



CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

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This chapter presents the conclusions of the study drawn from the two phases, and the recommendations in relation to three different perspectives. It starts by summarising the context in which the study was undertaken, the research questions and approach (Section 7.1). The main findings emerging from the Baseline Survey and from the Intervention Study are also discussed in this section. The discussion is presented along the two stages of the intervention phase and their impact on teachers and students. Section 7.2 further discusses methodological, substantive, and scientific reflections of the study. Section 7.3 summarises the main conclusions of the study. The chapter ends with Section 7.4 which presents recommendations for policy and practice, for further research, and for further development work.

7.1 Summary of research questions and approach

In order to be able to say anything about the improvement of assessment practices, it is important to consider the methods used to collect the data and whether the data collection instruments were fair to all participants (Pelgrum, 1989). The aim of this research was to investigate assessment practices used by Grade 12 Physics teachers in Mozambique and how can they be improved upon. What follows in this chapter is a consideration of the findings of this research, which leads to the conclusions, and a modest attempt to draw some recommendations on the use of research conclusions for policy and practice. The first subsection of this section provides the research context and research questions of the study (7.1.1), the findings of the Baseline Survey (7.1.2) and of the Intervention Study (7.1.3), and their impact on both teachers and students.

7.1.1 Research context and questions

The major education issues and challenges for Mozambique are, among others, the limited access to education, and the inefficiency (high repeat and dropout rates) of the

education system (UNDP, 2000). Concerning access, statistics available at the Ministry of Education and Culture (MinEd, 2003) indicate that at the Lower Primary School, Cycle 1 (EP1), the average enrolment net rate in 2003 was of 69.4%, consisting of 66.4% for girls and 72.4% for boys. As a result, every year, around 30% of children at school age become potentially illiterate, as they miss the chance of entering the school system with severe consequences for their access to the subsequent levels of education system. The devastating civil war, particularly in the 1980s, imposed severe restrictions on the Government efforts of promoting mass education. By 1992, when the war finally came to an end, about 3.530 schools (corresponding to 58% of those that existed by 1983) had been closed or destroyed, affecting more than 1.5 million pupils (MinEd, 1994). Although post-war education statistics (MinEd, 1994, 1999) show that both school enrolments and the number of schools has been increasing since the end of the war, the illiteracy rate remains high. In 2002 the average illiteracy rate was 53.5%, being even higher (68.6%) for females (Siteo, 2006). Despite the fact that community, private, and church schools offer alternative opportunities to some students (particularly for secondary education), their contribution is still insignificant in regard to the improvement of access to education. The majority of students from the poor social groups, particularly from rural areas, do not have access to secondary education and there are significant geographic (North, Centre, South, and rural vs urban) and gender disparities.

The efficiency of the Mozambique education system and its value, as is the case elsewhere, is judged by the quality of the outputs. Common sense judgments, normally drawn from the performance of the students leaving high school, are that their general knowledge is below average. Although there have not been clear indicators to assess the quality of the outputs of the education system, it is widely acknowledged that ‘nowadays students know less and less’ (Siteo, 2006:45). The concern is more acute in Science subjects and at secondary education level where, according to the UNDP Human Development Report, the quality and efficiency of the education system are the lowest (UNDP, 2000). One of the reasons for this situation is that the ESG2 curriculum is highly academic and demands a high level of theoretical knowledge, without promoting practical skills that would facilitate the integration of graduates into the labour market. Life skills do not feature sufficiently in the curriculum, and as a result, there have been high repetition and dropout rates. This weakens the possibility of

developing a critical mass of Mathematics and Science students, a fact which is subsequently reflected in the number of new entries to university. In fact, Entrance Examinations to the UEM have also been used as indicators of the quality of high school leavers. The pass rate in these examinations is below 20%. Mathematics, Portuguese and Sciences (Biology, Chemistry and Physics) are the subjects in which high fail rates are registered.

The Ministry of Education and Culture, in recognition of the need to achieve effective results in educational provision, is undertaking a curriculum review for secondary education and a coordinated curriculum and assessment strategy has been designed (MEC & INDE, 2007). This strategy indicates that there is a need to produce secondary level graduates to ensure an adequate supply of teachers and other public servants, as the future job market is uncertain and subject to rapid technological change.

It is within the context of the poor performance of the students leaving high school - particularly in science subjects - and the need to explore the potential of the new curriculum being proposed by MEC that this study had been undertaken. The central research question of the study was formulated as follows:

What assessment practices do Grade 12 teachers in Physics in Mozambique apply and how can they be improved?

To tackle this research question, the study adopted a twofold research approach. A Baseline Survey aimed at gaining an overall impression of the assessment practices used by secondary school Physics teachers in schools and an Intervention Study aimed at producing improvements on teacher assessment practices. While the Baseline Survey was basically a preliminary research following a survey research method, the Intervention Study is the main study. This followed an educational design research approach whose overall design comprised of two stages namely (i) prototyping and (ii) assessment, systematic reflection and documentation.

Specifically, the aforementioned main research question has been guided by the operational research questions set out below.

- For the Baseline Survey these are:
 - *What assessments practices do Grade 12 Physics teachers apply?*
 - *What is the quality of the assessment practices?*
 - *How relevant can the assessment practices be for students learning?*

- For the Intervention Study this is:
 - *How can the teacher assessment practices be improved?*

7.1.2 A summary of findings emerging from the Baseline Survey

As indicated earlier in this and previous chapters (see also Chapters 3 and 4), a preliminary research aimed at reviewing assessment practices used by secondary school Physics teachers in Mozambique. As a first step towards a good preliminary research to inform the study, a decision was made to conduct the Baseline Survey in carefully selected Mozambican secondary schools from different provinces. In order to address the three operational research questions of the survey, a purposive sample of 12 Physics teachers, four school directors, two pedagogical officers, and three assessment specialists was selected in order to obtain a representative picture of instruction, management and inspectorate perspectives.

The information needed to acquire answers for the operational research questions was obtained via interviews, questionnaires, classroom observations and written notes. A triangulation of both sources and data collection instruments made it possible to validate the information collected. The following are the findings of the Baseline Survey.

