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Implementing change in Science Teacher Education in Sub-Saharan Africa: challenges and opportunities.

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Abstract

Implementing change in education in Africa is both urgent and problematic. TESSA is a large-scale project that is successfully implementing change in primary teacher education across Sub-Saharan Africa. This paper describes the extension of the TESSA approach to secondary science education in a project designed to support pre-service teacher education. The project is based on the notion that change will come through improving teachers' classroom practices, and that change is more likely to be successful if it takes place with closest proximity to the problem. The concept of backward mapping is used to plan for implementation; this identifies teacher educators as the key players. This paper describes research carried out during the writing workshops, to better understand the perspective of the teacher educators involved and hence identify the challenges and opportunities afforded by this project. The work will also contribute to the wider learning about implementing educational change within the TESSA consortium.

Introduction

Improving educational outcomes in Sub Saharan Africa is one of the priorities of the Millenium Development Goals. The aim is to achieve universal primary education and a considerable expansion in secondary provision. Educational outcomes in Africa are poor at present owing to numerous factors, which certainly include an inappropriate curriculum, language difficulties, a lack of resources and poor teaching. The TESSA (Teacher Education in Sub Saharan Africa) project was established in 2005 with the aim of addressing, in particular, the issue of poor teaching. The project aims to support teachers and teacher educators in primary schools and there is evidence of considerable success in terms of changing practice (TESSA case studies, 2010). In 2010, funds were secured from the Waterloo Foundation to extend the 'TESSA approach' to secondary schools, focussing in particular on science education. It has been suggested (SEIA, 2007) that secondary education does not contribute to human capability development as effectively as it could and that student learning and achievement remain low. Furthermore, strong performance in mathematics and science is associated with economic growth so a focus on secondary education is appropriate. TESSA Secondary Science aims to produce resources to support teachers in developing pupil-centred approaches to learning, and crucially, to examine their own practice. This paper describes the development and integration of new materials and draws on the concept of 'backward mapping' (Elmore, 1980) to analyse and identify the challenges and opportunities presented when implementing change in this context.

Background to the project

There are four key principles that underpin the TESSA approach to affecting educational change:

- Educational outcomes could most effectively be improved by improving the quality of teaching.
- To be sustainable, the resources used to improve teaching need to be developed in Africa by Africans and versioned for different countries.
- The most effective way to produce high-quality materials that will be widely used is through collaboration.
- The materials must be freely available, with the ability to be adapted for individual use. (TESSA, 2008).

The TESSA resource bank includes 75 units of work, rooted in the primary curriculum, which support teachers in developing pupil-centred approaches to learning. The units have been developed by a consortium of 18 institutions representing 9 countries, led by The Open University. They are available as Open Educational Resources (OERs) and are currently in use in 19 teacher education programmes – pre-service, in-service and across different levels from CPD to BEd. A crucial feature of the units is that all the learning outcomes address the teacher and focus on developing their pedagogy (see Box 1).

Box 1 Examples of learning outcomes from TESSA units

At the end of this unit you will have:

- used different methods to find out pupils' ideas about forces around them;
- considered how to record your own and pupils' learning in this topic;
- supported your pupils to do investigations in small groups.

TESSA Secondary Science extends this approach to secondary level. The secondary context is different; few teachers are untrained, most have undergone training to degree level and training is focussed on pre-service experiences. Our initial aim is the collaborative development of resources that will be used by teacher educators with pre-service teachers; the hope is that this will expand to include in-service training. We are working in five countries: Ghana, Kenya, Tanzania, Uganda and Zambia. In the first instance one teacher educator from each of five institutions was invited to a planning workshop, in Tanzania, in which the themes, contexts and a template for the units was agreed (see box 2). A second workshop in Kenya included two representatives from each institution and identified suitable activities to be included in the units. Evidence and experience suggests that in the secondary

Box 2. TESSA Secondary Science Units

There will be 15 units. Five pedagogical themes were identified by the group based on our collective vision of an effective secondary science teacher. Each theme is exemplified in three contexts (biology, physics and chemistry). The units address the pre-service teacher. Each one has three activities and three case studies with a narrative which explains the rationale behind the activities and the link to the theme. Each unit also has up to six resources which might be support for subject knowledge, details to support the activities or pedagogy. For example, each of the units on 'Probing students' understanding' has a resource about 'Questioning'. The themes are:

