Science and Mathematics Education Centre

AN INVESTIGATION OF THE NATURE AND EFFECTS OF THE LEARNING ENVIRONMENT IN AGRICULTURAL SCIENCE CLASSROOMS IN NIGERIA

Suleiman Alhaji Idiris

This thesis is presented as part of the
requirements for the award of the
Degree of Doctor of Philosophy
of
Curtin University of Technology

October 1994

ABSTRACT

This study consolidates a long tradition of research involving the development/adaptation and validation of instruments assessing students' perceptions of psychosocial aspects of their classroom learning environments, and their use in investigating both the effects of classroom environment on student outcomes and determinants of classroom environment. The present study is distinctive, however, in that it is one of the few such studies conducted in Nigeria and the first classroom environment study conducted specifically in agricultural science classrooms.

The sample consisted of 1 175 students in 50 classes in 20 schools in eight states and the Federal Capital Territory. Both the individual student and the class mean were used as units of statistical analysis. The classroom environment instrument assessed negotiation, autonomy, student centredness, investigation and differentiation, and the student outcomes were attitudes, enquiry skills and practical performance.

Each classroom environment scale was found to have satisfactory internal consistency reliability and discriminant validity and to differentiate between the perceptions of students in different classrooms. Statistically significant associations were found between classroom environment and the two student outcomes of attitudes and enquiry skills, but not for practical performance. When classroom environment dimensions were used as dependent variables, significant differences were found between schools with different school-level environments and between schools in forest and savanna regions.

ACKNOWLEDGEMENTS

I would like to thank my Supervisor, Professor Barry Fraser, for his considerable help and guidance throughout the study. Also I would like to thank my Associate Supervisor, Professor Peter Okebukola of Lagos State University, for his input and Trudy Tanner for the help with wordprocessing

TABLE OF CONTENTS

(cont.)

TABLE OF CONTENTS (continued)

(cont.)

TABLE OF CONTENTS (continued)

(cont.)

TABLE OF CONTENTS (continued)

LIST OF TABLES

(cont.)

LIST OF TABLES (continued)

LIST OF FIGURES

Chapter 1

INTRODUCTION

Over the past quarter of a century, a strong international research tradition has involved the assessment of students' perceptions of classroom environment and the investigation of determinants and effects of classroom environment (Fraser, 1989, 1994; Fraser & Walberg, 1991; MacAuley, 1990). The research reported in this thesis consolidates this tradition in that it also involved the development and validation of a classroom environment instrument and its use in investigating both the effects of classroom environment on student outcomes and some determinants of classroom environment. The present study also extended past research by providing one of the few such studies conducted in Nigeria and by providing the first classroom environment study conducted especially in agricultural science classrooms.

This chapter introduces the purposes and background for the study under the following headings:

- Background to the study (Section 1.1);
- Aims of the study (Section 1.2);
- Significance of the study (Section 1.3);
- Overview of this thesis (Section 1.4).

1.1 BACKGROUND TO THE STUDY

According to *Information on Nigeria* published in 1992, the Federal Republic of Nigeria has a land area of 923 773 square kilometres, divided into 30 autonomous states and a Federal Capital Territory (FCT) at Abuja. Nigeria lies wholly within the tropics along the Gulf of Guinea on the Western coast of Africa between latitude 4 degrees and 14 degrees north of the equator, and 3 degrees east of the Greenwich Meridian. The country is bounded on the west by the Republic of

Benin, on the north by the Niger Republic, on the east by the Republic of Cameroon, and on the south by the Atlantic Ocean. Nigeria's mean annual rainfall figures ranges from 300 millimetres at the sahel savanna zone to 3 000 millimetres at the mangrove forest zone, and significantly determine agricultural practices in the vegetation zones. Nigeria's average temperature is 32 degrees Centigrade. When the Federal Government announced the result of the 1991 census, the total population of Nigeria was over 88 million. The population has diverse cultures and traditions, with over 250 tribal/ethnic language groups of which Hausa, Ibo and Yoruba are the three main groups. However, the official language in government and in schools is English. About 75% of the population lives in rural agricultural communities

At its independence in 1960 and a decade and a half later, agriculture has been the main-stay of economic development in Nigeria. In the First (1962-1968) and Second National Development Plans (1970-1974), agriculture accounted for two-thirds of the gross revenue for the country. This is a reflection of the great premium that is placed by the government and people of Nigeria on farming practices. This emphasis is reflected in the priority given to agricultural science in Nigerian schools. In the Third Plan (1975-1980), Universal Primary Education (UPE) was introduced, and this made elementary education compulsory and free for children of school age. The Fourth Plan (1981-1985) was the period when the implementation of a functional secondary education program began and replaced the earlier very academic type. Junior secondary school and agricultural science study are compulsory.