- Concerning the types of assessment practices, it is relevant to start by mentioning that the most frequently used assessment practices in schools are paper-and-pencil tests, verbal tests, and homework, while projects, portfolios, and peer-assessments are the less frequently used ones. In general terms, however, it can be concluded that that teachers appeared to be unfamiliar with some assessment practices or they had different understanding of the concepts

used to name some of them (e.g., portfolios and peer-assessment). This was illustrated by lack of consistency in teacher responses from the questionnaire to the interview, and the relatively large amount of missing data.

- As for the quality of assessments, several student activities were used as quality criteria namely oral communication during lessons, written work, presentations, notebooks, laboratory work, and solving problems. The most frequently assessed student activity is written work, followed by ability of students to solve problems. Laboratory work is the activity that was never assessed by many of the researched teachers. Another criterion used to verify the quality of the teacher assessments was the feedback given by teachers to students. The findings indicate that teachers were giving expressed (both favourable and critical), personal (the feedback was given individually to students) and timely feedback (teachers gave their feedback promptly while moving from one student's desk to another).
- Regarding relevance the level of student involvement in the evaluation of their own work was seen to be an indicator of the relevance of the assessment for student learning. The most common way used by teachers to get the students involved in the evaluation of their performance was to reflect with them about their assessment results in order to get them learn from their successes and failures. The use by teachers of assessment results for the evaluation of the student work was another indicator of relevance. The majority of teachers (nine out of twelve) indicated the encouragement of students to engage in active learning as the most used indicator of relevance. A point of concern, however, in relation to the relevance of teacher assessments, is that about one quarter of the teachers (3 out of 12) did not provide answers to the majority of relevance indicators namely (i) to assign grades, (ii) to identify student strengths and weaknesses, and (iii) to help students know and recognise the standards they are aiming for. This suggests that very crucial aspects of classroom assessment such as certifying mastery for assigning grades, diagnosing student strengths and weaknesses, as well as sharing goals with the students have not been taken into consideration by a relatively large proportion of the teachers.



In general, the baseline findings provided a clear direction for the intervention to be undertaken in the following phase of the study. These suggested that, although teachers have mostly used on-paper written assessments, they rarely involve students in performance type assessment. Even those teachers who conduct performance assessment still lack preparation in terms of designing and administering them properly.

During and after the Baseline Survey, an in-depth literature review was undertaken. The review was not only meant to discuss the arguments of several scholars on the topic but also to provide a platform from which to better conceptualise the intervention phase of the study. Five lessons emerged from the review as shown below:

1. Constructivism is one of the most relevant theories in student knowledge construction and it represents a powerful theoretical resource that may maximise student learning.
2. Besides the importance of other classroom assessment practices, performance assessment plays a crucial role in assessing Physics learning. It calls upon the students to demonstrate specific skills and competencies and requires them to perform real-world tasks that demonstrate meaningful application of essential skills and knowledge.
3. Teachers must be supported to contextualise assessment. In this respect, criterion-referenced assessment must be the basis of judging student evidence, the feedback must be judged and used by both students and teachers, and the assessment in general should be directed *for* learning.
4. In undertaking assessment *for* learning, teachers must consider completing the entire cycle of assessment events. This, however, should be done taking into consideration that classroom assessment occurs at the intersection of instruction, classroom management, and assessment, i.e., the broader curricular context has to be dealt with.
5. If assessment is to be effective for learning an entire cycle of goals-evidence-judgment of achievement-next steps in learning-goals has to be completed. In this respect, formative assessment is at the heart of student learning, where feedback for students is only effective when it is used to guide improvement.

Taking into account the findings from the Baseline Survey and considering what the literature outlines as good practice, it was concluded that somehow there was neither sufficient research dealing with the extent to which assessment strategies were used for Physics as a subject, nor a reported professional support for teachers to assist them in the development of performance assessment materials for use in an ordinary classroom environment. This study addresses these shortcomings as follows: firstly, by providing support to teachers in developing and using exemplary support materials on performance assessments; secondly, by ensuring that the development of such materials is done in an ordinary classroom environment to allow teachers and students to participate in the process while working in their own environment; and thirdly, by formatively evaluating all development stages of the intervention, so that the learning evidence is used to feed the teaching and learning process.

7.1.3 A summary of findings emerging from the Intervention Study

This stage of the study was directed towards designing and developing Physics assessment materials aimed at helping teachers to improve their assessment practices in schools. The intervention dealt primarily with the design and formative evaluation of a series of Physics prototypes in the context of demonstration experiments. The validity and practicality of the prototypes were verified using appraisal by *experts, university students, teachers* (for validity aspects), and *teachers and students* in a classroom tryout (for practicality). Secondly, the study addressed the issue of assessment and systematic reflection and documentation of the intervention as a whole where the effectiveness of the material was also subject to appraisal by experts. So, the overall discussion of the main findings from the Intervention Study is presented along the structure of (i) formative evaluation of the prototypes, (ii) systematic reflection and documentation of the materials, and the impact on both (iii) teachers and (iv) students from the perspective of practicality and usefulness of the intervention.

Formative evaluation of the PAM materials

The study selected the topics of force and inertia for the Grade 12 Physics curriculum for exemplifying the demonstration experiments. Exemplary PAM prototypes were developed, appraised and tested in a classroom tryout. The trajectory of the

prototyping process of the PAM materials in force and inertia was presented and discussed in Chapter 4 (Figure 4.4).

The results from the appraisal by experts, teachers and university students provided indications about the validity of the first version of the materials in terms of internal consistency between the materials and the state-of-art knowledge, and the consistency of the various components of the intervention. This stage of appraisal focused *more on improving the validity and less the practicality* of the prototype and it culminated in concrete suggestions for the revision of the first version. The revision suggestions were incorporated in the subsequent version of the prototype (Version 2), which was tried out in the classroom. The trial focused *more on the practicality and less on the effectiveness* i.e. the emphasis was on the usability of the materials by teachers and students in ways that are compatible with the developer's intention.

