

## **CHAPTER 2:** **THE CONDUCT OF THE SACMEQ II PROJECT**

Kenneth N. Ross, Mioko Saito, Stephanie Dolata, Miyako Ikeda, Linda Zuze,  
Saul Murimba, T. Neville Postlethwaite, and Patrick Griffin

### **Introduction**

There has been a worldwide growth of interest in the application of large-scale scientific survey research techniques to the study of issues related to improving the quality of education. Many developed countries are now applying these techniques to undertake systematic studies of the conditions of schooling and of student achievement levels. In developing countries there have been increased efforts to provide training for educational planners in the technical skills that are required to conduct these kinds of policy research studies.

In 1991 the International Institute for Educational Planning (IIEP) and a number of Ministries of Education in Southern and Eastern Africa began to work together in order to address training and research needs in this area. The focus for this work was on establishing long-term strategies for building the capacity of educational planners to monitor and evaluate the quality of their basic education systems.

In 1993 a proposal was prepared by a group of educational planners (Moyo et al., 1993) that aimed to extend the reach and formal status of this work by creating an association known as the Southern Africa Consortium for Monitoring Educational Quality (SACMEQ). The proposal received a positive reaction from Ministries of Education, and in 1995 SACMEQ was officially launched with the generous assistance of the Governments of Italy and the Netherlands. Fifteen Ministries of Education are now members of SACMEQ: Botswana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania (Mainland), Tanzania (Zanzibar), Uganda, Zambia, and Zimbabwe. The IIEP was invited to become a member of the consortium in 1997.

SACMEQ's main mission is to undertake integrated research and training activities that will: (a) expand opportunities for educational planners to gain the technical skills required to monitor and evaluate the general conditions of schooling and the quality of basic education, and (b) generate information that can be used by decision-makers to plan improvements in their education systems.

The SACMEQ consortium has enabled educational researchers and planners to develop important technical skills related to the design and implementation of large-scale data collections, and to the application of a wide variety of computer-based techniques for the preparation, management, analysis, and reporting of educational planning data. SACMEQ's research programme has resulted in the preparation of research reports that have contributed towards the conduct of informed debates concerned with: equity in the allocation of human and material resources among regions and schools, and literacy and numeracy levels for important sub-groups of pupils defined by gender, socio-economic background, and geographic location.

The first two educational policy research projects undertaken by SACMEQ (widely known as "SACMEQ I" and "SACMEQ II") were designed to provide detailed information that could be used to guide planning decisions aimed at improving the quality of education in primary school systems. During 1995-1998 seven Ministries of Education participated in the SACMEQ I Project and the results of this research were reported in a series of national policy reports (Kulpoo, 1998; Machingaidze et al, 1998; Milner et al, 2001; Nassor and Ali Mohammed, 1998; Nkamba and Kanyika, 1998; Nzomo et al, 2001; Voigts, 1998). Technical information about the sampling, instrument construction, and field work for the SACMEQ I Project may be found in these reports.

The SACMEQ II Project commenced in 1998 and has involved 15 Ministries of Education. Moving from the SACMEQ I Project (covering around 1100 schools and 20,000 pupils) to the SACMEQ II Project (covering around 2500 schools and 45,000 pupils) resulted in a major increase in the scale and complexity of SACMEQ's research and training programmes.

The main purpose of this chapter was to provide a detailed account of the key technical procedures that were involved in the design and implementation of the SACMEQ II Project.

The chapter has been presented in three parts.

Part A: "The Fourteen Main Phases of the SACMEQ II Project"

This part of the chapter has listed the fourteen main phases of the SACMEQ II Project. These commenced with pre-planning and initial planning, and then moved through instrument construction, trial testing, sampling, main data collection, data preparation, data merging and scoring, data analyses, and concluded with the writing of national policy reports.

Part B: "Sample Design Procedures for the SACMEQ Project"

This part of the chapter has provided a detailed explanation of the procedures involved in the selection of samples of schools and pupils for the SACMEQ II Project. The sampling procedures were evaluated through an examination of response rates and the calculation of design effects, effective sample sizes, and standard errors of sampling.

Part C: "The Construction of Tests for the SACMEQ II Project"

This part of the chapter has presented the main steps that were involved in test construction for the SACMEQ II Project, and then has examined the advanced scaling procedures that were used to score the tests and to describe pupil and teacher literacy levels according to increasing "levels of competence". Eight levels of competence were developed for the literacy and numeracy measures, and these represented a departure from "traditional approaches" (based on means and mastery percentages) to describing and comparing the educational performance of groups.

## **Part A: The Fourteen Main Phases of the SACMEQ II Project**

### **Phase 1: “Pre-Planning” for the SACMEQ II Project**

One of the distinguishing features of the SACMEQ Projects has been that their research results have been widely used for policy and planning purposes. This successful outcome has occurred because SACMEQ research reports were designed from the very beginning to address the high-priority policy concerns of decision-makers in Ministries of Education. **This was achieved via a three-step “pre-planning” process (described below for the SACMEQ II Project) that was completed before work commenced on the overall design and implementation of the research.**

**Step 1:** The SACMEQ II Project commenced by engaging senior decision-makers in Ministries of Education (for example, Ministers, Permanent Secretaries, Heads of Divisions, and Regional Directors) in discussions about high-priority policy concerns associated with their education systems. The SACMEQ National Research Coordinators (NRCs) structured these discussions by asking the decision-makers to identify the main areas where the Ministry needed to review, refine, change, monitor, and/or develop policies that had relevance for the general conditions of schooling and the quality of education. The decision-makers’ responses were then analyzed in order to identify groups of **”General Policy Concerns”** that were subsequently used as a foundation for guiding the research design.