The National Policy on Education was formulated in 1977 (and revised in 1985) to improve the quality of the Nigerian educational system (Federal Ministry of Education, 1977, 1985). The present '6-3-3-4' system of education is organised into six years of primary education, three years of junior secondary education, three years of senior secondary education, and four years of higher education. Emphasis at each educational system is on functionalism and relevance to the goals of social transformation and development of the Nigerian people. Junior

secondary education is both pre-vocational and academic for all pupils completing elementary education.

The intention at the elementary and junior secondary levels is that pupils acquire not only the three 'Rs' but also the three 'Ts', including toil, tolerance and teamwork (Ajeyalemi & Baiyelo, 1990). The academically gifted can proceed to the senior secondary level for mainly academic courses and subsequently to higher education of varying types. Agricultural science curriculum is structured around the three major concepts of production, protection and economics. Topics under these are classified into six units: basic concepts, crop production, animal production, agricultural ecology and systems, agricultural engineering and agricultural economics, and extension (Federal Ministry of Education, 1985).

Agricultural science has a place of pride in the school curriculum. Section 14E of the National Policy of Education document states that the "education provided to the Nigerian child should make s/he respect the dignity of labour (agriculture), appreciate those values specified under our broad national aims, and live as good citizens" (Federal Ministry of Education, 1997). Section 6 of the document makes agricultural science a core subject which is compulsory for secondary school students. The objectives of the agricultural science senior secondary curriculum are to stimulate and sustain students' interest in agriculture, enable students to acquire basic knowledge and practical skills in agriculture, prepare students for further studies in agriculture and prepare students for occupations in agriculture.

From the beginning of the 1970s, it was observed that Nigerians were shifting gradually away from agriculture (although subsistence farming still continues to be common up until the present time). A spin-off from this was the gradual reduction in the revenue accruing from agricultural produce. Petroleum now appears to be taking the centre stage. Economists and politicians have decried this trend, recognising that petroleum is a finite and non-renewable resource. In the last five years, there has been a plea that Nigerian youths should be encouraged to show more interest in farming. This situation is translated into a

renewed enthusiasm for agricultural science in Nigerian schools. Studies by Idiris (1988, 1990), Mohapelon (1973) and Olaitan (1984) have shown that Nigerian students in their samples have poor attitudes towards agricultural science and are underachieving in the subject. Relatively poor performance among students in the GCE O/Level examinations in agricultural science also has been reported (WAEC, 1960-1985).

Because of the importance of agricultural science within Nigerian schools, it is highly desirable that more systematic research is conducted into the environments for teaching and learning agricultural science. Moreover, given that problems have been noted regarding both the achievement and attitudes of Nigerian agricultural science students, it also is a high priority that research into agricultural science classroom environments in Nigeria examines not only the nature and determinants of classroom environment, but also the effects of environments of student achievement and attitudinal outcomes.

A possible reason for the less-than-desirable achievement and attitudes among Nigerian agricultural science students could be that students are not given the opportunity to make meaning out of agricultural science concepts, by being personally involved in knowledge construction (Tobin, 1993; Taylor, Fraser, & White, 1994). It is possible that, if the students are given an environment which caters for their individual needs and which allows students to construct their own meaning during transactions in agricultural science classes, then cognitive, attitudinal and performance skills of these students could improve.

Okure, Idiris, Ogu and Igbokwe (1991) listed the patterns of agricultural practice in the rain forest and savanna of Nigeria, and in rural and urban areas. The savanna zone of Nigeria usually is taken to be the region lying north of Rivers Niger and Benue. The rain forest zone of Nigeria, on the other hand, is taken to be the area south of these two rivers. The savanna zone lies between latitude 7 degrees to 14 degrees north of the equator and has a characteristic savanna vegetation, loam sandy soil, a short rainy season and a long dry season (October–May).

Southern states, which lie between latitudes 3 degrees to 8 degrees north of the equator, have a characteristic forest vegetation, humus loamy soil, a double maximum rainy season and a short dry season (November–March). The climatic differences lead to the diverse agricultural practices in northern (savanna) and southern (forest) states of Nigeria. In the northern part of the country, the soil and climatic conditions permit the growing of shallow-rooted crops such as pulses, millet and other grains. Irrigation farming is also predominant. On the other hand, tree crops (cocoa and rubber) and tuber crops (cassava and yam) are grown mostly in the southern states. Unlike in the northern states, livestock production does not enjoy a pride of place. Rather, poultry and fish farming feature prominently in the southern states. On the basis of the existing differences in the farming practices between the savanna (northern) and forest (southern) states, there are expectations that the agricultural science learning environment could be different in savanna and forest schools. One of the purposes of this study was to examine possible differences between schools in savanna and forest regions.