The results from the classroom tryout showed that the overall impressions of both teachers and students were positive. The two participating teachers indicated that they liked the presentation and structure of the materials following the POE strategy, and regarded the material as being very useful in helping to enhance their professional experience and to prepare their own assessments. As for the conduct of experiments, they referred to the aspect of their commitment as crucial for achieving the desired experiment results. Preparation of experiments takes time and effort from teachers in such overcrowded classrooms. These are not always available within the curriculum schedule. Effectively, both teachers agreed on the need to improve managerial strategies related to time and class size. Students enjoyed the POE strategy (the sequence of the three steps) because it allowed them to realise their misconceptions during the experiments and to develop their own explanations of the observed differences between prediction and observation of the events. Doing experiments in groups - particularly during the observation phase - was the aspect that they did not like. They argued that working individually permitted better visualisation of the events and it helped in developing their own ideas, which could later be shared in groups during the reconciliation phase of the POE strategy. When asked about the differences between demonstration experiments on PAM materials and their regular Physics laboratory lessons, they highlighted the important role played by the teacher during the

tryout. They said that the teacher acted more as a guide to students than as a transmitter of knowledge.

Overall, the revision decisions from the classroom tryout were used during the second phase of the intervention - systematic reflection and documentation – to improve the effectiveness of the material and the sustainability of the intervention as a whole.

Systematic reflection and documentation

The first stage of the systematic reflection and documentation consisted of final appraisal by two experts who assessed the material in terms of their *effectiveness* and *sustainability* of the study. The outcome of this reflection led to the production of the last version of the prototype (Version 4). During the second stage, an evaluation workshop with teachers and university students was conducted. Although all participants attested that they were convinced about the potential of the materials to improve classroom assessments, the teachers appeared to be concerned about the process of implementation of the intervention. Effective management strategies to deal with overcrowded classrooms and support from school leadership were mentioned as some of enabling factors which could contribute to the success of the innovation. The following subsections present reflections on the impact of the intervention on teachers and students. The reflections are presented in connection with findings from the classroom tryout and with teachers' suggestions from the evaluation workshop.

Impact of the intervention on teachers

At the outset of this study (Chapter 1, Section 1.1), it was stated that Mozambican secondary school teachers strive to meet the same learning outcomes for all students. An assumption underlying this research was that good assessment practices used by teachers in their classrooms could well serve as one of the vehicles to realise these learning outcomes. It was assumed that if all teachers, regardless of their different levels of qualifications, are made familiar with the characteristics and usefulness of formative assessment, they can generally improve their assessment practices and particularly help students learn Physics better. Two reasons support this assumption: firstly, the Mozambican Government, through the MEC, decided to consider the revision of assessment practices as one of the strategic priorities to be taken into account during the curriculum review of the secondary education curriculum (MEC &



INDE, 2007). Secondly, arguments from various authors about classroom assessment (Chapter 3, Section 3.6) indicate that teachers need support in developing and using exemplary support materials on performance assessments, and that, more importantly, these materials should be evaluated formatively to allow the learning evidence to be used to feed the teaching and learning process.

The central research question of this study dealt with how to improve assessment practices used by Grade 12 Physics teachers in schools. After investigating the assessment practices currently used in the classroom, it was decided to undertake an intervention aimed at improving such practices. However, measuring the impact of the intervention on teachers' familiarity with formative assessment materials, and on the use of the learning evidence to feed the teaching process, has been daunting. This is because the overall success of the intervention is not limited to the teachers' ability to conduct demonstration experiments but also depends on their subject knowledge – worrisome teachers' under- or non- qualifications levels are reported – on methodological aspects within the new curriculum, and on the supervision process undertaken by the MEC on school follow-ups. This is in line with Joyce and Showers (1988, 1995) who indicate that a systematic combination of five training components (theory, demonstration, practice, feedback, and coaching) leads to effective teacher learning about an intended change and its transfer into classroom practice. For this reason, a decision was made to explore the indications of teacher learning by triangulating self-reported statements during the evaluation of the intervention and classroom observations by the researcher.

The participating teachers reported that, after the demonstration experiments, their awareness and skills in designing and conducting experiments were enhanced. Effectively, there are indications that demonstrate teacher learning from these experiments. Classroom observations conducted after the intervention, and results from the evaluation workshop, indicated that teacher lesson preparation (e.g., lesson plans and organisation of the materials and equipment) had followed the specific suggestions from the exemplary PAM materials. However, as it was emphasised by the two teachers who participated in the tryouts, an improvement of teacher assessment practices will have to depend (i) on their personal commitment and (ii) on the flexibility of the curriculum regarding time allocation because the POE strategy

requires a step-by-step guiding of students which is not easy in the context of overcrowded classrooms. Furthermore, based on classroom observations, it was evident that in a school where the teacher was more active and committed, it was possible to organise students to conduct the experiments with relatively less time than in the other, even with the involvement of far more students. This shows that the findings between the teachers' perceptions of the demonstration experiments and lessons learnt as measured by the workshop results and classroom observations, are concurrent.

The impact of the findings on teacher learning concurs with Garet et al., (2001). These authors argue that professional development interventions aimed at improving teacher content knowledge, pedagogical content knowledge, and active learning opportunities, when integrated into school daily life are related to teachers' perceptions of enhanced knowledge and skills. However, as was suggested earlier in Chapter 6 (Section 6.6), the overall success of the intervention will ultimately depend, amongst other factors, on the support teachers receive from various educational stakeholders. This is illustrated by the teachers' answers during the evaluation workshop of whether the respective schools have provided support to the implementation of the Physics demonstration experiments (refer to Level 3 of Guskey's model in Table 6.6). Although they said it was too early to make an evaluation, their general impression was characterised by certain scepticism about the potential success. They argued that they were sceptical because in similar initiatives, schools were not very supportive, particularly regarding the financial costs. They are of the opinion that, unless changes are embedded in teacher training programmes and gain support from the MEC right from the initial phase of the teacher training programmes, it will be difficult to predict positive changes at the school level alone.