For example, decision-makers in most SACMEQ countries were concerned about policy issues linked with: (a) equity in the gender balance and home background profiles of Grade 6 pupils, and (b) the magnitude of the age range of Grade 6 pupils and its implications for teaching and learning. The NRCs summarized these and similar concerns in the form of a single question: “What are the personal characteristics (for example, age and gender) and home background characteristics (for example, books at home and parent education) of Grade 6 pupils that might have implications for monitoring equity, and/or that might impact upon teaching and learning?” This question represented the first General Policy Concern developed by the NRCs for the SACMEQ II Project.

A total of 20 General Policy Concerns were prepared for the SACMEQ II Project. These have been grouped in Figure 2.1 under five “themes” concerned with: pupils’ characteristics and learning environments, teachers’ characteristics and viewpoints, school heads’ characteristics and viewpoints, equity in the allocation of human and material resources, and the reading and mathematics achievement levels of pupils and their teachers.

**Step 2:** The NRCs linked each of the 20 SACMEQ II General Policy Concerns to a set of **“Specific Research Questions”** that provided precise guidance concerning the information that was required in order to respond to the General Policy Concerns. That is, the Specific Research Questions were used to decide exactly what should be included in, or excluded from, the data collection instruments.

## **Theme A: Pupils' Characteristics and Their Learning Environments**

**General Policy Concern 1:** What were the personal characteristics (for example, age and gender) and home background characteristics (for example, parent education, regularity of meals, home language, etc.) of Grade 6 pupils that might have implications for monitoring equity, and/or that might impact upon teaching and learning?

**General Policy Concern 2:** What were the school context factors experienced by Grade 6 pupils (such as location, absenteeism (regularity and reasons), grade repetition, and homework (frequency, amount, correction, and family involvement)) that might impact upon teaching/learning and the general functioning of schools?

**General Policy Concern 3:** Did Grade 6 pupils have sufficient access to classroom materials (for example, textbooks, readers, and stationery) in order to participate fully in their lessons?

**General Policy Concern 4:** Did Grade 6 pupils have access to library books within their schools, and (if they did have access) was the use of these books being maximized by allowing pupils to take them home to read?

**General Policy Concern 5:** Has the practice of Grade 6 pupils receiving extra lessons in school subjects outside school hours become widespread, and have these been paid lessons?

## **Theme B: Teachers' Characteristics and their Viewpoints on Teaching, Classroom Resources, Professional Support, and Job Satisfaction**

**General Policy Concern 6:** What were the personal characteristics of Grade 6 teachers (for example, age, gender, and socio-economic level), and what was the condition of their housing?

**General Policy Concern 7:** What were the professional characteristics of Grade 6 teachers (in terms of academic, professional, and in-service training), and did they consider in-service training to be effective in improving their teaching?

**General Policy Concern 8:** How did Grade 6 teachers allocate their time among responsibilities concerned with teaching, preparing lessons, and marking?

**General Policy Concern 9:** What were Grade 6 teachers' viewpoints on (a) pupil activities within the classroom (for example, reading aloud, pronouncing, etc.), (b) teaching goals (for example, making learning enjoyable, word attack skills, etc.), (c) teaching approaches/strategies (for example, questioning, whole class teaching, etc.), (d) assessment procedures, and (e) meeting and communicating with parents?

**Figure 2.1:** SACMEQ II: General Policy Concerns of Ministry Decision-Makers

**General Policy Concern 10:** What was the availability of classroom furniture (for example, sitting/writing places, teacher table, teacher chair, and bookshelves) and classroom equipment (for example, chalkboard, dictionary, maps, book corner, and teacher guides) in Grade 6 classrooms?

**General Policy Concern 11:** What professional support (in terms of education resource centres, inspections, advisory visits, and school head inputs) was given to Grade 6 teachers?

**General Policy Concern 12:** What factors had most impact upon teacher job satisfaction?

**Theme C: School Heads' Characteristics and their Viewpoints  
on Educational Infrastructure, the Organization and Operation of Schools,  
and Problems with Pupils and Staff**

**General Policy Concern 13:** What were the personal characteristics of school heads (for example, age and gender)?

**General Policy Concern 14:** What were the professional characteristics of school heads (in terms of academic, professional, experience, and specialized training)?

**General Policy Concern 15:** What were the school heads' viewpoints on general school infrastructure (for example, electrical and other equipment, water, and basic sanitation) and the condition of school buildings?

**General Policy Concern 16:** What were the school heads' viewpoints on (a) daily activities (for example, teaching, school-community relations, and monitoring pupil progress), (b) organizational policies (for example school magazine, open days, and formal debates), (c) inspections, (d) community input, (e) problems with pupils and staff (for example, pupil lateness, teacher absenteeism, and lost days of school)?

