From those 28 teachers, 15 actually participated in all units of the course (including use of curriculum materials in class). From those 15 teachers, nine were invited (primarily based on practical considerations such as travelling, distance, and available time) to belong to the group of teachers whose teaching behaviour was monitored before, during, and after the intervention. One teacher stopped participating in the study halfway through the data collection process.

Some particulars of the participating eight teachers are provided in Table 4.

The data collection events of this study (for teaching behaviour in relation to intended outcomes) are summarized in Figure 1. The procedures used during these events are further explained in the following for data collection before, during and 1 year after the in-service intervention, respectively.

Table 4. Some particulars of participating teachers

Teacher	Gender, age (years)	Experience (years)	Teacher training	Number of SMART courses already involved in
A	Male, 28	7	B.Sc. (bio+chem), PGCE	>10
B	Male, 38	16	Diploma in Education	0
C	Male, 28	7	B.Sc. (bio+geo), CDE	>10
D	Female, 29	5	B.Sc. (bio+chem), PGCE	8
E	Female, 33	10	B.Sc. (bio+chem), CDE	>10
F	Male, 26	3	B.Sc. (bio+chem), PGCE	4
G	Male, 27	4	B.Sc. AgEd	4
I	Female, 27	3	B.Sc. (bio+chem), PGCE	2

Note: PGCE, Post Graduate Certificate in Education; CDE, Concurrent Diploma in Education.

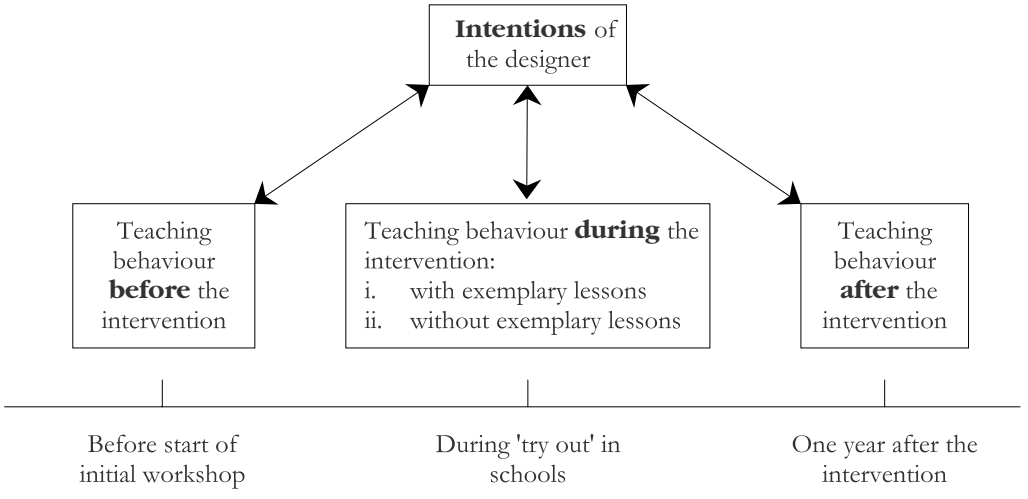

Figure 1. Main data collection events of the study in relation to intentions of the designer for behavioural change

The initial data collection was geared toward clarifying the teaching behaviour of the eight teachers *before* the intervention. Teachers' perceptions of their own teaching were collected through a questionnaire. Also, the students' perceptions of their teachers' teaching were collected through a questionnaire.

Subsequently, data were gathered on the teaching behaviour of the case teachers *during* the in-service trajectory, particularly during the practice period at school. In four to five visits to all nine teachers, three lessons per teacher were observed, questionnaires were administered, documents (e.g., logbook of teacher and notebooks of pupils) were collected, and interviews were held. This data collection was geared toward clarifying whether teachers practised with the exemplary lessons as intended, assessing to what extent hands-on/minds-on activities were used as intended without guidance of materials (as an indicator of the use of student-centred strategies), and assessing to what extent the basic teaching skills were practised as intended. For the three observed lessons, teachers were asked to teach one of the exemplary lessons and to use hands-on/minds-on activities from the SMART student materials in two other lessons they had prepared themselves.