Impact of the intervention on students

One of the criteria for measuring the impact of demonstration experiments on student learning of Physics is the learning outcomes. It was assumed that changes in participant teacher skills and knowledge in conducting Physics demonstration experiments and formative evaluation of their students would, therefore, improve student learning. The assumption was based on the fact that an improvement in teacher assessment practices would ultimately lead to better results. However, as was the case



with teachers, connecting the dots between intervention findings and student learning has been a difficult task for this study. Firstly, because, as referred by Sykes (1999), demonstration experiments, like the ones reported in this study, alone cannot produce student learning outcomes unless the educational system in which they are embedded is supportive enough to produce positive changes (e.g., adequate teacher training system, conducive classroom environment, government willingness to support changes). Secondly, learning outcomes are also influenced by student activities outside the school environment – peers, parents and the media (Guskey, 2000; Ogunniyi, 1986). The focus of the study did not allow any investigation into the influence of these external factors. One way to address this complexity of measuring the impact of demonstration experiments on student learning would be to evaluate the students through an achievement test or by an interview. Because of time constraints, the researcher was not able to do such an evaluation.

Another criterion to measure the impact of demonstration experiments on students is their attitude towards the experiments. The students' general attitude was positive. In the evaluation questionnaires they reported that they enjoyed their participation in the experiments particularly the opportunity to develop their own explanations of the events. They felt that the three steps of the POE strategy increased their motivation to study Physics. It allowed them to start any experiment by voicing their own predictions and observing the actual course of the event before drawing any conclusion about it. Comparing their own thinking with that of the others, evaluating their own mental ability, and drawing informed conclusions were some of the aspects referred to by students as the most valuable insights gained from the demonstration experiments.

The last criterion used to evaluate the impact of the demonstration experiments on students was the demonstration experiment report, which was prepared and submitted by the students after the experiments. This report helped to give an idea of the quality of student learning in terms of research skills and reasoning abilities. By writing the report, the students were able to express their level of understanding of force and inertia, as well as their ability to design, conduct, and communicate the results of the experiments.

7.2 Reflections of the study

Section 7.1 provided a summary of the context in which the research was carried out and the research questions that guided the investigation. The section has also reflected on the main findings of the two components and provided an in-depth discussion of the impact of the demonstration experiments on both teachers and students. The present Section (7.2) discusses the main reflections about the study in relation to three perspectives namely methodological, substantive, and scientific.

7.2.1 Methodological reflection

As referred to in Chapters 1 and 4, the study concentrated on investigating and improving assessment practices used by secondary school teachers in Mozambique situated within the pragmatic knowledge claim, making use of a mixed mode methodological approach. It employed a survey approach to investigate the assessment practices currently used by Grade 12 Physics teachers in schools prior to an educational design research approach used in the Intervention Study and aimed at improving such practices. As argued in Chapters 1 (Section 1.2) and 2 (Section 2.3), the importance of the Baseline Survey for the intervention lies on the prior understanding of the assessment practices taking place in schools and classrooms before designing an effective intervention aimed at improving these practices. This understanding implied looking at the school and assessment practices into three perspectives: firstly, the characteristics of the curriculum in place, the situation of the teachers working in school, the existing infrastructures and the whether the school culture is conducive to the design and implementation of the intervention (input); secondly, the understanding of the existing classroom practices in terms of how the instruction is related to assessment (process) and thirdly, the analysis of student achievement and of their attitudes towards the learning of Physics (output). All this baseline information on the conditions in place was important for designing and implementing an effective intervention for improved classroom practices.

The survey approach permitted the collection of data in cross-sectional studies using a variety of data collection instruments such as questionnaires or semi-structured interviews, with the intention of obtaining a maximum variation sample. Both



qualitative and quantitative descriptive methods were used to analyse the data so that an overall picture of the survey could be captured. The triangulation of sources and data collection instruments also made it possible to explore the views of teachers, school directors and educational officers about the types, quality, and relevance of assessment practices used by teachers in schools. Due to the potential of this approach, it was possible to obtain a good picture of the types assessment practices used in such a huge and wider population across the country as well as considering assessment from various perspectives (instruction, management and inspectorate).

This mixed method approach, however, also involved some constraints during the course of the research. During the Baseline Survey the problem was linked to the discrepancies between answers given by teachers to questions in the questionnaires and in the interviews, possibly due to the fact that data collection instruments were piloted with teachers in Maputo, whilst all schools in the sample were from outside Maputo. The decision to pilot in Maputo was deliberate because of the costs and time constraints involved in doing a countrywide pilot study, although it meant that the possibility for diverse responses increased (refer to considerations about assessment practices used by teachers under 5.2.1). A greater unfamiliarity with the concepts seems to increase as one move away from Maputo area due to the lack of libraries and information dissemination generally, and poor teaching conditions that the teachers face countrywide. As a result, some teacher limitations in dealing with data collection instruments went unnoticed during the pilot phase. The lesson that can be learnt from this is that, irrespective of any logistical problems, additional efforts must be made to minimise problems resulting from differences between subject characteristics of the pilot process and those of the actual research.

In the Intervention Study, the applied educational design research approach provided flexibility in developing an intervention step-by-step within the problem. Van den Akker (1999) argues that the approach enables the realisation of small-scale examples of interventions, and generates methodological guidelines for the design and evaluation of such interventions. Therefore, the educational design research approach was considered appropriate and useful for the Mozambican context because of the opportunity given to teachers to design, develop and evaluate the intervention with a local relevance, while working in their own environment. Teacher participation in the

process advocated by the approach, was influential in understanding their potential difficulties in the implementation process as well as the local conditions, which were crucial to the future improvement of the intervention. However, one of the methodological problems with the educational design research approach, which is linked to its formative research character of working in the natural setting, is the generalisability of findings (Walker, 1992; Yin, 1994). The concern is the extent to which the research findings are transferable from the situation being studied to situations not being studied. In fact, this was the case with this study because, during the prototyping process, results from the formative evaluation activities were incorporated into the design process of the subsequent prototypes. This makes the generalisation of the findings of this study to a wider population a daunting exercise, due to the lack of statistical representation – a very small number of teachers took part in the formative evaluation of the prototypes – and to the lack of replications of the evaluation findings into different users.