**Theme D: Equity in the Allocation of Human and Material Resources  
Among Regions and Among Schools Within Regions**

**General Policy Concern 17:** Have human resources (for example, qualified and experienced teachers and school heads) been allocated in an equitable fashion among regions and among schools within regions?

**Figure 2.1 (Ctd): SACMEQ II: General Policy Concerns of Ministry Decision-Makers**

**General Policy Concern 18:** Have material resources (for example, classroom teaching materials and school facilities) been allocated in an equitable fashion among regions and among schools within regions?

**Theme E: The Reading and Mathematics Achievement Levels  
of Pupils and Their Teachers**

**General Policy Concern 19:** What were the levels (according to descriptive levels of competence) and variations (among schools and regions) in the achievement levels of Grade 6 pupils and their teachers in reading and mathematics – for my country and for all other SACMEQ countries?

**General Policy Concern 20:** What were the reading and mathematics achievement levels of important sub-groups of Grade 6 pupils and their teachers (for example, pupils and teachers of different genders, socio-economic levels, and locations)?

**Figure 2.1 (Ctd):** SACMEQ II: General Policy Concerns of Ministry Decision-Makers

For example, three of the Specific Research Questions linked to the first General Policy Concern were: “What is the age distribution of pupils?” “What is the gender distribution of pupils” and “What is the level of parents’ education?” These questions implied that the pupil questionnaire should collect information about pupil age, gender, and the educational level of pupils’ parents.

**Step 3:** The NRCs used the SACMEQ II Specific Research Questions to design “**Dummy Tables**” – which were blank (or empty) data tabulation templates that employed the variables and information layouts that would be used in the final SACMEQ II national policy reports.

The main advantages of producing Dummy Tables were that this process forced the NRCs to (a) check that the data collection instruments covered all information needs, (b) ensure close linkages between the specific research questions and the questions on the data collection instruments, (c) reach agreement on the selection of variables and the types of data analyses to be applied, and (c) design and justify the data tabulation templates to be used in reporting the data analyses.

In Figure 2.2 an example of moving through the above three steps has been presented – starting with the first General Policy Concern developed for the SACMEQ II Project, then moving to a set of Specific Research Questions, and finally arriving at a suitable Dummy Table. The table shown in Figure 2.2 only covers information related to the six Specific Research Questions that have been presented in bold type. A different table was developed for the other six Specific Research Questions.

### **General Policy Concern 1**

**What were the personal characteristics (for example, age and gender) and home background characteristics (for example, parent education, regularity of meals, home language, etc.) of Grade 6 pupils that might have implications for monitoring equity, and/or that might impact upon teaching and learning?**



### **Specific Research Questions**

**What was the age distribution of pupils?**

**What was the gender distribution of pupils?**

**How regularly did pupils eat meals?**

**How far did pupils travel to school?**

**What percentage of pupils spoke the language of the test at home?**

**What was the level of the parents' education?**

**What support did pupils get at home regarding homework and interest in schoolwork?**

**Did teachers ask parents to sign that homework assignments have been completed?**

**Where did pupils live during school days, i.e., when school is on?**

**How many books were there in pupils' homes?**

**What access to reading materials and electronic media did pupils have in their homes?**

**What was the socio-economic status of pupils' parents?**



### **First Dummy Table for General Policy Concern 1**

**Dummy Table :**      Grade 6 Pupil Age, Gender, and Home Background Characteristics

<b>Region</b>	<b>Age</b> (months)		<b>Gender</b> (pupils)		<b>Books</b> <b>at Home</b> (books)		<b>Possessions</b> <b>at Home</b> (index)		<b>Meals</b> (index)		<b>Parent</b> <b>Education</b> (index)	
	Mean	SE	%	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Region 1												
Region 2												
Region 3												
Region 4												
Region 5												
Region 6												
Region 7												
Region 8												
<b>Nation</b>												

Variable Names for SACMEQ I = XPAGEMON, XPSEX, XPBOOKSH, XPTOTP, XPREGME, XPFAMOED.  
Variable Names for SACMEQ II = ZPAGEMON, ZPSEX, ZPBOOKSH, ZPTOTP, ZPREGME, ZPFAMOED.

**Figure 2.2:**      An Example of Transforming a General Policy Question into  
Twelve Specific Research Questions and One (of Two) Dummy Tables

The upper section of the Dummy Table in Figure 2.2 was used to name the variables (for example Age, Gender, Books at Home, etc.) and also to provide guidance as to whether the variables were to be based on a single question in the data collection instruments (which was the case for the first three variables), or whether the variables were to be derived from two or more questions to form an “index” (which was the case for the second three variables). In this example, the information in the Dummy Table has been broken down by administrative regions - which was a popular approach because most SACMEQ school systems operated on the basis of some form of regional administration.

Each variable in the table was linked with “statistics” and “units”. For example, the Age variable was expressed as a mean and the units were months, the Gender variable was expressed as a percentage and the units were pupils, and Books in the Home was expressed as a mean and the units were books. The statistics for the final three variables were “indices” and therefore the units depended on the procedures used in their construction. Some indices, such as “Possessions at Home”, were based on a simple count generated from a checklist of possessions, and therefore this index referred to the counted number of possessions. However, other indices (in other tables) were constructed using principal components analysis, and this resulted in “standardized” units of measurement.