Figure 1.1 shows a map of Nigeria. City dwellers in Nigeria are mainly blue/white collar job workers, while the rural area is dominated predominantly by peasant farmers (Idiris, 1988). The map in Figure 1.1 shows the eight states and the Federal Capital Territory from which schools were drawn for the purposes of the present study (see description of the sample later in Section 3.2).

A number of authors have highlighted the distinction between classroom-level and school-level environment and have stressed the important influence of the school environment as a whole on individual classrooms within a school (Fraser, 1994; Genn, 1984). However, only a handful of studies have attempted to establish linkages between school environment and classroom environment (Fisher, Fraser, & Wubbels, 1993; Fraser & Rentoul, 1982). In the present study of agricultural science classes in Nigeria, school environment was included as one of the determinants of classroom environment to be investigated.

MAP OF NIGERIA AND STATES AND THE FEDERAL CAPITAL TERRITORY INVOLVED IN THE STUDY

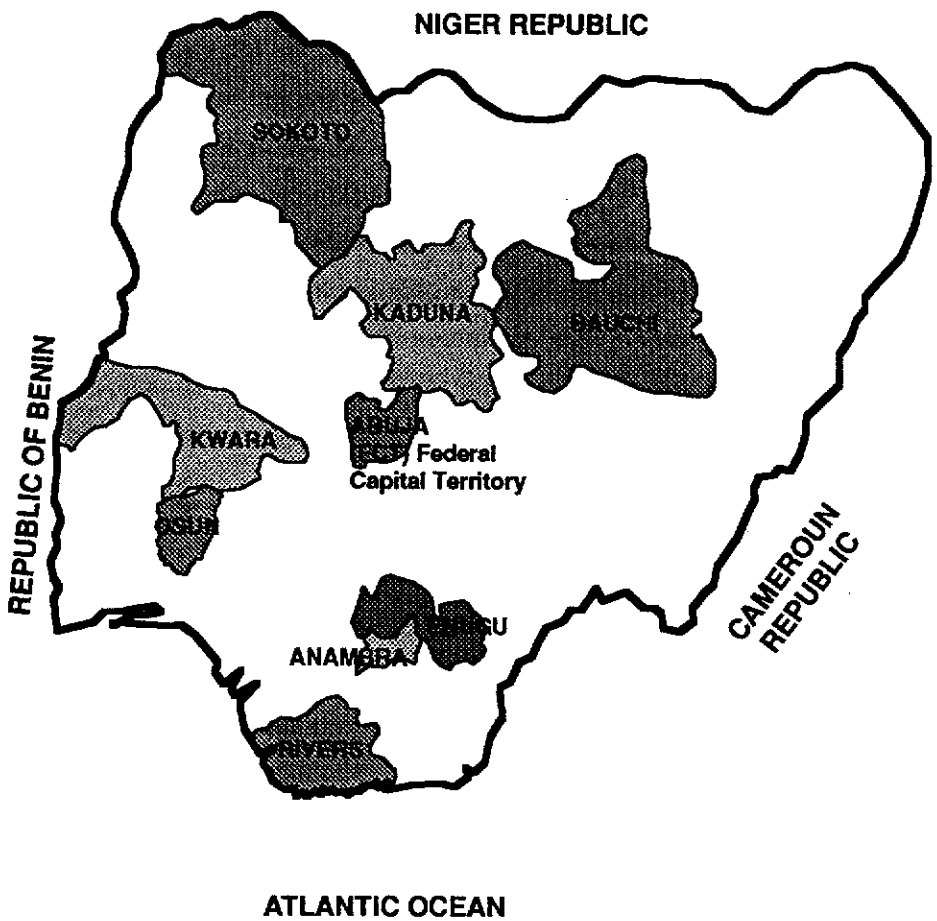


Figure 1. 1 Map of Nigeria and States and the Federal Capital Territory Involved in the Study

1.2 AIMS OF THE STUDY

The four aims of the present study of Nigerian agricultural science classes can be stated in the following way:

1. To develop and validate a classroom environment instrument specifically for use in agricultural science classes in Nigeria.

2. To ascertain the nature of actual and preferred classroom environment in Nigerian agricultural science classes.

3. To investigate associations between the nature of the learning environment of agricultural science classes and three student outcomes:

    - attitudes towards agricultural science;
    - enquiry skills in agricultural science;
    - practical performance skills in agricultural science.