The data collection *1 year after* the intervention was aimed at finding out to what extent the teachers had durably integrated elements from the course into their teaching repertoire (in relation to the intended outcomes) and comparing this with the previous findings. It also sought to clarify what their motives had been for the degree of implementation. In three to four subsequent visits, two lessons per teachers were observed, questionnaires were administered, documents were collected, and interviews were held. For the observed lessons, the teachers were asked to teach a lesson, as they would normally have done without an observer present.

The data collected for each of the case teachers have been analysed per data collection method, consisting of lesson observation data, interview data, teacher's logbook data, questionnaire results, and further document data. After the final interviews, reports were written and teachers were asked to review these as a validity or member check (Krathwohl, 1998). They were asked to make any corrections if required and sign it if it was considered a true reflection, with or without corrections. This was done through another visit to the teachers, enabling clarification from both sides, if required. All teachers signed the report (including corrections made, if any).

Findings of the Study

In this study, participants' satisfaction with the in-service course (Effect Level 1) is seen as conditional for a potential effect in terms of participants' use of new knowledge and skills (Effect Level 4).

The participants of the biology in-service course indicated having been satisfied with the course components and the impact these have had on their teaching. However, the participating teachers tended to give socially desirable answers. Therefore, these kinds of outcomes reveal little in terms of potential for effect on a higher effect level. Nonetheless, these investigations are essential in the sense that they limit the chances of appraising non-events on higher effect levels. It was concluded that these results did not stand in the way of the further explorations of the impact of the in-service course on Effect Level 4

Table 5 provides an overview of the effects that the intervention has had on the teaching of the eight case teachers as intended by the designer. The teachers are clustered into four groups according to commonalities that had been emerging between the teachers, as will be elucidated later in the section "Teachers' Metaphors".

The outcomes are discussed hereafter for the elements of basic teaching skills and learner-centred teaching.

Improvement of Basic Teaching Skills

Lesson Planning and Lesson Evaluation

Examples of the evaluation criteria used:

1. A topic scheme is used for the selection of the "hands-on/minds-on" activities …
2. The teacher can show a lesson plan containing at least …
3. Self-evaluation is done as exemplified …

Lesson planning and lesson evaluation has exhibited barely any change in the intended direction (a more purposeful and reflective approach towards teaching).

The inexperienced teachers (Teachers F, G, and I) were more seriously engaged in lesson planning, but this mainly consisted of mastering the content of the curriculum and preparing notes. Lesson planning was a "must" to get through a lesson. These teachers completed their prep-book, as required by their administrators, but mostly

Table 5. Long-term effect scores for the basic teaching skills and learner-centred teaching for the eight case teachers

	Effect scores[a] based on specific evaluation criteria					
	Basic teaching skills				Learner-centred teaching	
Teacher	Lesson planning	Note-giving	Textbook use	Homework	"Hands-on/ minds-on" activities are used	"Hands-on/minds-on" activities are used in a student-centred way
F	–	±	±	+	±	–
G	–	±	–	+	±	–
I	–	–	–	+	±	–
C	–	–	±	–	–	–
E	±	±	–	+	±	–
B	±	–	±	–	±	+
D	±	±	–	+	+	+
A	–	+	+	+	+	+

Note: [a] Effect score: +, outcome close to what was intended; ±, considerable limitations in actual outcomes; –, no outcomes as intended.

only after lessons had been taught. More purposeful planning to achieve specific learning targets, as well as more reflective teaching, asked too much of the novice teachers.

All experienced teachers spent little or no time in planning and reflecting on their lessons because most of them repeated the same lessons year-in, year-out. For three teachers (Teachers B, D, and E) who demonstrated some degree of lesson planning during the intervention, as intended, it appeared to be a "Hawthorne effect". For Teachers C and E notes formed the main basis for teaching, while Teachers A, B, and D based their teaching on learning activities along with their notes. The hands-on/minds-on activities were considered attractive because these enabled teachers to promote student involvement without too much lesson planning on their part.