The computer-stored names of each variable were listed in the base of each Dummy Table. It was important to include these so that the person responsible for data processing knew exactly which variables to use in the analyses. In the Dummy Table presented in Figure 2.2 the computer-stored variable names have been given for both SACMEQ Projects – indicating that this table needed to be completed twice for the countries that participated in both projects.

In Appendix A the SACMEQ II General Policy Concerns have been listed in association with Specific Research Questions. This list has also included the sequence numbers of the Dummy Tables prepared using either SACMEQ I or SACMEQ II data, and the relevant question numbers in the data collection instruments that were used to collect the required information. The 20 General Policy Concerns were associated with 75 Specific Research Questions, and these were linked to around 150 Dummy Tables.

For example, the first Specific Research Question for the first General Policy Concern was: “What was the age distribution of pupils? From the first page of Appendix A it may be seen that this information was to be entered into Dummy Tables 3.1(a) and 3.1(b) for the SACMEQ I and SACMEQ II Projects, respectively. The source question for this information was the second question on the pupil questionnaires for both the SACMEQ I Project (SI: P2) and the SACMEQ II Project (SII: P2).

## **Phase 2: Moving From Pre-Planning to Instrument Construction**

A meeting of National Research Coordinators (NRCs) was held in Durban, South Africa during April 1998 in order to use the Dummy Tables produced during the “Pre-Planning” phase of the SACMEQ II Project to guide the construction of data collection instruments. Three experienced South African teachers also attended the



meeting in order to participate in sessions concerned with an analysis of the structure, sequence, and content of curricula across countries. The first major decision taken at the meeting was that the data collection for the SACMEQ II Project should be expanded beyond the SACMEQ I Project to include an assessment of both reading and mathematics performance levels for both pupils and teachers.

The meeting operated as two parallel working groups that focussed on test and questionnaire construction. The test construction group completed a comprehensive analysis of the official curricula, school syllabi, textbooks, and examinations that were used in SACMEQ countries. This analysis was used to construct test blueprints as frameworks for writing a large pool of test items for pupils and teachers in both reading and mathematics. The questionnaire group concentrated on using the Dummy Tables to guide the construction of questionnaires for pupils, teachers, and school heads.

By the end of the meeting the following data collection instruments had been drafted: Pupil Reading and Mathematics Tests, Pupil Questionnaire, Teacher Reading and Mathematics Tests, Teacher Questionnaire, and School Head Questionnaire. In addition draft manuals had been prepared for the NRCs and data collectors.

During the meeting the NRCs were invited to make a presentation to a UNESCO meeting of African Ministers of Education that was being held in Durban at the same time. They also attended a special meeting for SACMEQ Ministers of Education in order to discuss the policy impact of SACMEQ research, and to launch the first five SACMEQ I national reports. These events enabled Ministers to gain a much clearer picture of how the SACMEQ research programme could be used for the preparation of policies aimed at improving the quality of education.

After the Durban meeting, work proceeded at the IIEP and within the SACMEQ countries to finalize the overall SACMEQ II Project research design and to complete “try-out” versions of data collection instruments and manuals. These materials were circulated among the NRCs via the Internet and, on the basis of further NRC inputs, edited and then re-circulated for further comment and improvement.

### **Phase 3: “Small-Scale Trial Testing” of Instruments and Manuals**

When the first drafts of the SACMEQ II data collection instruments and manuals had been completed it was agreed to hold a combined planning and training meeting for NRCs and their Deputies in Harare, Zimbabwe during February 1999.

The main purpose of the meeting was to undertake a small-scale “try-out” of the draft data collection materials. To achieve this, a field test was conducted in 10 schools located in a variety of social and geographic situations within a 50 km radius of Harare. The data gathered during this exercise were entered into computers by the NRCs, and then analysed to provide information about the quality of the data collection instruments and the field procedures. On the basis of these analyses further improvements were made to the tests, questionnaires, and manuals.

An important benefit of the “try-out” exercise was that the NRCs were required to act as both data collectors and data entry staff. This gave them first hand experience of the complexities of these two tasks, and also provided them with a sound foundation for training their own research teams for the trial testing and the main data collection.

In the period March to May 1999, the data collection materials tested at the Harare meeting were shared and edited via the Internet. IIEP staff coordinated this "virtual workgroup" approach and arranged inputs from external consultants.

#### **Phase 4: “Large-Scale Trial Testing” of Instruments and Manuals**

The “large-scale trial test” versions of the SACMEQ II data collection instruments were distributed in electronic format via the Internet in June 1999. Paper copies were also distributed to several countries because some NRCs had experienced difficulties with downloading documents in a manner that preserved the integrity of graphical figures and special fonts contained within the tests and questionnaires.

Each NRC was provided with specialized software that could be used to transform the trial test data into computer-readable files. In Lesotho, Malawi, and Swaziland difficulties were experienced in loading and using this software on Ministry of Education computers. An IIEP staff member visited these countries during September 1999 in order to reconfigure the software so that it would operate properly on the available computers. During these visits the NRCs and other Ministry staff were provided with training in computer-based data entry and data cleaning techniques.

The trial testing of the data collection instruments and manuals took place during August-September 1999. More than 400 schools and 8000 pupils were involved in the data collection. During September 1999 these data were entered into computers under the supervision of NRCs and then transmitted via the Internet to the IIEP where they were checked and merged into a single database. At the IIEP a number of validity checks were undertaken on the data, and any errors and/or omissions that emerged were corrected and/or clarified by email communication with the NRCs.