4. To investigate some determinants of classroom environment, namely:

    - school environment;
    - geographical region.

1.3 SIGNIFICANCE OF THE STUDY

Although the study of learning environments has spanned many different countries, this line of research has been almost nonexistent in Nigeria, with the only three examples of prior studies being a cross-national study of science laboratory classroom environment settings (Fraser, Okebukola, & Jegede, 1992), a study of the socio-cultural environment (Agada, 1988; Jegede, Fraser, Agada, & Okebukola, in press), and a study of relationships among student attitudes, school

environment and classroom environment (Akindehin, 1993). Recent comprehensive literature reviews (e.g., Fraser, 1994; Fraser & Walberg, 1991) suggests that previously no learning environment study has been conducted specifically in agricultural science classrooms in any country.

The present study resulted in the development of some widely-applicable, valid and reliable instruments that can be used in future research to assess classroom environment, school environment and student outcomes in Nigerian schools. Also, the present investigation of relationships between student outcomes and classroom environment specifically in agricultural science classes in Nigeria had the potential to replicate numerous prior studies in other subject areas in several other countries, and to provide practical guidance for improving student outcomes through the creation of productive classroom environments. This study is distinctive not only because there has been little past research in the area of classroom environments in Nigeria, but also because research which specifically examines the environments of agricultural science classes has been nonexistent worldwide.

1.4 OVERVIEW

The remainder of the thesis is organised into the following four chapters:

- Chapter 2 provides a literature review involving agricultural science education in Nigeria (Section 2.2), learning environment research (Section 2.3), classroom environment instruments (Section 2.4), past research on the effects of classroom environment on student outcomes (Section 2.5) and past research on determinants of classroom environment (Section 2.6).

- Chapter 3 is devoted to methodology and encompasses the sample (Section 3.2), the various instruments used to assess classroom environment, school environment, attitudes, enquiry skills and performance skills (Section 3.3) and the various

procedures used in the research (including data analysis—Section 3.4).

- Chapter 4 reports the results, including descriptive information for the classroom environment instrument (Section 4.3), reliability and validity information for the classroom environment instrument (Section 4.4), the outcome measures (Section 4.5) and the school environment instrument (Section 4.7), associations between classroom environment and student outcomes (Section 4.6), associations between school and classroom environments (Section 4.7) and differences between classroom and school environments in forest and savanna schools (Section 4.9).

- Chapter 5 provides a summary of the thesis, discusses the study's limitations and practical implications, and makes suggestions for desirable directions for future research.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to review the literature relevant to the present investigation involving the assessment, effects and determinants of classroom environment in agricultural science classes in Nigeria. The discussion is organised under the following headings:

- Agricultural science education in Nigeria (Section 2.2);
- Learning environment research in science classes (Section 2.3);
- Instruments for assessing classroom environment (Section 2.4);
- Effects of classroom environment on student outcomes (Section 2.5);
- Determinants of classroom environment, especially school environment (Section 2.6).

2.2 AGRICULTURAL SCIENCE EDUCATION IN NIGERIA

2.2.1 Historical Perspectives

As early as 1472, Portuguese merchants visited the Nigerian coastal areas of Lagos and Benin (Fafunwa, 1974). The Roman Catholic Mission, through the influence of Portuguese traders, were able to establish schools and preach the gospel at Warri near Benin. The Catholic activities were disrupted by the slave trade which ravaged West Africa for almost 300 years.

Fafunwa reported that the second coming to Nigeria of the missionaries was in 1842. The English-speaking Reverend T. B.

Freeman of the Methodist Mission, accompanied by W. de Graff, an educationist of Ghanian origin, arrived in Badagry near Lagos in September 1842. The Methodist Mission set up a school in Badagry in 1843. Later, other mission organisations arrived at the coast and followed the example of their predecessors. The activities of the Christian missions gradually spread to the hinterland of the Nigerian territory. Taiwo (1980) reported that, by the year 1882, the Wesleyan Methodist Mission secondary school had science in the school program. In 1889, there was introduced in the colony the dual system in which the government and the private organisations together ran the schools. It was the beginning of the secularisation of education.