- Probing students' understanding
- Making science practical
- Making science relevant and real
- Problem solving and creativity
- Dealing with challenging concepts.

context, most teachers will have some familiarity with the ideas that underpin pupil-centred learning but that they have difficulty implementing them (TESSA Workshop, 2010). In a school environment in which resources are limited, classes are large and the demands of the curriculum are considerable, affecting change presents a considerable challenge. It is important to plan for implementation and it is helpful have a framework on which to base a plan.

Theoretical Framework

Over a number of years and projects, experience developing in TESSA suggests that intervention should start at the point of maximum impact; the classroom. The work of Richard Elmore on the concept of 'backward mapping' has been highly influential here. He argues that solving problems in complex systems involves maximising discretion at the point where the problem is most immediate and 'the closer one is to the problem the greater is one's ability to influence it' (Elmore, 1980, 605). Formal organisational structures with a high degree of hierarchal control are not necessarily helpful and the more steps that are required for implementation, the less likely that a policy will be successful. Dyer (1999) used the concept of backward mapping in order to research the implementation of a project in India designed to promote a child-centred approach with activity-based learning (Operation Blackboard). She found that 'the policy initiative seemed to almost all these teachers to have provided a remedy for the wrong ailment.' (p54). The resources supplied to schools were often not in use, and certainly not in the way that was intended. Dyer reminds us of the importance of planning for implementation and suggests that 'backward mapping is a useful tool in generating the necessary information to do so' (p60). She analyses 'Operation Blackboard' in terms of a hierarchical diagram, starting with the teachers and working up to the Ministry. Her thesis is that decisions made at the Ministry level had very little impact on teachers. We present a similar analysis for TESSA (see figure 1) in which we start at the intended point of impact, which in this case is the pre-service teacher. Successful implementation will involve the resources being used by pre-service teachers to plan and deliver, effective lessons in which students are actively involved in their own learning. This will be sustained if the resources become embedded in the institutions training teachers and in the schools in which teachers are working.

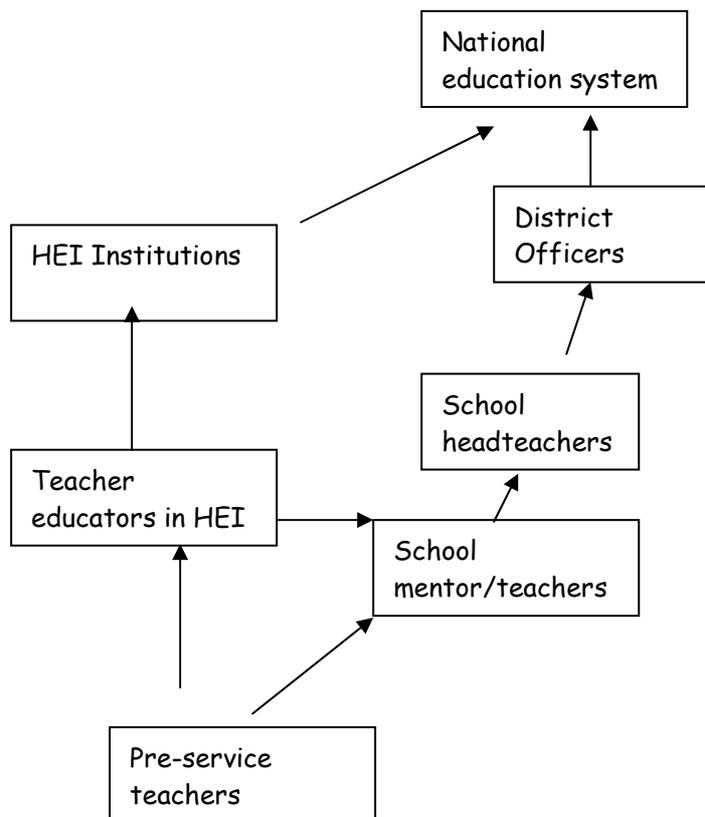


Figure 1: Backward mapping for TESSA Secondary Science

Backward mapping suggests that success of a policy is predicated on the ‘limited ability of the actors at one level of the implementation process to influence the behaviour of actors at other levels’ (Elmore, 1979, 604).