#### **Phase 5: Finalization of Instruments and Manuals for the Main Data Collection**

A meeting of SACMEQ II NRCs and their Deputies was held at the IIEP in October 1999 in order to analyze the trial test data. This meeting was held at the same time as the biennial meeting of the SACMEQ Assembly of Ministers, and the NRCs took advantage of this coincidence by presenting a "Policy Forum" for the Ministers.

The meeting concentrated on analyzing the trial test data that had been collected on reading and mathematics performance from pupils and their teachers. The aim was to select the best possible sets of test items for the main data collection by reducing the two forms of the trial tests for pupils and teachers to single forms.

At the close of the meeting another "virtual workgroup" was established in order to use the Internet during the period October 1999 to May 2000 to finalize the preparation of tests, questionnaires, and manuals. The IIEP agreed to prepare final

forms of the data collection instruments and to distribute these in "camera-ready" electronic and paper formats that would be suitable for immediate printing.

The preparation of the final forms of the data collection instruments and manuals proved to be a massive task because of the different notations used in different countries. For example, changes were made in order to address the use of: (a) a comma or a full stop for decimals, (b) a comma, a full stop, or a space for "separating" digits in numbers greater than or equal to 1000, (c) different currency units, (d) different nomenclature for grade levels, (e) different methods for expressing dates, and (f) 12 hour or 24 hour clocks for time. Since no two countries used exactly the same conventions for items (a) to (f), it was necessary to prepare a unique set of data collection instruments and manuals for each country.

An extra complexity for several countries at this stage was the need to translate the SACMEQ II tests, questionnaires, and manuals into local languages. Mozambique translated the materials into Portuguese, while Tanzania and Zanzibar translated the materials into Kiswahili. In order to ensure high quality translations for the reading and mathematics tests, each item was translated into the local language and then back translated. The back translations were compared with the original (English) versions of the tests in order to check for omissions, additions, unwanted changes in meaning, or other problems.

#### **Phase 6: Sample Design, Sample Selection, and Sample Evaluation**

The sample designs used in the SACMEQ II Project were selected so as to meet the standards set down by the International Association for the Evaluation of Educational Achievement. These standards required that sample estimates of important pupil population parameters should have sampling accuracy that was at least equivalent to a simple random sample of 400 pupils (thereby guaranteeing 95 percent confidence limits for sample means of plus or minus one tenth of a pupil standard deviation unit). Detailed descriptions of the sample design, sample selection, and sample evaluation procedures have been presented in Part B of this chapter.

#### **Phase 7: Preparations for Computer-Based Entry of Data**

After the completion of the SACMEQ II data collection instruments and manuals, work commenced on the preparation of data entry structure files for the full data collection. These computer files provided a complete specification of the nature of the data that were to be entered into computers. Separate structure files were prepared for each country as follows: four tests (pupil and teacher reading and mathematics tests), three questionnaires (pupil, teacher, and school head), and two "tracking forms" (used to gather supplementary data about sample schools and sample pupils).

The SACMEQ II structure files were tested extensively throughout August-September 2000 so as to make sure that they contained the correct specifications for linking each variable with specific questionnaire and test items. This process included the specification of valid ranges for each variable so that "wild-codes" (that is, variable

values that fall outside realistic ranges) could be intercepted as part of the on-going process of data entry.

Separate sets of structure files had to be prepared for each country – even though the same data collection instruments were employed in all countries. This occurred because each country had its own specific valid code ranges, and because some teacher information used for the identification of subject specialities and classes was country-specific.

The validated structure files and copies of the WINDEM data entry and data cleaning software were sent to NRCs during September 2000. These materials were accompanied by instructions on how to load the software and how to access the structure files. Where problems were encountered, the IIEP provided tutorial support via the Internet. By early October 2000 the NRCs had installed and tested all of these materials.

When the WINDEM software and associated structure files were fully operational, each NRC selected and trained a data entry team. This training was provided “on the job” whereby the data enterers were given completed data collection instruments to enter into computers. After the data enterers had completed data entry for the first 100 pupils their work was checked and discussed during a group meeting so as to clarify all instructions and to ensure that everybody was working carefully and accurately. At regular intervals, similar pauses were made in the data entry work in order to monitor progress and to ensure that standards of work were kept at the highest possible level. If a data enterer submitted poor quality work then that person was given extra training or, in occasional cases, was removed from the data entry team.

### **Phase 8: Preparations for the Main Data Collection**

For the main SACMEQ II data collections each NRC was required to organize at least three days of intensive training for the data collectors. This was conducted for most SACMEQ countries in the period July-September 2000 – just prior to the commencement of the main data collection.

Between 15 and 50 data collectors were trained in most countries. On the first day of training the NRC presented a “simulated” data collection exercise in which he/she acted as a data collector and the trainees took the roles of pupils, teachers, and school heads. The second day involved an intensive study of the Manual for Data Collectors. This document set down, in sequential order, all of the actions to be taken by the data collector from the time of receiving packages of data collection instruments from the Ministry of Education to the time when the data collector had completed the data collection and was preparing all materials for return. The third day involved a second “simulated” data collection whereby the trainees supervised a full-fledged data collection in several schools that were not involved in the main data collection. The experiences gathered during these exercises were shared and discussed during a later meeting so that all data collectors understood the procedures to be completed within schools.