In 1900, the Protectorate of Northern Nigeria was proclaimed. Fafunwa (1974) reported that, at the time of proclamation, there was one western-type school in the Northern territory of Nigeria. It was the Church Missionary Society (CMS) School at Lokoja, the then headquarters of the Royal Niger Company. But, by 1906 in the Lagos colony, the Roman Catholic secondary schools' curriculum included the science subjects of botany, chemistry, physics and physiology. In the Western territory, by the year 1910, technical or applied science education was confined to mission schools and government departments (e.g., railway, marine, public works, telegraph and survey). In 1909, the chief education officer for the Northern territory, Dr Vischer, opened a government school at Nassarawa in Kano. At that period, the education policy of the Northern territory was a model of Gordon College Khartoun, and the main aim of education was Islamic literacy. In 1912, the education department for the Northern territory was based at Nassarawa, Kano. The staff of the department included the Director of Education, Dr Vischer, a superintendent of Agriculture and a technical instructor. Fafunwa (1974) listed the composition of the education department, which included one primary school, one secondary school, a technical school and a school farm.

In 1914, the protectorates of Northern and Southern territories were amalgamated and the area was named Nigeria. According to Taiwo (1980), Lord Lugard, the Governor General of Northern territories,

proposed an education policy which entailed a dual system of school control. The type of education included in the policy comprised literary training, the teaching of crafts and agriculture, and a type of elementary schooling suitable to village life. The curriculum included the science subjects of agriculture, forestry and surveying. Lord Lugard also opened provincial schools in many parts of the Northern provinces. Practical agriculture was common in the curriculum of the schools. In 1920, the Phelps-Stokes commission on education sponsored by the Phelps-Stokes fund of the USA was set up, and the West African sub-commission submitted its report in 1922. Taiwo (1980) reported that the recommendation included a suggestion for the establishment of farm demonstration movements which involved agricultural scientists demonstrating modern farming systems on the local farmers' farm land. These recommendations speeded up the process that set up the school of agriculture in Ibadan, Samaru and others that followed these schools.

Akinyemi (1983) reported that, in 1929, the education departments of Northern and Southern protectorates were merged to form a single department. The years after the Second World War (1939–1945) witnessed government emphasis on higher education and educational improvements in general. In January 1948, University College Ibadan was opened as an extension of the University of London in Nigeria. Taiwo (1980) reported that 104 students were enrolled in 1948, and that 38% were science students. In April 1959, the Ashby commission on investment in education was appointed by the federal government. Fafunwa (1974) identified that the purpose of the commission was to conduct an investigation into Nigeria's needs in the field of postsecondary school and higher education for the next 20 years. Of importance to secondary school science and applied science education was an item in the recommendation suggesting that, in primary and secondary schools, some manual subjects should be a compulsory part of the curriculum, so that children would develop appreciation of manual and skilled (scientific) labour. Such experiences might lead some children to a trade offered at the trade centre. It was recommended that secondary schools should have courses in technical

subjects leading to careers in technical fields. Fafunwa confirmed that these recommendations were accepted by the government.

In September 1969, 10 years after the Ashby commission report, the National Curriculum Conference was held in Lagos. It was the first of its kind in Nigeria (Fafunwa, 1974). Fafunwa described the major aim of the conference as being an effort to identify new national goals for Nigerian education for the social and economic benefits of the country. He further reported that the 1969 conference involved a cross-section of Nigerian people involved in the curriculum reform. The conference members comprised representatives of trade unions, farmers' union, women's organisations, religious bodies, teachers' associations, professional organisations, business people, Ministry officials, university teachers and administrators, youth club organisers and representatives from governments of most of the then 12 states of Nigeria. The 1969 curriculum conference report was accepted by the government and culminated in the 1977 statement of a National Policy on Education.

According to Na Allah, Nabate and Mani (1982), the various levels of the restructured educational system were given functions. The pre-primary and primary sector was intended to help to turn out a literate and motivated young population. The junior secondary stage was intended to train craftpersons. The senior secondary sector was intended to produce junior-level manpower. At the highest tertiary level, the polytechnics and advanced colleges were intended to produce senior-level professionals. Finally, the university faculties and schools of professions were to cater for the education of high-level professionals.

National Policy of Education (1985) guidelines for curriculum restructuring at all of the stages of the educational system emphasised Integrated Science and Technology at the primary and junior secondary school levels. The content of the subjects included agriculture and food production. The senior secondary curriculum had general, terminal and preparatory objectives. For facilitating the achievements of all the three types of objectives, seven streams were accommodated

within the school. Each of the streams derives its name from a terminal core around which the stream was designed. One of the streams was the agricultural stream. The teacher education stream also accommodates agricultural science by including integrated science and technology in its curriculum. The offerings at the polytechnics are structured to incorporate agricultural studies within technological studies. The universities' schools or faculties of agriculture and food sciences offer agricultural courses. Thus, agricultural science has a place of prominence all along the ladder of the Nigerian educational system.