In light of these considerations, the readers of this dissertation are encouraged to consider some of the analytical forms of generalisation suggested by Miles and Huberman (1994), Tecle (2006), and Yin (1994). These are as follows:

- an in-depth description of the research context, research design, and formative results;
- the rationale for choosing the quality criteria and research design;
- the researcher's role in the research activities;
- a detailed description of the data collection instruments, their administration procedures, the number and characteristics of respondents, and the methods of data analysis; and
- the replications of intervention findings in more tryouts to determine whether the same results may occur.

In summary, the combination of survey and educational design research approaches added a great value to this study in the sense that not only reflected the perceptions of a varied sample of Physics teachers countrywide but also allowed them to participate in the research while working in their own environment.

7.2.2 Substantive reflection

At the outset of this chapter (subsection 7.1.1) it was mentioned that one of the main problems that the Mozambican education system has been facing is linked to the limited access to education for the majority of children of school going age. In more recent years, however, the government of Mozambique has shifted the attention to the issue of efficiency of the school system. This is in recognition of the fact that, although there are still children who are out of the school system, those who are in it are not yet benefiting from the desired quality education. The reason for this is attributed to the quality of outputs at the end of different learning cycles. The steady increase of unqualified teachers in schools exacerbates this problem. This implies that there is a need for teachers (both qualified and unqualified) that should be seriously addressed through a sound teacher-training programme. Several reports (INDE, 2005; Lauchande, 2001; MinEd, 1998; Palme, 1992; Popov, 1994) indicate that secondary school teachers show a lack of skills in designing and administering valid formative tests and in addition, they have also had to face problems in formulating test items requiring the analysis and comprehension levels of cognition. The Government of Mozambique, through the MEC, expects that in the new secondary education curriculum, teachers should become familiar with the characteristics and usefulness of formative assessment and learn to develop formative assessments to be used in the classroom to inform and enhance the learning process (MEC & INDE, 2007).

This study is intended to be a modest contribution to the seeking of a solution to the problem of system inefficiency by investigating the quality of school leavers at Grade 12. Among the few studies that have been conducted about the quality of system outputs, some address issues related to teacher training and curriculum implementation (Afonso, 2007; Cupane, 2007; Fagilde, 2002; Huillet, 2002; Kouwenhoven, 2003), others look at students' alternative conceptions and beliefs (Mutimucuo, 1998; Siteo, 2006) and some others (Januário, 1997; Lauchande, 2001; Palme, 1992; Popov, 1994) address the issue of school effectiveness, with particular emphasis on the assessment of student learning. Most of these studies focus on primary education. More recently, some studies were conducted with the focus on secondary education in assessment for Mathematics (Machado, 2007), and in practical work for Biology (Cossa, 2007) and Chemistry (Chevane, 2002). Not one of these studies, however, has investigated the

way students are assessed in authentic research situations within the context of demonstration experiments and involving teachers in the design and evaluation of assessment materials. A very distinctive element of this study is its potential to generate improvement suggestions into the assessment system, drawn from the work with teachers who participated as designers and users.

7.2.3 Scientific reflection

As referred to earlier in Chapter 4 (Section 4.3), this study used a combination of qualitative and quantitative data collection methods for collecting information (Baseline Survey) and for the summative evaluation of the prototypes (Intervention Study). The combination of Baseline Survey and Intervention Study has conferred on the study a particular uniqueness in the Mozambican research context. As indicated in Chapter 3, studies conducted in and about the country in the area of assessment for secondary education are still scarce, and none of them have employed an educational design research approach. The formative evaluation activities incorporated into a cyclic process of design and evaluation of the PAM prototypes of this study, took place in naturally existing schools. Authentic research situations were used to test the expected practicality and expected effectiveness of the material. This iterative process of design and formative evaluation between users (teachers and students) and the researcher, which occurred in the ordinary classroom environment, has enabled the researcher to observe the main characteristics of the prototypes in action and to suggest timely improvements. The findings of the prototyping process in particular, and those of the demonstration experiments in general, have shed light on several issues related to classroom assessment, namely: (i) the time needed within the curriculum to accomplish the tasks; (ii) the classroom managerial aspects like grouping and assessment of students; (iii) the practicality of the POE strategy; and (iv) the role of teachers and students during the experiments. Drawing from experiences of previous studies carried out in different areas and contexts, the author of this study claims that it is acceptable to assume that, by supporting teachers in designing and trying out assessment prototypes in one type (performance assessment) and in a given context (laboratory setting), it will be possible to see teachers transfer their knowledge and skills to other assessment practices and contexts.

Furthermore, the collaborative element has also been beneficial in this study. The involvement of teachers, school directors and policy-makers (pedagogical officers and assessment specialists) in the various stages of the study had the advantage of accommodating the teachers' needs in the assessment materials and of raising the decision makers' awareness on the importance of incorporating these needs into curriculum review process and teacher training programmes.

Finally, it would be misleading to suggest that the role of the researcher during the study was consistent and went unnoticed, particularly in the intervention phase. When the researcher started his research, he assumed the role of the designer who developed the data collection instruments and the first version of the PAM prototypes. During the formative evaluation of this and the subsequent versions, he acted as co-developer with teachers and expert appraisers, a position that led to designer-researcher. In the classroom tryout of the material, this role diminished considerably giving way to a participant-observer playing more the role of task facilitator. As the designer, the researcher aimed at developing high quality materials, as facilitator at ensuring that teachers are adequately introduced to the intervention, and as researcher at being objective. These multiple roles not only brought benefits but also some practical problems. An example of a problematic situation was when students asked for clarification of how to conduct a certain experiment properly. It was compromising for the researcher to help students while maintaining his role as researcher. Being constantly aware of the potential bias of these multiple roles, the researcher had to rely on the informed opinions of critical outsiders amongst the experts, supervisors and colleagues within the Faculty of Education at UEM. In fact, in order to reduce these dilemmas, van den Akker (2002) suggests the use of multiple methods and sources of data collection, and discussions with many parties involved in the development process. This means that the perceptions and interpretations of the events by the researcher were shaped by the triangulation of multiple data collection methods (evaluation questionnaires, interviews, classroom observations) and various sources of information (teachers, students, school directors, educational officers, university students) representing multiple perspectives, which prevented bias in the interpretation of data and the analysis of findings from the development process (Krathwohl, 1998).