Overall, the teachers were more engaged in covering content and/or promoting student involvement than in attaining specific learning targets. The findings indicate that the intervention was not successful in convincing any of the teachers that the quality of their teaching would improve with investments in intensive lesson planning as suggested by the designers. This finding indicates limited potential of the intervention in this regard.

Some illustrative teacher reactions:

> I hardly prepare for my lessons because I do the same lessons every year using my notes. (Teacher C)
>
> The booklets with hands-on/minds-on activities made my teaching easier. (Teacher A)
>
> Only inexperienced teachers prepare for lessons [and] I sometimes complete the prep-book because it is required by the school administration. (Teacher B)

Note-giving and Textbook Use

Examples of the evaluation criteria used:

1. Notes given are concentrating on a limited number of concepts and are summarizing …
2. Teacher instructs students to copy the notes …
3. All students have the same recommended textbook …
4. Students take their textbook to class and teacher makes use of it in class …

Note-giving and textbook use has also hardly changed in the intended direction (more summarizing and explanatory notes, combined with active use of the textbook by students). Yet, as a side effect, the intervention played a facilitating role in improving the degree of textbook possession by students. Table 6 illustrates the effects of the intervention on note-giving, in terms of change in comprehensiveness and detail, based on notebook analysis.

Attempting to adapt the note-giving and textbook use appeared to be unrealistic for the inexperienced teachers (Teachers F, G, and I) because they simply had too many other problems to worry about. All inexperienced teachers adopted note-giving and lecturing as the main elements of their teaching from the moment they started at their first school. "Doing what most of your colleagues do and your students seem to expect" was clearly a logical and safe strategy for these beginning teachers. Furthermore, note-giving is an ideal instrument to exercise control over a class during the turbulent situations that frequently arise at the start of a teaching career.

Most experienced teachers (Teachers B, C, D, and E) also did not reduce note-giving, because they perceived it as involving many risks (e.g., protesting students) and requiring considerable effort. These teachers only used the textbook as an

Table 6. Note-giving of the teachers before, during, and after the intervention expressed in Notes Index values

	Notes Index values		
Teacher	Before intervention	During intervention	1 year after intervention
A	8/4[a]	0/0	5/4
B	10/4	8/7	9/8
C	10/8	10/8	10/9
D	9/9	6/6	9/9
E	10/3	3/6	10/8
F	7/10	2/10	4/10
G	8/5	3/6	9/8
I	–	–	9/10

Note: [a]The Notes Index values indicate the degree of comprehensiveness and detail of the notes on scales from 1 to 10 (e.g., 10/10 stands for complete and very detailed notes, and 4/4 indicates that the notes cover a limited number of concepts and that they are summarizing).

appendix to their notes, if at all. Yet, Teacher A succeeded in reducing note-giving and promoting textbook use by students. Elaborate note-giving did not fit in the paradigm of student-centred teaching, for which he had a strong preference that was promoted partly through his frequent participation in SMART in-service courses over several years.

The fact that some of the teachers (Teachers D, E, F, and G) drastically reduced their note-giving temporarily during the intervention is assumed to be a "Hawthorne effect" (cf. Tables 5 and 6).

The results indicate that it was unrealistic to pursue the proposed changes in note-giving through this intervention for most teachers. Such a change would entail a fundamental shift in their way of teaching, and a departure from the conventional way of teaching in Swaziland high schools. The intervention fell short in adequately addressing the concerns of most teachers with this change (especially at the implementation and impact phases). The findings also indicate that promoting students' active use of textbooks through in-service courses is a futile exercise if the note-giving of teachers is not addressed. Yet, this type of intervention has potential when it comes to promoting possession of affordable, good quality textbooks by students (realized by Teachers A, B, C and F). This can improve the learning of those students who take the initiative to start using their textbook in addition to their "textbook-replacing" notes.

Some illustrative teacher statements:

> Maybe it is because we are all used to this way of teaching, and it is difficult to get out of it. (Teacher C explaining his predicament)

Teacher F happened to be participating in a PGCE course at the time of the research. He claimed that his tutors had told him not to give any notes, which he did. This brought an unexpected aspect to SMART's efforts to influence note giving, which was expressed as follows by a student of Teacher F:

> The booklets assist the students to gain more information and to understand the topics better … they act as our notes and contain some questions which help us revising … also every straightforward information is found there … in this way a student can do without a teacher as the booklets make everything to be clear.