Nigeria's educational system is centralised. The Federal Ministry of Education (FME) administers the curricula to the States' Ministries of Education (MOE) primary, secondary and tertiary schools. The curriculum of private and public schools at the primary and secondary levels is uniform as students respond to centralised graduation examinations at those educational levels. In high schools, students study agricultural science for four periods which include double lessons of practical (laboratory) work each week, as in Junior Secondary Schools. Some schools have a laboratory assistant who maintains the inventory of laboratory equipment and who is responsible to teachers for setting up, removing and storing materials for laboratory work and demonstrating. These laboratory assistants often are high school graduates with science backgrounds. In Nigeria's secondary schools, there exist senior masters/mistresses in each school and a head of department in each subject area. These people have reduced teaching loads and supervisory responsibility over the teachers on their staff. Promotions are based on productivity and leadership characteristics. Further, outstanding teachers are posted to Ministry of Education sections concerned with improving programs and support materials for teachers in their field.

Clearly, throughout Nigeria's educational history, the teaching of science has remained a cornerstone at all educational levels (Jegede, 1990). Today, agricultural science still has a central and prominent place in the Nigerian curriculum. Therefore, it is important and

timely to conduct research into teaching and learning in agricultural science classrooms in Nigeria.

2.2.2 Learning Environment in Agricultural Science Classes

Ivowi (1992) summarised the objectives of secondary education in Nigeria as the provision of comprehensive, flexible and directional curriculum for all ability ranges of students, and an integration of productive work and academic performance for self-reliance. The major objectives of science, technology and mathematics (STM), including agricultural science, are to provide: a preparation for further training in science, technology and mathematics; basic mathematics and scientific literacy for everyday living; essential skills and attitudes as preparation for technological development; and the stimulation and enhancing of creativity. As part of the implementation strategies, the following have been recommended: to emphasise the fundamental unity of science and mathematics concepts; to teach science and mathematics as activities; to realise that the order of accuracy is not as important as the illustration of principles; and to evaluate students in the three domains of educational objectives (i.e., cognitive, affective and psychomotor). According to a Nigerian school survey (Yoloye, 1989), the most prevalent approaches to science teaching in schools, in order, include: teaching or explaining new content to the entire class; revising old content with the entire class; whole-class discussion; and demonstration of experiments by the teacher. The survey revealed that a fairly large amount of time is spent maintaining discipline in about 40% of the schools surveyed. Yoloye concluded that the acquisition of the student's knowledge really could be of little significance because of its 'static' character, as far as the development and application of creative skills and the initiative to solve problems are concerned.

Idiris (1988) reported information about agricultural science classroom environments in Kaduna State in Nigeria. In terms of school location, 64.3% of the schools were located in the urban areas at that time, while 35.7% were rural schools. The majority of agricultural science teachers (93.4%) were males. Forty of the 70 respondents (57.1%) represented

the single largest subgroup aged 31-40 years of age. Respondent teachers' opinions indicated that 71.4% thought that the Bachelor of Education (Science/Agriculture Education) to be the minimum educational qualification required for a post-primary agriculture teacher. Also 21.4% and 7.1% of the respondents, respectively, suggested the Nigeria Certificate in Education (NCE) and Master of Science/Education (MSc/Ed), respectively, as a minimum and highest qualification. Concerning respondents' professional organisations, 35.7% belonged to professional organisations. Responses regarding specific learning facilities indicated that 7.1% of the schools had an agricultural science laboratory, and that 28.5% and 75.7% managed livestock and arable crop farms, respectively. An average of 80% of the schools had simple farm tools on the farm, some agricultural science books in their libraries, and an agricultural science club in the school. Respondent teachers indicated that 7.1%, 18.6% and 61.1% of their students, respectively, were suitably prepared for dairy, poultry and arable farming. None of the students were prepared suitably for fishery and farm mechanisation.

Students' responses indicated that 55.0%, 8.8% and 8.2%, respectively, reported that their choice of subjects of study was influenced by parents, teachers and peers. Respondent students' reasons for studying agricultural science were the availability of qualified teachers (15.9%), that the subject was easy to study (9.6%), a rural area background (42.2%), and a preference to take agriculture as a career (1.2%). Respondent students' opinion about agriculture as a profession indicated that 90.9% thought that agriculture is a reasonably well-paid occupation.

A very low percentage of the post-primary schools offered candidates for the senior secondary West African Examination Council (WAEC, 1960-1985 annual reports) agricultural science examinations. Respondents' home background influenced the student's choice of subject (e.g., most students from rural areas who chose agricultural science indicated they grew up in the rural areas). Females were not keen about choosing agriculture as a profession. A larger proportion of the agricultural science teachers were males. There were inadequate

learning resources in the schools, in terms of agricultural science teachers' qualifications, agricultural science indoor and outdoor laboratories, textbooks and farm tools. Student respondents believe that agriculture is a well-paid occupation, even though agriculture was not among the jobs for which they thought themselves qualified after secondary school graduation.