A special effort was made to ensure that the data collections were conducted according to explicit and fully-scripted steps so that the same verbal instructions were used (for pupils, teachers, and school heads) by the data collectors in all sample schools in all countries for each aspect of the data collection. This was a very important feature of the study because the validity of cross-national comparisons arising from the data analyses depended, in large part, on achieving carefully structured and standardized data collection environments.

Two other important matters related to preparing for the main data collection were to obtain formal permission to visit sample schools, and to manage the printing and packaging of a complete set of data collection instruments for each sample school. The arrangement of permission to visit sample schools was a straightforward procedure because all Ministers had previously approved the implementation of the SACMEQ II Project.

In some cases the NRCs arranged printing through the Government Printing Office and in other cases through private printers. Some of the NRCs had difficulty in finding the resources required for these tasks and therefore needed to obtain assistance from the IIEP in order to search for supplementary funding. When all instruments were printed, the NRCs conducted a “hand check” of all materials so as to verify that there were no missing pages or misprints or omissions. All work related to the printing and packaging of the data collection instruments was undertaken under strict security arrangements – so that there was no possibility of a “leakage” of information about the content of the pupil and teacher reading and mathematics tests.

The final task for this phase was to have NRCs establish expert committees with the mission of selecting subsets of “essential” pupil reading and mathematics test items that were central to the core curriculum in their country. These subsets of “essential” test items were designated for use at a later stage when the scoring of pupils would be undertaken on both the total test and the essential items (after they had been scaled appropriately using Rasch procedures). This task was completed before the main data collection because there was a need for decisions concerning the selection of essential items to be taken without being influenced by a knowledge of pupil performance on these items. The selection of “essential” reading and mathematics test items for the SACMEQ II Project has been summarized in Appendix B and Appendix C, respectively.

### **Phase 9: Implementation of the Main Data Collection**

The main SACMEQ II data collection occurred for 12 of the 15 SACMEQ Ministries of Education in the period September to December 2000, the Mauritius data collection was completed in July 2001, and the Malawi data collection in September 2002.

The numbers of schools involved in the data collection for each school system ranged from 24 in the Seychelles (where the whole target population of schools and Grade 6 pupils were involved), to 275 in Namibia (where the known magnitude of the coefficient of intraclass correlation and the requirement to gather data in “new” administrative regions added substantially to the required number of schools). The average number of schools per country for the designed samples was around 165.

In smaller countries it was possible to assemble the whole data collection team at the head office of the Ministry of Education and then travel out to sample schools. However, the management of transportation represented a major undertaking for NRCs in larger countries such as Kenya, Namibia, and Mozambique - where much greater distances had to be travelled, and sample schools were sometimes located in extremely remote and difficult-to-find locations. For these countries, the NRCs enlisted the assistance of Regional and District Education Offices.

Two days of data collection were required for each sample school. On the first day pupils were given the pupil questionnaire and the pupil reading test, and on the second day they were given the mathematics test. The teachers (who completed a questionnaire and one of, or both of, the reading and mathematics tests) and school heads (who completed a questionnaire) were asked to respond on the first day. These arrangements made it possible for the data collectors to check all completed questionnaires (pupil, teacher, and school head) during the evening of the first day and then, if necessary, obtain any missing or incomplete information on the second day.

The data collection for teachers was in three parts: questionnaire, reading test, and mathematics test. Where sample teachers taught both reading and mathematics, they took both tests. Where they taught only one of these subjects, they were given the relevant test.

The manual used by the data collectors contained detailed instructions concerning the random selection of 20 sample pupils and up to 6 sample teachers within schools. The data collectors were given intensive prior training in the strict application of these procedures. It was necessary to do this because the validity of the whole SACMEQ II data collection could have been seriously damaged if “outside influences” had been applied to selecting respondents. A further measure that was applied in order to avoid the inclusion of unknown biases into the data collection was to absolutely forbid the replacement of absent pupils.

The data collectors were provided with a 40-point checklist in order to ensure that they completed all important tasks that were required before, during, and after their visits to schools. Each task was cross-referenced to specific pages of instructions in the data collectors’ manual.

## **Phase 10: Data Checking, Data Entry, and Data Cleaning**

### **(a) Data Checking and Data Entry**

Data preparation commenced soon after the main data collection was completed. The NRCs had to organize the safe return of all materials to the Ministry of Education where the data collection instruments could be checked, entered into computers, and then “cleaned” to remove errors prior to data analysis. The data-checking involved the “hand editing” of data collection instruments by a team of trained staff. They were required to check that: (i) all questionnaires, tests, and forms had arrived back from the sample schools, (ii) the identification numbers on all instruments were complete and accurate, and (iii) certain logical linkages between questions made sense (for

example, the two questions to school heads concerning “Do you have a school library?” and “How many books do you have in your school library?”).

The next step was the entry of data into computers using the WINDEM software. A team of 5-10 staff normally undertook this work. In some cases the data were “double entered” in order to monitor accuracy.

The numbers of keystrokes required to enter one copy of each data collection instrument were as follows: pupil questionnaire: 150; pupil reading test: 85; pupil mathematics test: 65; teacher questionnaire: 587; teacher reading test: 51; teacher mathematics test: 43; school head questionnaire: 319; school form: 58; and pupil name form: 51.