Dyer suggests that the implementation process involves being aware of a series of levels and looking at the behaviours of the ‘actors’ within those levels. In our situation (working with pre-service teachers), we would argue that whilst this is true – it is helpful to think in terms of the classroom, the school, the district and HEIs and the State as different ‘levels’ – some of the ‘actors’ actually span the levels and therefore have the ability to influence the process more than others. In our case, the key ‘actors’ are the teacher educators; they work directly with our student teachers, yet all the individual members of the project hold significant roles within their institutions. They have considerable influence and the ability to make an impact but also experience a range of external pressures and internal demands. This analysis suggests that planning for the successful implementation of TESSA Secondary Science depends on better understanding our teacher educators – their beliefs, their understanding of the context in which they work, their perception of the pressures they experience, and their relationship with their pre-service teachers and the schools in which they gather experience (see figure 2).

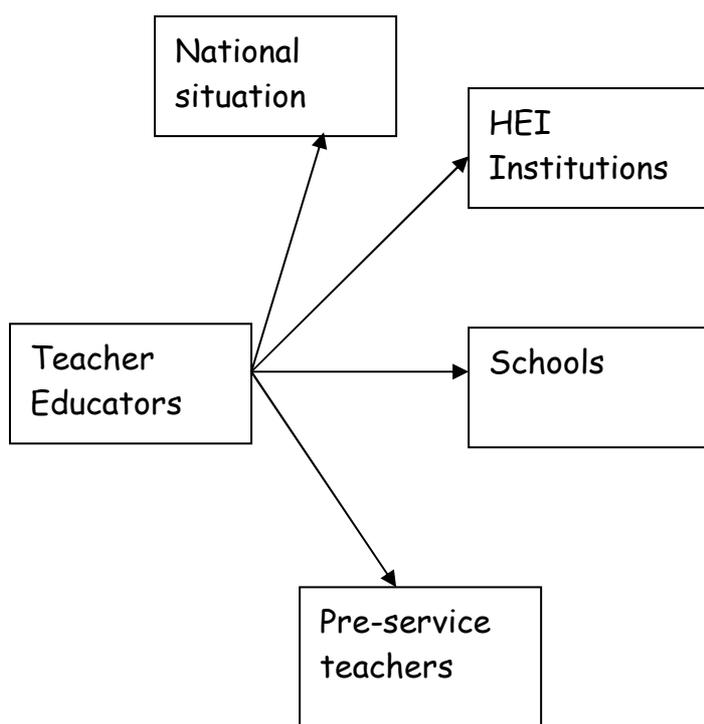


Figure 2: Teacher Educators as 'key' actors in the implementation of TESSA Secondary Science.

The study

In order to examine what has been learnt about the teacher educators and their roles in relation to each level (as represented in figure 2), we will draw on data from eleven interviews (two delegates from each country), observed collaborative discussions, the documentation that emerged from those discussions and shared lesson observations in two secondary schools. We will identify what we have learnt about the teacher educators as actors operating at different levels and examine the challenges and opportunities that have emerged from this analysis. Our thesis is that by identifying the challenges in a systematic manner at an early stage in the project, the chances of implementing the project successfully will be increased. The data was analysed by focussing first on the teacher educators themselves and then considering their perspective on pre-service teachers, schools, their institution and the situation in their country (figure 2).

The teacher educators had all been nominated by their Vice Chancellor or Faculty Dean (see box 3).

Box 3. TESSA Secondary Science teacher educators.

Eleven teacher educators are involved – two from each country (three from Kenya). There are nine men and two women. They include three Heads of Department and one Faculty Dean. Five of the eleven have had substantial teaching experience in schools: three were heads of department in school, one is a former Headteacher, and one still works mainly as a teacher. They all lecture in science education on undergraduate courses leading to a BSc in science education. Most of them are involved in visiting pre-service teachers in school.