Homework

Examples of the evaluation criteria used:

1. Adequate attention is paid to homework at the start of the lesson through …
2. At the end of the lesson students are assigned to do homework, which is …

The intervention did improve *homework*-related skills of teachers in the intended direction (frequent evaluation of students' progress through giving and checking of homework assignments). Especially, indications of students, on frequency of homework giving and checking before and after the intervention (obtained through questionnaires), reinforced results obtained from other forms of data collection in this regard.

The inexperienced teachers (Teachers F, G, and I) were seriously engaged in homework giving and checking, mainly because they wanted to gain more control over students and their learning.

Some experienced teachers also regularly gave and checked homework, either because they were convinced that it improved student learning or simply because it was required by the school administration (Teachers A, D, and E). Yet, some experienced teachers (Teachers B and C) hardly gave and checked homework at all; they were convinced that students only applied themselves in preparation for tests. In their opinion, homework was more laborious and less effective.

The results indicate that this type of intervention can be effective in reinforcing and improving homework giving and checking because many teachers are aware of the importance of these activities for themselves and/or their students. The results also indicate that checking homework is hardly used by teachers to evaluate progress in student learning in a formative way; it is more to enforce that students do the work that has been assigned to them.

Teacher D illustrates the effectiveness of the SMART in-service in this regard as follows: "I give students exercises and learning activities now in almost every lesson" and "I now give students homework almost every day".

Promoting Learner-centred Teaching

Examples of the evaluation criteria used:

1. Biology student materials containing "hands-on/minds-on" activities are used …
2. "Hands-on/minds-on" activities are used in a student-centred way …
3. The teacher involves the students in the lesson by applying the question and answer method …

The intervention has been successful in promoting more student-centred approaches with experienced teachers, but has had little effect on inexperienced teachers (see also Table 5).

Table 7 illustrates the long-term effects of the intervention as far as use of curriculum material is concerned.

The results indicate that Teachers A and D made frequent use of the student materials, Teachers B, E, F, G, and I made moderate use, and Teacher C very limited use of the materials. It appeared that only limited long-term use was made of the exemplary teacher's guides.

The relatively experienced Teachers A, B, and D succeeded in promoting more student involvement in their lessons through the intervention. These teachers had a strong personal motivation to actively involve students in their lessons, which is assumed to have been instilled—at least in part—through their previous participation in SMART in-service courses. Providing these teachers with appropriate instruments to achieve student involvement (i.e., ready-to-use and relatively simple student materials) had already been proved to be quite effective. Yet, it must be noted that these teachers were more engaged in promoting student involvement than

Table 7. Use of SMART biology curriculum materials by the case teachers 1 year after the intervention

	Use of SMART student materials 1 year after intervention			
Teacher	Number used according to teacher (eight were available)	Number of booklets in possession by students of two classes[a]	Frequency of use in lessons according to students[b]	Use of teacher's guides (according to teacher)
A	7	1/3	Often/almost always	Yes
B	4	1/1	Often/often	No
C	1	0/1	–/sometimes	No
D	7	3/3	Almost always/often	Yes
E	8	0/0	–/–	Yes
F	4	0/2	–/often	Yes
G	4	2/0	Almost always/–	No
I	4	0/4	–/often	Yes

Notes: [a]These numbers indicate the numbers of booklets in possession by students of the two classes that have been observed. [b]Average frequencies indicated by students of two classes of each teacher are presented; in case students did not posses any booklets, no frequency is indicated (–).

in reaching learning targets (see also later section on lesson planning). Furthermore, the use of more complex "hands-on/minds-on" activities (i.e., simulations, investigations, field work, and projects), in which higher cognitive level objectives are more prominent, was not successfully adopted by these teachers. Considerable additional support (e.g., through in-school coaching) seems required to accomplish this.