This information can be re-expressed to give the total number of keystrokes for the whole body of data for one country by multiplying the above figures by the number of instruments in the final data collection. In the case of Namibia the total number of keystrokes was as follows: pupil questionnaire: 762,600; pupil reading test: 429,080; pupil mathematics test: 328,250; teacher questionnaire: 358,657; teacher reading test: 15,504; teacher mathematics test: 14,061; school head questionnaire: 86,130; school form: 39,150; and pupil name form: 259,284. That is, a total of 2,292,716 keystrokes were required to enter all of the data for Namibia.

An experienced keyboard operator can work at a rate of 25 keystrokes per minute (working from multi-paged questionnaires and stopping occasionally to clarify individual questionnaire entries with the supervisor). Assuming that this kind of work rate could be sustained for, say, around a maximum of six hours per day, then the whole data entry operation for Namibia was estimated to amount to around 255 person days of data entry work. This implied an estimated five weeks of work for the 10 person data entry team that operated in Namibia.

The Seychelles data collection was much smaller than Namibia’s – with an estimated total of only 68 person days of data entry required. However, this implied an estimated seven weeks of work because the Seychelles only had access to a two-person data entry team.

There was a great deal of variation in the delivery dates for the initial versions of the computer-stored SACMEQ II data files. This occurred because of different testing dates and also because of different amounts of time required to complete entry of data into computers. The dates associated with the initial delivery of SACMEQ II data for cleaning have been presented in the second column of Table 2.1. The first data files were delivered by Botswana and the Seychelles in February 2001, and the last were delivered by Malawi in December 2002.

**Table 2.1: Number of Cycles and Amount of Time Required for the Completion of SACMEQ II Data Cleaning.**

<b>School System</b>	<b>Date When Data Arrived</b>	<b>Date When Cleaning Finished</b>	<b>Number of Cleaning Cycles</b>	<b>Number of Months</b>
Botswana	8-Feb-01	5-Dec-01	15	10
Kenya	20-Jun-01	23-Oct-02	24	16
Lesotho	20-Mar-01	25-Jan-02	15	10
Malawi	15-Dec-02	5-May-03	13	5
Mauritius	9-Oct-01	15-Apr-03	11	18
Mozambique	8-Feb-01	27-Jan-03	23	24
Namibia	2-May-01	25-Jan-02	9	9
Seychelles	15-Feb-01	13-Jun-01	5	4
South Africa	9-Mar-01	26-Aug-02	22	18
Swaziland	7-Jun-01	27-Sep-02	14	16
Tanzania	26-Mar-01	19-Nov-02	25	20
Uganda	26-Feb-01	22-Jan-03	31	23
Zambia	23-Jan-01	29-Nov-02	25	22
Zanzibar	15-Jun-01	23-Apr-03	27	22

### **(b) Data Cleaning**

The NRCs received written instructions and follow-up support from IIEP staff in the basic steps of data cleaning using the WINDEM software. This permitted the NRCs to (i) identify major errors in the sequence of identification numbers, (ii) cross-check identification numbers across files (for example, to ensure that all pupils were linked with their own reading and mathematics teachers), (iii) ensure that all schools listed on the original sampling frame also had valid data collection instruments and vice-versa, (iv) check for “wild codes” that occurred when some variables had values that fell outside pre-specified reasonable limits, and (v) validate that variables used as linkage devices in later file merges were available and accurate.

A second phase of data preparation directed efforts towards the identification and correction of “wild codes” (which refer to data values that fall outside credible limits), and “inconsistencies” (which refer to different responses to the same, or related, questions). There were also some errors in the identification codes for teachers that needed to be corrected before data could be merged.

During 2002 a supplementary training programme was prepared and delivered to all countries via the Internet. This training led each SACMEQ Research Team step-by-step through the required data cleaning procedures – with the NRCs supervising “hands-on” data cleaning activities and IIEP staff occasionally using advanced software systems to validate the quality of the work involved in each data-cleaning step.

This resulted in a “cyclical” process whereby data files were cleaned by the NRC and then emailed to the IIEP for checking and then emailed back to the NRC for further cleaning. The figures presented in the final two columns of Table 2.1 show the



number of cleaning “cycles” (that is the number of times that SACMEQ II data were sent from a country to the IIEP for detailed checking and then returned to the country for further cleaning) and the total amount of time in months required to complete the data cleaning for each country.

The number of cycles required to complete all of the data cleaning ranged from lows of 5 and 9 cycles in the Seychelles and Namibia, respectively, to highs of 27 and 31 cycles in Zanzibar and Uganda, respectively. The time required to complete the all of the data cleaning took from lows of 4 and 9 months in the Seychelles and Namibia, respectively, to highs of 23 and 24 months in Uganda and Mozambique, respectively.

### **Phase 11: Merging and Weighting**

As each NRC finalized the cleaning of the SACMEQ II data for his/her country, the data from all sources within a country were merged and weighted.