Although no previous studies of agricultural science classroom environments in Nigeria have been reported, the few classroom environment studies that have been carried out in Nigeria are of relevance to the present investigation. Therefore they are reviewed in Section 2.3.1.

2.3 LEARNING ENVIRONMENT RESEARCH IN SCIENCE CLASSES

2.3.1 Overview of the Field

Fraser (1989) discusses background information about the field of classroom environment and its focus upon students' and teachers' perceptions of psychosocial aspects of the learning environment which pervade school classrooms, and provides compelling evidence that the classroom environment is a potent determinant of student outcomes that should not be ignored by those wishing to improve the effectiveness of schools. The use of students' and teachers' perceptions can be contrasted with the method of direct observation which involves external observers in systematic coding of classroom communication and events according to some category scheme (Dunkin & Biddle, 1974; Rosenshine & Furst, 1973). Murray (1938) introduced the terms 'alpha press' to describe the environment as assessed by a detached observer and 'beta press' to describe the perceived environment of milieu inhabitants. Rosenshine (1970) distinguished between 'low inference' measures which tap specific explicit phenomena (e.g., the number of student questions), and 'high inference' measures which require the respondent to make a judgement about the meaning of classroom events (e.g., the degree of teacher friendliness).

Fraser and Walberg (1981) listed some advantages which student perceptual measures have over observational techniques. Paper-and-pencil perceptual measures are economical, involve students' experiences over many lessons, involve the pooled judgements of all students in a class and, as determinants of student behaviour, account for more variance in student learning outcomes. Other approaches to studying classroom environment involve application of the qualitative techniques of naturalistic enquiry and case study. Perceptual measures formed the main basis for assessing environmental perceptions in the present study.

Walberg began developing earlier versions of the globally-used *Learning Environment Inventory* as part of the research and evaluation activities of Harvard Project Physics (Walberg & Anderson, 1968). Simultaneously, Moos began developing the first of his world-recognised social climate scales, including those for use in psychiatric hospitals (Moos & Houts, 1968) and correctional institutions (Moos, 1968), which ultimately resulted in the development of the well-known *Classroom Environment Scale* (Moos & Trickett, 1987). A perspective germinated from Moos and Walberg's research, and this has influenced the ways of conceptualising, assessing and investigating classroom environment, as synthesised in books (Fraser, 1986a; Fraser & Walberg, 1991; Moos, 1979; Walberg, 1979), monographs (Fraser, 1981a; Fraser & Fisher, 1983a), a guest-edited journal issue (Fraser, 1980), an annotated bibliography (Moos & Spinrad, 1984), and literature reviews (Chavez, 1984; Fraser, 1989, 1991, 1994; MacAuley, 1990). Fraser (1991) fully acknowledges the relevance of earlier work like Lewin (1936) and Murray (1938) and those that followed such as Pace and Stern (1958).

School-level and classroom-level environment are distinct, with school environment (Anderson, 1982; Fraser & Rentoul, 1982; Genn, 1984) involving psychosocial aspects of the whole schools and owing much in theory, instrumentation and methodology to earlier work on organisational climate in business contexts (Anderson, 1982). Because school environment was included in the present study as a

determinant of classroom environment, school environment is discussed in greater detail in Sections 2.6.

The work of Murray has been extended by Stern, Stein and Bloom (1956) who distinguish between 'private beta press' and 'consensual beta press'. Perception scores obtained from individual students (private press) could be combined to obtain the average (consensual press) of the environment scores of all students within the same class. Numerous writers (Burstein, 1978; Cheung et al., 1990; Cronbach & Snow, 1977; Goldstein, 1987; Raudenbush, 1988; Raudenbush & Bryk, 1986) consider hierarchical or multilevel analysis of data. The use of individuals when the classes are the primary sampling units violates the requirement of independence of observations and results in incorrect sampling errors (Ross, 1978). One solution is to use the individual as the unit of analysis but to employ the Jack-knife technique (Mosteller & Tukey, 1977) or the Bootstrap technique (Luecht & Smith, 1989) to adjust significance levels to allow for nonindependence of observations. Burstein, Linn and Capell (1978) pointed out that the use of different units of analysis involves the testing of conceptually different hypotheses. In the present study, many analyses were performed at two levels: the individual student score; and the school mean.