However, the experienced Teachers C and E, who had been teaching in a teacher-centred way for many years, did not increase student involvement in their lessons because they perceived this as a major diversion from what they and their colleagues had been doing for so long. They thought that a diversion in teaching style would be a disruption to their students. Also, the inexperienced teachers (Teachers F, G, and I) did hardly or not increase student involvement in their lessons because it was a major departure from the conventional way of teaching, which is risky especially at the start of a teaching career. Furthermore, these teachers tended to have other more pressing (survival) concerns and did not want to be bothered with new demanding changes.

It seems that most of the (biology) teachers in Swaziland have practised a teacher-centred approach from the start of their career. The results indicate that the investigated type of intervention has the potential to arouse interest for more student-centred forms of teaching, and to facilitate more experienced and motivated teachers to successfully integrate this into their teaching repertoire in the long term. Good quality (and not too complex) student materials appeared instrumental in achieving this. Yet, the findings also indicate that it was unrealistic to pursue this fundamental change in teaching for the majority of the teachers because of the rather radical way it was

exemplified. As with the note-giving and textbook-related changes, the SMART intervention probably fell short in addressing the concerns of many if not most Swazi science teachers with this major and radical change in an adequate way, especially at the implementation and impact phases. And the students? They had mixed feelings, depending on their preference of teaching/learning mode:

> We have to write fewer notes since the booklets provide us with the information needed … the booklets provide exercises thus promoting the understanding of the topic … it was fun being taught in this manner … I am very much helped, the worksheets assist us a lot because they add more information to the notes the teacher gives us. (Student of Teacher D)

> Through the booklets we could do role-play and fieldwork which is really practical to us as students … the booklets make it easier to understand rather than only our textbook … the booklets were simple … the booklets provided us with drawings that would make us understand more easily than the teacher talking and giving us notes. (Student of Teacher A)

> I like to be involved in whatever topic we are doing and in this topic I listened more to the teacher than do and sometimes I find it hard to concentrate … there is less practical work and as student we are only given a few chances to do our own talking … the teacher keeps on talking making the topic less interesting to us as students; we also like to take part … we would like to have more practicals … the booklets are wasting a lot of our time because we have to read everything. (Student of Teacher C expressing his unhappiness with his teacher's use of the SMART material)

Teachers' Metaphors

At the end of the overall data analysis, an effort was made to characterize the eight teachers under different labels that had been emerging. The commonalities of these teachers have been encapsulated in the following metaphors: the "inexperienced survivor", the "pragmatic adjuster", the "revolutionary changer", and the "experienced talker & chalker".

The "Inexperienced Survivor" (Teachers F, G, and I)

These teachers hardly changed their behaviour towards more student involvement in their lessons. They changed their behaviour in the intended direction as far as "basic teaching skills" are concerned, albeit often to a limited extent. All of them had "survival problems" (e.g., in terms of workload, class control, and adaptation). They therefore were not enthusiastic for new demanding tasks

The "Experienced Talker & Chalker" (experienced Teachers C and E)

These teachers stuck to their teacher-centred style of teaching as they had practised for years. They did not, or hardly did, move in the intended direction of "student involvement in lessons". These teachers also hardly changed their "basic teaching skill" related behaviour. Asking these teachers—who probably form the

majority—to change in isolation, without support from the system they operate in, appears futile.

The "Pragmatic Adjuster" (Inexperienced Teacher D and Experienced Teacher B)

These teachers adopted a more student-centred teaching style to some extent as intended. They did not change their behaviour in relation to "basic teaching skills" in the intended direction, or only to a limited extent. These teachers had already gained considerable confidence in their teaching to the extent that they were able to make the (often pragmatic) adjustments in their teaching they deemed fit: still considerably teacher-centred with, now and then, some experimentation with learner-centred activities in which they were interested.

The "Revolutionary Changer" (Experienced Teacher A)

This teacher moved towards more student involvement in his lessons almost as intended. The teacher also made adaptations in his teaching, as intended, in relation to "basic teaching skills". These changes, however, were rather radical for himself and for his students, causing unhappiness among his students and possibly frustration with the teacher himself in the long run.

Discussion

Although the potential of the SMART intervention—in terms of professional development—clearly has been demonstrated for individual teachers, the role of SMART in-service training has probably not been substantial when it comes to improving basic teaching skills and facilitating learner-centred teaching for science education as a whole in the high schools of Swaziland.