Overall, it can be concluded that the combination of the survey and the educational design research approaches added value to the research community in Mozambique. An informed intervention aimed at improving assessment practices involving potential users in real situations was undertaken on the basis of a needs assessment. This was crucial for the improvement of the ecological validity of the study findings (Cohen et al., 2000).

Section 7.3 presents the conclusions of the study resulting from the reflection about the findings.

7.3 Conclusions of the study

The aim of this study was to investigate and improve assessment practices in Physics used by secondary school teachers in Mozambique. Specifically, the study intended to investigate how assessment practices of teachers can be improved, with a focus on Grade 12 Physics. Methodologically, to address this aim a twofold approach was employed. An Intervention Study consisting of development and tryout of consecutive prototypes of assessment practices for Physics teachers undertaken in the context of demonstration experiments. But, prior to the intervention, a survey intended to achieve a good understanding of what was actually going on in the classroom in terms of types, quality and relevance of assessment practices used by teachers, was conducted. Based on findings obtained from various data collection instruments and drawing from reflections of the literature review, the conclusions listed below are presented and discussed.

1. Basic assessment practices undertaken by Physics teachers in Mozambican secondary schools appeared to be of poor quality and there is a need for improvement.

During the Baseline Survey, a large number of teachers could not provide answers to some of the assessment practices due to their apparent poor understanding or lack of knowledge. They showed lack of understanding between what they do in the classroom and what they were actually being asked by the researcher. One of the evidences of the teachers' lack of understanding of most of assessment practices are expressed by the teachers' claim that students can not assess their work or that of their peers (peer-assessment) because they are in school to study and could give each other

low marks (refer to Chapter 5, subsection 5.2.1). More evidence of teacher lack of understanding was shown by the inconsistencies in teacher responses from the questionnaires to the interviews (see Chapter 5, Table 5.1). Very often, teachers contradicted themselves from one data collection instrument to another and when questioned, it appeared that the lack of knowledge and understanding was the cause for this. The amount of missing data in the questionnaire also reflected teachers' unfamiliarity with basic assessment practices.

An analysis of the way teachers assessed some of the student activities also expressed how low was the validity, in terms of content, of the teacher assessment (refer to Chapter 5, subsection 5.2.2). For instance, at the question of *how often teachers assess student activity of solving problems*, some of the teachers interpreted the meaning of 'solving problems' as finding answers of some questions using calculations while, for the context of this study, it referred to generate solutions of real-world problems. Furthermore, although there were positive aspects of feedback provision (articulation, timeliness, and personalisation), generally spoken, there was a lack of input given to students in order to empower their learning.

During the intervention study, teachers also seemed to have difficulty in both reporting experimental results and evaluating student performance in demonstration experiments (refer to Chapter 6, subsection 6.3.4). Although the experiment report template contained guidelines on what to include in each section, teachers focused their attention more on student manipulative skills than other investigative skills. Student ability to communicate the results of their experiments was also not dealt with by the teachers because teachers, like their students, lacked investigative skills. It can then be concluded that teachers in schools are conducting most of the basic assessment practices with limited knowledge and skills about assessing effective student learning.

2. Developing and applying exemplary assessment materials has the potential to improve performance assessment practices associated with demonstration experiments in Physics.

Despite all the problems with teacher assessment in schools, the findings of this study have shown that it is possible to develop a potential solution for the assessment of student learning, particularly for Physics. Training teachers in designing exemplary lesson materials and supporting them with the materials, which includes an assessment

component, is essential for the improvement of both teaching and learning. Physics is, by nature, an experimental subject in which effective learning can only take place if students are required to perform real-world tasks that demonstrate meaningful application of essential skills and knowledge. According to research (Airasian, 2000; Moskal, 2003; Popham, 2002), one of the most successful assessment practices in Science education is performance assessment, because of its crucial role in assessing performance tasks. Still according to research, an effective performance assessment for experimental subject like Physics is most likely to succeed when it is undertaken in a laboratory context, where students can perform real demonstration experiments. During the classroom tryout, teachers and students were positive about demonstration experiments (refer to Chapter 6, subsection 6.3.4). It emerged that experiments allow students to develop their own explanations of the events they observe and to draw informed conclusions. The Predict-Observe-Explain (POE) strategy, associated to the experiments, not only enhance student learning of Physics but also add an element of motivation and enjoyment because *“starting any experiment by making your own prediction of the event is so fascinating that you never forget the results of the comparison (...)”*. However, two elements appear to be relevant in addressing the improvement of demonstration experiments, namely: time spent during preparation and execution of experiments and class sizes. Experiments were described as being time consuming and they can be difficult to conduct in large classes if adequate class management strategies are not adopted.

In conclusion, these study’s findings indicate that performance assessment, when conducted in the context of demonstration experiments, represents a potential solution to the poor quality of teacher assessment practices in schools. It appeared to be one of the most successful means of assessing students learning of Physics and one may expect that the same approach will work for other subjects and other assessment strategies.

3. Exemplary assessment materials containing specific guidelines appear to be essential to support teachers’ effective practice.

One of the most challenging problems faced by teachers in Mozambique is the availability of support materials for teaching and the limited access to libraries, especially in schools located outside Maputo. Good curriculum materials and effective

teacher training programmes may fail to produce impact in teaching and learning in schools due to the lack of supplementary lesson materials. Intervention studies in Science education conducted internationally (see Chapter 3, Section 3.5) have shown the importance of developing exemplary support lesson materials for teachers. These materials not only support teachers in aspects like subject knowledge, lesson preparation, teaching methodology, assessment and feedback, but also help students to construct their own knowledge. Characteristics of such materials are that they should be (i) based on the objectives of curriculum, (ii) developed from materials teachers are already using, (iii) made to engage students, support curriculum implementation, improve student teaming, and to report individual student progress, and (iv) made to help teachers adopt a student-centred approach.