Teacher Educators – attitudes and beliefs

Successful implementation of this project is very dependent on the teacher educators from the five institutions. They will need to be involved in adapting the materials for use in their country and they will need to make changes to the curriculum (and assessment schemes) in order to incorporate these materials into their own teaching. There are various models that they will be able to draw on based on our analysis of use of primary materials (Thakrar et al, 2009), but nevertheless, they will need to take ownership within their own institution and instigate the change themselves. We felt that it was important not to make assumptions about their acceptance of the aims of the project and sought understanding at this stage of their personal priorities and beliefs. Generally, there was much to be encouraged about. Several delegates talked with passion about the power of education to transform the lives of young people. *'I want student teachers to realise that if we can change individuals then we can change Africa'*.

And there was an awareness of the scale of the difficulties facing their countries and the power of education to tackle those problems.

'Science teaching should be relevant to the learner – we have so many problems we need to solve'.

'TESSA is coming at the right time. It is the right thing to do but in implementation it will be difficult'

A powerful message that emerged from a number of interviews and group discussions was the willingness to learn and their recognition that involvement with the project represents an opportunity to upgrade their own skills.

...the benefit would be to improve on my teaching methods, become an effective teacher of student teachers'.

You know we are training people who are going to become teachers in secondary schools, so this is of great benefit in terms of being more efficient in my teaching, acquiring greater pedagogical skills.

They value greatly the opportunity to change people's attitudes towards learning and particularly want to encourage more girls into science.

View of teaching and pre-service teachers

All our teacher educators have a good theoretical knowledge of pedagogy. There was a consensus around the view of effective secondary teaching with participants all wanting to see lessons in which learners were actively engaged and discussing their work. They want the science to be presented in a way that makes it relevant to pupils' everyday lives; they want to see learners engaged in practical activities and they want to see student teachers making use of effective questioning and involving pupils in discussions. Some delegates referred directly to 'social constructivism'.

Professionalism was also something considered very to be very important, alongside giving clear explanations and *'making difficult topics seem easy'*. In Uganda and Tanzania in particular secondary teachers are under considerable pressure to deliver good examination results and one of the delegates remarked that a good teacher is one that is not driven purely by the examination syllabus but highlighted the reality of the

situation in secondary schools. One teacher educator talked about modelling the techniques they want to see in use:

But as much as possible I try to get their own thinking before I even tell them what I think or what it should be. The teacher trainees when it comes to training methods, pedagogy, you also put them in that position, you give them activities to carry out. You want to see what they come up with. They should go through the experience themselves. Activities should not necessarily be always using apparatus or manipulating. But you can also have role play.

Another one remarked:

'I model in through my own teaching and tackle people who have doubts'

The importance of modelling practical approaches and setting assignments which require student teachers to develop materials to support their teaching was referred to a few times, but on probing, this amounted to doing experiments rather than adopting active pedagogies. When asked about how they seek to develop the skills they wish their student teachers to learn, some responses were less encouraging: *'we lecture them on methods'*.

The evidence from our conversation with a group of young teachers is that they know and understand the theory of constructivist approaches to learning, but have not developed the capacity or resources to apply these to their own teaching. Developing this capacity will be crucial to the success of our project, and much will depend on the teacher educators and their ability to model appropriate teaching approaches. In general, the clarity of the vision articulated was not matched by a commitment to modelling the approaches through their own teaching of pre-service teachers.

The relationship with schools

Trainee teachers in all five countries undertake some training in school, although in Zambia this is only an eight week placement at the end of the course. The picture established is one in which the emphasis during school experience seems to be on assessment rather than on learning and support. The Headteacher generally has responsibility for assessment, with the Head of Department providing support, but mainly with the development of subject knowledge rather than pedagogy. Mentors are only asked to comment on 'conduct' rather than on teaching ability. One delegate acknowledged that, when they hand over their classes to a student teacher, some teachers see this as an opportunity to take time off. In some schools, there is no-one who is considered sufficiently well-qualified to be a mentor and teachers are sometimes not enthusiastic about becoming a mentor through *'fear of exposing themselves'* to being observed. All the delegates are involved in visiting students in school themselves, but it is clear that there is no tradition of mentoring, very little (if any) specific training for mentors and considerable variation in interpretation in of the role. As the pressure to take on more pre-service teachers increases, the ability of the institution to provide support in school through visits is compromised and most people referred to the fact that the number of visits to each student was being reduced. There are clearly significant challenges around school experience and the ability of the teacher educators to influence schools at a time when there is pressure on resources will be limited.