The merging process required the construction of a single data file for each school system in which pupils were the units of analysis. This was achieved by “disaggregating” the teacher and school head data over the pupil data. That is, each record of the final data file for a country consisted of the following four components: (a) the questionnaire and test data for an individual pupil, (b) the questionnaire and test data for his/her mathematics and reading teacher, (c) the questionnaire data for his/her school head, and (d) school and pupil “tracking forms” that were required for data cleaning purposes.

The merged file enabled linkages to be made among pupils, teachers, and school heads at the “between-pupil” level of analysis. To illustrate, with the merged file it was possible to examine questions of the following kind: “What are the average reading and mathematics test scores (based on information taken from the pupil tests) for groups of pupils who attend urban or rural schools (based on information taken from the school head questionnaire), and who are taught by male or female teachers (based on information taken from the teacher questionnaire)?”

The calculation of sampling weights could only be conducted after all files had been cleaned and merged. Sampling weights were used to adjust for missing data and for variations in probabilities of selection that arose from the application of stratified multi-stage sample designs. There were also certain country-specific aspects of the sampling procedures, and these had to be reflected in the calculation of sampling weights.

Two forms of sampling weights were prepared for the SACMEQ II Project. The first sampling weight (RF2) was the inverse of the probability of selecting a pupil into the sample. These “raising factors” were equal to the number of pupils in the defined target population that were “represented by a single pupil” in the sample. The second sampling weight (pweight2) was obtained by multiplying the raising factors by a constant so that the sum of the sampling weights was equal to the achieved sample size.

## **Phase 12: “Scoring” Literacy and Numeracy Levels**

A particularly innovative aspect of the SACMEQ II Project was its approach to presenting the literacy and numeracy performance of pupils in a manner that provided descriptive accounts of increasing levels of competence. This was made possible through the use of the Rasch scaling procedures - which permitted, for each test, the performance of pupils to be aligned along a single dimension that could be broken into groups or levels – each being named according to the skills required to successfully complete the items within each group. This method of defining reading and mathematics performance moved far beyond the traditional approach of assigning scores based on the number of correct test items.

The traditional approach to describing test performance is of limited use concerning the identification of specific strategies that can be understood by teachers who would like to plan either remediation programmes or performance improvement for their pupils. In contrast, the levels of competence approach provides meaningful descriptive information about the tasks that pupils can currently manage, and the knowledge and skills that pupils require if they are to move to higher levels of competence.

Four main steps were used in the SACMEQ II Project to define levels of competence. First, Rasch Item Response Theory was used to establish the difficulty value for each test item. Second, the NRCs subjected each test item to an intensive “skills audit” (in order to identify the required problem-solving mechanisms for each item “through a Grade 6 pupil’s eyes”). Third, the items were clustered into eight groups or “levels” that had similar difficulties and that required similar skills. Finally, the NRCs wrote descriptive accounts of the competencies associated with each cluster of test items by using terminology that was familiar to ordinary classroom teachers. These four steps have been described in detail in Part C of this chapter.

The work undertaken to define the descriptive levels of competence was commenced at a meeting of NRCs and their Deputies in the Seychelles during June 2001. This work continued via the Internet and was eventually finalized at another follow-up meeting of the same participants that was held in Mauritius during December 2002. The major delay in finalizing this aspect of the work was due to the problem that the scaling of test scores using the Rasch technique required all countries to have completed their data cleaning.

When all data were available, it was possible to transform the Rasch scores to an international mean and standard deviation of 500 and 100, respectively. These two figures were established by using a special sampling weight that treated the samples in each country as if they were the same size.

## **Phase 13: Analysing the Data**

The data analyses for the SACMEQ II Project were very clearly defined because they were focussed specifically on generating results that could be used to “fill in the blank entries” in the Dummy Tables described above. There were two main tasks in this area. First, the SPSS software system was used to construct new variables (often

referred to as “indices”) or to recode existing variables. For example, an index of “socioeconomic level” was constructed by combining recoded variables that described the educational level of the pupils’ parents, the materials used in the construction of pupils’ homes, and the number of possessions in pupils’ homes. Second, the IIEP’s specialized data analysis software, IIEPJACK, was used to “fill” the Dummy Tables with appropriate statistics along with their correct measures of sampling error.

#### **Phase 14: Writing the SACMEQ II Policy Reports**

The NRCs commenced the process of drafting their national educational policy reports during early 2003. Two workshops (in Mauritius in December 2002 and in Paris during September 2003) were organized to support the NRCs in this work. These workshops permitted the NRCs to work together and exchange ideas concerning the policy implications of the research results.

Some sections of the national reports were written as “group tasks” because they described aspects of the SACMEQ II Project research programme that were common across countries. However, the tasks of reporting and interpreting the research results were undertaken on a country-by-country basis.

The general structure of the national reports was common across all SACMEQ countries. The 5 “themes” listed in Figure 2.1 were used as chapter titles, the 20 “General Policy Concerns” listed in Figure 2.1 were used within the chapters as main headings, and the 75 “Specific Research Questions” listed in Appendix A were used as sub-headings.

Throughout each national report the NRCs introduced “policy suggestions” based on the research results. In the final chapter these policy suggestions were drawn together into an “agenda for action” that grouped the suggestions according to timeframe and estimated costs. These ranged from low cost and easy to implement actions (for example: adapting the established School Census Questionnaire to include some questions on the availability of certain school and classroom resources) up to long-term expensive investments (for example: the implementation of a nationwide programme of in-service training for teachers).