Despite the importance of the specifications in the materials, it is important, however, to indicate that empirical evidence has shown that teachers feel uncomfortable working with lengthy materials and, therefore, they should be designed to be user-friendly (refer to Chapter 6, subsection 6.3.4). In this study, assessment materials not only contained the characteristics described above, but also had specific guidelines on how teachers can design and conduct performance assessment in the context of demonstrations experiments following the POE strategy. Specifically, the materials provided teachers with specifications on components and functions of assessment including a practice-oriented lesson plan (Appendix P, Part 2), on designing assessment practices and providing feedback (Part 3), and on conducting demonstration experiments and assessing student performance (Part 4). The participating teachers reported that, after the demonstration experiments their awareness and skills in designing and conducting experiments were enhanced. In fact, there are indications that demonstrate teacher learning from these experiments. Classroom observations conducted with teachers after the intervention, and results from the evaluation workshop, indicated that their lesson preparations (e.g., lesson plans and organisation of the materials and equipment) following specific suggestions from the exemplary PAM materials had improved significantly (refer to Chapter 6, Section 6.5). Study findings also revealed that the involvement of teachers in developing assessment materials appears to improve their confidence and their ability to think critically. Therefore, exemplary materials with detailed specifications on how

to design and use different parts of the lessons – including assessment - appear to be one possible solution to address the problem of poor teacher assessment practices.

4. The study findings from Mozambique confirm what the international literature has indicated in relation to effective classroom assessment practices.

Findings from this study confirm what international literature says and what previous studies have found in relation to classroom assessment practices in more developed contexts. An example of this is found in the role of both teachers and students in formative assessment. There is evidence from this study that formative assessment is a process requiring a close interaction between the teacher and the students (refer to Chapter 6.3.4). During the demonstration experiments, when students were asked to indicate the difference between the demonstration experiments based on PAM materials and their regular Physics laboratory lessons, they referred to the fact that the lessons in the tryout, were closely facilitated by the teacher and were accompanied by worksheets with detailed instructions on how to do things. In this regard, one student said: *“In our regular laboratory lessons the teacher would simply tell us what needs to be done and wait to see whether or not we managed to reach the desired outcome (...)”*. For the demonstration experiments to be successful, the teacher had to guide students on the POE strategy, i.e., on how to predict the behaviour of the events, how and what to actually observe during the experiments, and how to reconcile the predictions and the observations. In so doing, students had to use the information they acquired during learning to draw conclusions about their observations. This is line with what Black et al., (2003) report about formative assessment – a process in which information about learning is evoked and then used to improve the teaching and learning activities in which teachers and students are engaged.

Another example is related to the time involved in developing and trying out exemplary materials. This study showed that teachers needed more time to conduct effective demonstration experiments and to provide formative feedback to all students given the context of large classes (refer to Chapter 6, Table 6.6). The time was revealed as problematic in other intervention studies conducted elsewhere. Motswiri (2004) calls it lack of congruence of the exemplary materials where the intended practice appeared to be incongruent with the teachers’ current practice. Tecele (2006) refers that, in her study, teachers were observed encountering problems with group

work activities throughout the tryouts and the issue of time continued to be problematic. Ottevanger (2001) argued that, although teachers seemed to address the time issue in their own ways, this appeared to be a continuous problem in completing lessons.

5. Research only conducted in Maputo cannot be generalised to the rest of the country.

Research findings of this study cannot be generalised to a wider perspective, i.e., nationwide. Two aspects are the reasons for this. Firstly, although the sample of the Baseline Survey was drawn to meet a maximum variation in its representation across the country, library facilities and other teaching conditions in schools countrywide tend to decrease and worsen the further when one moves away from Maputo. This situation had implications on the way teachers perceived the various data collection instruments and interpreted the different assessment related concepts and practices within them. As a result, some teachers' responses lacked consistency as referred to in Chapter 5 (Section 5.2). Secondly, only the second version of the PAM materials designed in this study was tried out with potential users in the classroom. Whether the characteristics of the final version (Version 4) of the material will produce effective improvements on the way teachers conduct performance assessment is a point to be proven. As Yin (1994) points out, the generalisability, beyond the investigated teachers and students, of the study findings similar to the one reported in this dissertation, can only be made if several replications of intervention findings are undertaken in more tryouts and with more users (refer to Chapter 4, Section 4.4).

7.4 Recommendations

This study has shown the way teacher assessment practices in the context of Physics demonstration experiments can be improved, employing an educational design research approach. The study findings have partially confirmed results from earlier studies about the nature of design and formative evaluation of assessment materials and the potential difficulties inherent in teacher participation in formative evaluations. This final section ends by providing some recommendations formulated from three perspectives namely (i) policy and practice, (ii) further research, and (iii) further

development work. Some of these recommendations are based on the findings drawn from the study while others result from the researcher's professional experience.

7.4.1 For policy and practice

- A relevant conclusion of this study is that Physics teachers in secondary schools have limited knowledge and skills to conduct effective classroom assessments. The implication of this fact is that these teachers need support in designing and using appropriate and relevant assessment practices as well as in identifying effective assessment approaches. It is then worthwhile to recommend that the MEC and teacher training institutions promote the up scaling of Physics teacher knowledge and skills in this respect within an in-service mode to allow teachers to benefit from training while they are working.
- Promoting an effective in-service training for teachers in schools implies having exemplary support assessment materials which can help teachers not only to prepare and conduct lessons but, more importantly, to monitor student learning. But these materials, as argued by the literature (Mafumiko, 2006; Motswiri, 2004; Tecele, 2006), and supported by study conclusions, have the potential to improve teaching and learning if they are designed by the teachers themselves (refer to conclusion nr. 2). In this context, it appears to be relevant that teachers are trained on developing exemplary assessment materials for their own use in schools. This can be done in the form of regular workshops with teachers of the same school or of different schools during selected days of school vacations or over weekends. It is, however, important to note that exemplary PAM materials alone are not sufficient to support teachers in conducting demonstration experiments and, hence, improve their assessment practices. Incorporating the materials into teacher training programmes is desirable. For instance, in-service education can provide teachers with the opportunity to interact with the material, to clarify related theories, to practise and demonstrate the intended innovation. Short-term in-service courses for selected teachers and assignments for them to read and discuss can be used to promote this purpose.