Roles within the Higher Education Institution.

All the delegates are influential people in their institutions with the ability to influence the curriculum for teacher education and the assessment regime. However, they all feel under pressure and a number of specific pressures were identified including:

- The expectation that more students will be recruited to make up for shortfalls in teacher numbers, with no corresponding increase in resources.
- The workload on lecturers from teaching large classes and supervising large numbers of students in the field is considerable.
- Resources are inadequate. In some countries, frequent power cuts impede teaching.
- Lecturers are expected to take part in research programmes and upgrade their own qualifications, but the pressures of teaching make this difficult.
- Low salaries which mean some delegates feel under pressure to seek consultancy work outside their main role.

But this section also highlights some of the opportunities for the project. In particular, there was no feeling that lecturers are not autonomous in their own roles and micro-management of the curriculum that they deliver in the HEIs is not an issue. Collins and Gillies (2008) suggest that teacher education institutions are struggling to expand in order to meet the demand for more secondary teachers and that the structure of the current system will not allow the changes required. They suggest that pre-service teacher education courses need to be shorter with more emphasis on in-service education. If such changes take place, educative resources will have an important strategic role in supporting the in-service professional development of secondary school teachers.

The national picture

The nature of the bottom up approach to change embodied in the concept of backward mapping means that national problems and issues will not form the focus of the implementation. However, they do form part of the context and some of the issues are very important to our teacher educators.

The issues that were identified, during the workshops by the delegates include:

- Frequent reviews of and changes to the school curriculum by Government.
- The lack of girls choosing to take science.
- An increasing divide between rural and urban schools. The latter, in some places, are beginning to have access to ICT and other resources.
- The lack of relevance of the school curriculum. For example there is very little on global warming, mobile phones, HIV, and ICT.

It is interesting to note that although these issues have not been at the heart of the rationale for the project, it might still be possible to address them. For example, the emphasis on learning outcomes for the teacher, focussing on sound pedagogical approaches, makes the resources adaptable to different contexts. Changes to the curriculum would not automatically mean that they were no longer relevant. Also, the ability to provide access to the resources electronically, or in print, means that TESSA primary units are in use in some of the most deprived rural areas in Africa.

Discussion

The purpose of this analysis was to identify the key challenges for implementation and the opportunities afforded by this project.

Challenges

Based on the analysis above, the key challenges would seem to be:

- Supporting teacher educators in embracing the ‘substance’ of learner-centred approaches and modelling these approaches in their own teaching.
- Developing the capacity of pre-service teachers to implement pupil-centred approaches to teaching, rather than to teach in the way in which they were taught.
- Ensuring that pre-service teachers are supported when they are in school.
- Making sure that the resources support the curriculum in a way that means they are used and not seen as a distraction from the matter in hand – preparation for examinations.

We will consider each of these challenges, drawing on evidence from the literature and the original TESSA project.

Experience from South Africa (Brodie et al., 2002) suggests that teachers taking part in an in-service programme designed to promote learner-centred approaches, found it difficult to undergo the transformation. Brodie defines the ‘form’ and the ‘substance’ of teacher-centred learning; the ‘form’ refers to strategies such as appropriate resources, groupwork and questioning which may or may not enable the ‘substance’ of learner-centred teaching. The ‘substance’ is the extent to which teachers elicited and engaged with learners’ ideas and interests in order to develop new ideas and meanings. They found that the majority of teachers taking part in the programme embraced the ‘form’ without necessarily engaging with the ‘substance’. We are targeting student teachers; it is important that the teacher educators embrace and demonstrate the ‘substance’ of learner-centred teaching and that they do so throughout the four years of the teacher training course. A ‘TESSA unit’ in the final year is not likely to have significant impact on student teachers, especially if they are having difficulty moving away from the model of teaching that they experienced when they were at school. Another experience from South Africa illustrates this point. Free High School Science Texts (FHSST) was started in 2002 with the aim of producing OERs to support the South African curriculum. In a case study of the project, Petrides and Jimes (2008) suggest that the sustainability of such projects depends on ‘the importance of instilling structures and practices that are aligned to project goals’. In the case of TESSA Secondary Science this emphasises the importance of using the resources with student teachers in the way in which they should be used in school i.e modelling their use within institutions. It is highly likely that the resources we will produce will promote a way of learning that is different from that experienced by the student teachers when they were at school.