The *basic teaching skills* that have been addressed in this intervention were rather diverse. In hindsight it can be noted that the intentions of the designers sometimes went beyond improving just "basic" skills. For lesson planning and evaluation, as well as homework, the focus was indeed more on improving basic skills, which required minor adjustments in teaching behaviour. Yet, note-giving and textbook use involved a more radical change in teaching behaviour, regardless of the fact that the skills to be mastered were relatively simple. This study has shown that the provision of "textbook replacing" notes is deeply rooted among science teachers in Swaziland, which is confirmed by findings of Rollnick, Manyatsi, Lubben, and Bradley (1998). The intervention appeared more successful when minor adjustments in teaching were pursued, especially if they were responding to specific professional development and/or support needs as expressed by teachers.

This study also indicates that a radical pursuit of more *learner-centred teaching* through this type of intervention is probably unrealistic for most (biology) teachers in Swaziland. A more pragmatic approach, in which student-centred elements are gradually integrated into a basically teacher-centred framework, might be more

successful to start with. The "pragmatic adjuster" showed how this could be approached.

The findings of this study confirm that it is important for INSET design to clarify the target group and their professional development needs in detail for specific contextual situations, so that essential and realistic targets can be set and adequate modes of in-service can be chosen, taking into account teachers' concerns. It is ineffective to organize the intervention for the whole population of science teachers of Swaziland in the same way. Although SMART intended otherwise, it could not realize a more focused in-service because the higher policy levels demanded the in-service provision to be open for all science teachers.

An important pillar of the intervention therefore was addressing change concerns through a skill acquisition model. Informational concerns were adequately addressed but, although teachers were given the opportunity to discuss their personal concerns with the change, it was not possible to address individual concerns of all teachers in an adequate way. Furthermore, the practice phase appeared to have limited functionality for most teachers, in the sense that they only used a limited number of exemplary lessons (from the teacher's guide) as intended by the designer. This means that most of these teachers have only been confronted by the pursued change in the practice period in schools in a limited way, so that management concerns have not been optimally addressed with most teachers. Teachers mostly used the student materials by adapting them to their usual way of teaching. The follow-up workshop, therefore, mainly dealt with problems that teachers had experienced in the "try out" phase when they used student materials in their own way and hardly with management concerns related to the change that the designer pursued. However, some teachers changed in a more student-centred direction as intended, mainly through the use of student materials, and primarily because they wanted to change themselves. Addressing personal and management concerns appeared less an issue for these teachers, at least in the short term.

The SMART intervention did not provide any further support to teachers to integrate the change more widely in their teaching. It was implicitly assumed that this was not required for the improvements that were pursued. This assumption appeared to be false for most teachers when it comes to changes in note-giving, textbook use, and student involvement. Yet, the assumption might be more valid when teachers already see a need for improvement themselves.

The importance for teacher education programmes to address specific concerns (i.e., self, task, and pupil impact concerns) that teachers have in specific stages of their professional development has been supported by considerable empirical evidence (Pigge & Marso, 1997), whose findings support the assumptions in this arena originally postulated by Fuller (1969). These results indicate that teachers' concerns for their own survival decrease as they experience success with their teaching efforts. This shift is seen to be accompanied by an increase in concerns about the actual tasks of teaching. However, it was found that concerns about their students' learning might develop differently, with the more capable teachers experiencing higher levels of concern over a longer period than the less capable teachers. The

observations of teachers in Swaziland are in line with these findings. Still, the low morale that existed among many teachers in high schools—originating, for example, from labour disputes with government—had a negative influence on their motivation for teaching, and probably also on their concern for the "pupil impact" of their teaching.