- As already discussed in Chapter 6 (Table 6.6) and acknowledged in the conclusions of the study (refer to conclusion nr. 4), the two participating teachers in the classroom tryouts of the PAM prototypes expressed concerns related to the time needed to conduct the experiments following the POE strategy. The high number of students per class, which makes the supervision of all students a daunting exercise, worsens the problem. It then seems to be relevant for the Ministry of Education and Culture to reconsider the time allocated for Physics lessons within the Grade 11 and 12 Syllabus especially for the so-called ‘practical lessons’. The on-going process of curriculum review is an excellent opportunity to embed the change.
- Another concern mentioned by teachers, particularly during the evaluation workshop, is the limited capacity of teachers and schools when it comes to the reproduction of student worksheets and teachers’ guides. If the Ministry of Education and Culture is to accommodate the implementation of the PAM materials, school budgets and the existing system of cost sharing with Parents’ Councils need to be addressed and revised. This means that the implementation in schools should not be left to the teachers alone.

7.4.2 For further research

- The main purpose of this study, as stated in Chapter 1 (Section 1.1), was to investigate and improve assessment practices used by secondary school Physics teachers in Mozambique. The teaching and learning process, however, is inherently an iterative endeavour, involving two main agents, namely teachers and students. Thus, from this perspective there is a need for other studies to be undertaken so that these assessment practices can also be investigated and improved from the students’ perspective. The constructivist approach advocated by this study rests on cognitive principles according to which knowledge is not received passively but actively built up by a cognising subject. This means that student epistemologies exert influence in the way they are likely to perceive and approach knowledge (Sitoe, 2006).



- This study involved one tryout of the experimental materials (Version 2 of the prototypes) with two teachers and their students. From empirical point of view this activity cannot be sufficient for concluding that the PAM materials are practical and effective. As has been emphasised in previous chapters, the emphasis of the intervention was put on investigating the expected practicality and expected effectiveness of the material in terms of their potential to improve teacher assessment practices through experts and not via empirical testing. Further research is needed to prove the actual practicality and effectiveness of the materials.
- Any process of implementation of innovation takes time, and research is needed to explore changes in and of the process. According to a model by Hall and Hord (2001) there are some elements which play a role in the change process namely, the change facilitators who provide assistance, the individuals who implement the change and the resource systems from which support is drawn. Facilitators can probe the change and the results can be used to match resources with the users' needs. As discussed in Chapter 6, it appears that there are short-term impacts of the PAM materials on both teachers and students. It may be interesting to investigate the long-term impacts of the intervention particularly related to the use of the POE strategy in assessing student learning, and on teacher familiarity with formative assessment.
- Guskey (2000) explains that educational innovations sometimes have a counter-productive effect on those who implement them, particularly when they oppose the existing policies. This could be the case with this study from the perspective of the teachers if, for instance, some teachers recruited by the Ministry are not familiar with formative assessment materials and with the use of the learning evidence to feed the teaching process. Teachers attempting to implement the innovation may discover that certain colleagues contradict their efforts. Therefore, conflicting or supportive environmental factors are important aspects to be researched further.

- The level of access to teaching and learning materials including library facilities has proven to be difficult for teachers in Maputo and those of other parts of the country. Teachers working outside Maputo are more in short supply of support materials for their work than their colleagues from Maputo. This was reflected by the difficulties that teachers from the provinces other than Maputo had on understanding and interpreting data collection instruments and assessment related concepts. These difficulties did not emerge during the pilot process of the instruments with Maputo teachers. This fact implies perhaps that, for future studies, despite all logistical and financial constraints involved in conducting research countrywide, data collection instruments need to be piloted in other parts of the country to allow that all potential teacher difficulties are totally uncovered and timely addressed.

7.4.3 For further development work

- When designing and developing demonstration experiments, special attention needs to be paid to the *time* required to address student questions and difficulties in order to reflect on unforeseen issues, and on *class management*, given the fact that the majority of schools are characterised by overcrowded classrooms.
- The effect of innovations and changes on student learning takes time because learning outcomes are also influenced by some other factors taking place outside school environment. Demonstration experiments, like the ones reported in this study, alone cannot produce improvements in teacher assessment practices and consequently in student learning outcomes, unless the educational system is supportive enough to accommodate, for instance, the findings in teacher training programmes. Furthermore, parents, peers and the media influence the way students are actually learning. This means that in future an evaluation study using, for instance, achievement tests could help determining the extent to which demonstration experiments could ultimately have impacted on student learning.



- The POE strategy suggested by this study requires collective and individual observation, reflection, and the reconciliation of ideas. A complete and sound sequence of these events is only successful if all students are engaged. So, advice on how to deal with large classes is a challenge that needs to be carefully addressed in future studies.

Although the findings of this study indicate that the most frequently used assessment practices in Mozambican schools are paper-and-pencil tests, verbal tests, and homework, while projects, portfolios, and peer-assessments are the less used ones, a critical need for the improvement of teacher skills in designing and utilising assessment practices specially those required for science subjects such as Physics has been highlighted. Curriculum review by the MEC should further emphasise the need for assessment to become an integral part of teaching and learning, as a planned process of identifying, gathering and interpreting information about the performance of students, which would have a positive effect on the education system.

Effective teaching and learning can only take place if assessment practices are being implemented effectively as part of this teaching process. This is very true in Mozambique where teachers have many challenges to deal with both within the community and the classroom. The role of Physics education and more broadly Science education is critical to the development and economy of Mozambique and therefore it is of utmost importance to obtain effective teaching (including assessment) and learning practices across the entire country in this domain. This can only happen if the researchers, policymakers and practitioners combine and share their expertise.