It is known that teacher practices are informed by the ideas and beliefs that teachers developed before embracing teaching (Dembele, 2003) and it is important that pre-service teacher education courses challenge these beliefs, especially as they are likely to be based on student teachers’ own experiences of learning in a system where levels of achievement are generally low. The implications for the project are that careful planning will be needed in order to integrate the resources into the curriculum of BEd and BSc courses, with resources and support being made available to partners.

The challenges presented by the conditions in schools are considerable. Experience from the TESSA primary project (Thakrar et al, 2009) demonstrates that effective support is a key factor in the successful implementation of educative curriculum materials. Establishing a culture in schools of mentoring with support for pre-service teachers in developing pedagogy, represents a huge challenge, and the ability to

influence Headteachers would clearly make a difference. However, it would be difficult to achieve, whereas supporting pre-service teachers to develop networks for peer-support, based on the use of mobile phones and internet chat-rooms, is more realistic, and perhaps needs to be a focus during the implementation stage of the project. The backward mapping approach highlights the need to focus on the actors and situations that we can realistically hope to influence.

The key issue highlighted by a group of young teachers that we interviewed was the over-loaded curriculum and the pressure for students to achieve good results. It is essential therefore that the resources that we develop are closely and specifically linked to the curriculum and that the activities are achievable in short periods of time and are not perceived to be detracting from 'real' teaching. We all believe that the approaches that we are advocating will lead to improved student outcomes, but we recognise that persuading teachers and students to work differently will require patience and a certain amount of tact and cunning. Despite the potential challenges, it is clear that some real opportunities have emerged.

Opportunities

A key opportunity is the willingness of the teacher educator partners to learn and the potential of collaborative working, based on a shared vision, to build capacity. Some of the key contributors to the original TESSA project have become well-known in their countries; the TESSA Secondary Science definition of an effective secondary science teacher is now informing policy in the Kenyan Education Ministry. For some of the delegates, their own research and career advancement is a priority, alongside the ability to supplement what they perceive to be low incomes. For one, in particular, who is under pressure within his own institution, a significant priority is the opportunity to interact with external partners. As project co-ordinators, we need to respect this and organise implementation activities in such a way that project-members feel empowered within their own institutions. They all have the ability to influence the curriculum in their institutions but will need resources to do so. In the past, resources have been used to support implementation in individual institutions and this will continue to be important.

Finally, the overwhelming impression left by our joint observations of two science lessons, was that if teachers had made relatively small changes to their practice, the impact would have been significant. So although the challenges are considerable, they are not impossible.

Conclusion

Our analysis suggests that backward mapping would seem to provide a structure for thinking about implementation that provides helpful insights, and shapes the project in such a way that it is more likely to be successful. We based the framework on the ideas of Caroline Dyer (1999) but realised that in our context, rather than think about the actors at each level of the process, we needed to recognise that the 'key actors' – the teacher educators – operate at different levels and that we need to understand their perspective in relation to each of those. Specific actions that we have identified as a result of this analysis include:

- Keeping the activities short so that we can begin to convince teachers that they do have time to develop child-centred approaches
- Making sure the activities are tied directly to the curriculum

- Providing a consultant to visit each institution to support planning for implementation
- Modelling during the workshops some of the ways of working that we hope teacher educators will use with pre-service teachers
- Looking ahead to try and secure funds to support peer-networks of pre-service teachers.

We would argue that the project has already experienced some successes through the engagement of the teacher educators and their contribution to the writing of the resources; the challenges and opportunities identified here will certainly shape the way in which the project progresses and the plan for implementation. This work represents a starting point for a more detailed critique of the implications of backward mapping, which will be reported elsewhere.

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