The exemplary material for teachers could not be very effective because of limited functional use in the "try out" phase, while the student materials have been quite instrumental in promoting student involvement in lessons as intended. This indicates that some, albeit modest, effects can be achieved through the provision of good quality student materials (materials that fulfil a specific need of teachers) in workshops, even without further support in school through exemplary materials and/or coaching. Also, it is expected that exemplary material for teachers can be a useful and even an essential instrument; especially for beginning teachers (those who require specific support to survive and develop basic skills), but also for experienced teachers who want to embark on more complex changes and need examples of how to do it. Empirical evidence for this claim has been offered through other recent studies in science education in Namibia (Ottevanger, 2001) and Tanzania (Tilya, 2003). Yet, the results of our study indicate that the real potential of these materials can only manifest itself when adequate follow-up support is provided in a conducive school environment. Recent work of Rogan and Grayson (2003) on science curriculum implementation in developing countries confirms the importance of synergy between teacher learning, school development, and external support to facilitate successful change.

The in-service approach adopted by the SMART team (a combination of elements of a skill acquisition model and the concerns-based adoption model (CBAM): a model for change in individuals), had a lot in common with the "expert model" as described by Sprinthall, Reiman, and Thies-Sprinthall (1996). In-service based on the "expert model" aims at shaping skills through behaviour modifications, after which the teachers are expected to incorporate such individual behaviours in their teaching (a process) to promote student learning (a product). In hindsight, the "expert model" was probably a plausible "choice" for SMART under the given circumstances. It also has been adopted because it seemed to be a successful model at the time that the deliberations on the SMART design took place. Joyce and Showers (1980) even indicated that when in-service was geared to fine-tuning of knowledge and skills, the elements of instruction with demonstration probably would suffice. They did, however, emphasize that when complex models of teaching were being introduced, that instruction, demonstration, practice with feedback, and coaching were all crucial elements of in-service programmes. Because SMART staff decided to limit the change to improvement of basic teaching skills, the skill acquisition model seemed to be an appropriate model, and probably still is. However, it seems fair to say that SMART has gone some steps beyond the fine-tuning of basic teaching skills in the biology in-service course. And, although the reduction of note-giving in combination with promotion of use of textbooks by students might have seemed fine-tuning in the eyes of the designers at that time, it appeared to be a major

leap in the eyes of most teachers. This study makes clear that for these kinds of behavioural changes—which appear to be major—the "expert model" does not suffice for most teachers in the way it has been designed. More tailor-made, collaborative approaches embedded in a conducive school climate are probably required to facilitate such changes for most teachers.

Yet, currently the skill acquisition/CBAM model still forms an important basis for design of in-service courses all over the world (Guskey, 2000; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Sprinthall et al., 1996), albeit that integration with more collaborative elements is recommended—especially when considerable changes in teaching behaviour are pursued (see also Ross, Rollheiser, & Hogaboam-Gray, 1998, and Olson, James, & Lang, 1999, for examples).

Several authors (Beeby, 1966; de Feiter et al., 1995; Verspoor & Leno, 1986) have attempted to draw an overall picture of how educational systems work and advance in developing countries, and how in-service education should tie in with these insights to remedy shortcomings or facilitate improvement. Of course, there is a danger for oversimplification of such attempts, as pointed out by Harvey (1999b). The findings of this study indicate that a more flexible approach—one that combines realistic end-points for specific target groups in specific situations with appropriate design principles—has greater potential. The theoretical framework for curriculum implementation in developing countries developed by Rogan and Grayson (2003) seems a promising start towards this end. Using this framework in developing countries is expected to have more potential than just superimposing "expert models"—see, for example, Sprinthall et al. (1996) for an overview and Joyce and Showers (1988) for an example—or more "collaborative models" (i.e., Aubusson, 2002; Bell, 1998; Harland & Kinder, 1997; Joyce & Showers, 1995; Lieberman, 1992; Marx, Freeman, Krajcik, & Blumenfeld, 1998) that have proven effectiveness in western countries. The results of this study of the SMART in-service intervention in Swaziland point in the same direction.

Notes

1. In this article, the term "science" is used as an overall term to refer to the subjects of biology, chemistry, physics, and mathematics, unless indicated otherwise.
2. Following Bolam (1982), in-service education is defined as follows: those education and training activities engaged in by teachers, following their initial professional certification, intended to further develop their professional knowledge, skills, and attitudes in order that they can educate pupils more effectively.
3. These effect levels are further referred to in this article as Effect Levels 1–5.

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