Fraser (1994) notes that the most common line of classroom environment research has involved investigation of the effects of classroom environment on student outcomes. In fact, considerable research has replicated the finding that the nature of the classroom environment affects student achievement and attitudes (Haertel, Walberg, & Heartel, 1981). The practical importance of this research is that student outcomes can be improved by emphasising those classroom environment dimensions found empirically to be linked with better achievement. Because the investigation of associations between classroom environment and student outcomes was a major aim of the present study, past research along these lines is reviewed in a separate section (Section 2.5).

In addition to its focus on the effects of classroom environment on student outcomes, the present study also investigated some determinants of classroom environment (e.g., the school environment). Because of the relevance to the present study of past research on determinants of classroom environment, past work in this area is the subject of a separate section later in this chapter (Section 2.6).

In a person-environment fit study, Fraser & Fisher (1983b) provided many methodological improvements over prior research. In particular, the research measured the person and the environment as sets of commensurate and continuous variables, it provided control for student background characteristics and actual environment when studying the effect of actual-preferred interaction, and it reduced the overall Type I error rate by ensuring that individual interactions were interpreted only in cases in which the block of all interactions was associated with a significant amount of criterion variance. Regression surface analysis provided a powerful multivariate method of statistical analysis which enabled person-environment interactions to be represented as the products of continuous variables. The practical implication from this study is that class achievement of certain outcomes might be enhanced by attempting to change the actual classroom environment in ways which make it more congruent with that preferred by the class.

Fraser and Fisher (1986) describe five fundamental steps in a procedure aimed at improving classrooms environments: assessment; feedback; reflection and discussion; intervention; and reassessment. The preferred form of a classroom environment instrument was administered to the class one week before the actual form in a case study reported by Fraser and Fisher (1986). After scoring the students' questionnaire, the teacher considered profiles of class mean scores on the actual and preferred versions. The teacher decided to increase the levels of Teacher Support by talking and mixing with students and assisting them more than usual, and to increase Order and Organisation by insisting that students work more quietly than previously and taking considerable care with distribution and collection of materials. Significant improvements in classroom

environment occurred on these dimensions (namely, Teacher Support, Task Orientation, and Order and Organisation). The results showed that some change in actual environment occurred during the time of the intervention. Statistically significant changes occurred ($p<0.05$) on the two dimensions (namely, Teacher Support and Order and Organisation) on which the teacher had attempted to change. However, it appears that the interventions also led to an undesirable side effect in which the class became more task oriented than the students would prefer. This study emphasised to the usefulness of teachers employing classroom environment instruments to provide meaningful information about their classrooms and a tangible basis to guide improvements in classroom environments. Another recent report of teachers' successful attempts to improve their science classroom environments can be found in Thorpe, Burden and Fraser (in press).

A small number of the past classroom environment studies were conducted in Nigeria. The *Socio-Cultural Environment Scale* (Jegede & Fraser, 1989; Jegede, Fraser, Agada, & Okebukola, in press) was developed to measure five aspects of the socio-cultural environment (namely, Authoritarianism, Goal Structure, African Worldview, Societal Expectation and Sacredness of Science) which students bring into the science classroom from their traditional culture and which could affect student learning. A sample of 586 ninth grade students in six secondary schools in Benue state, Nigeria, responded to this instrument as well as the seven-scale *Test of Science-Related Attitudes* (Fraser, 1981b). Overall, it was found that most of the socio-cultural environment scales were associated with most of the attitude scales. Jegede and Fraser (1989) speculated that it is possible that the negative attitudes which children in non-Western societies like Nigeria manifest towards science come about as the result of the inhibiting effect of socio-cultural factors.

Akindehin conducted a study of classroom environment involving 1 382 students in 32 schools in Ondo state. Students' classroom environment perceptions were assessed with selected scales from the *Individualised Classroom Environment Questionnaire* (Fraser, 1990),

while student attitudes were assessed with several scales from the *Test of Science-Related Attitudes* (Fraser, 1981b). Significant environment attitude relationships emerged in approximately half of the cases.

Because of the importance and uniqueness of laboratory settings in science education, Fraser, McRobbie and Giddings (1993) developed a new instrument to assess five important aspects (Student Cohesiveness, Open-Endedness, Investigation, Rule Clarity and Material Environment) of the environment of science laboratory classrooms at the senior high school or university levels. This new instrument was field-tested with 5 447 students in 269 classes in six countries, namely, the USA, Canada, England, Israel, Australia and Nigeria). Overall, analysis of data collected from the 388 Nigerian students in 11 classes attested to the cross-cultural validity of the *Science Laboratory Environment Inventory* for use in Nigeria. Also the association between science laboratory classroom environment and student enjoyment of science laboratory classes found in other countries was replicated for the Nigerian samples (Fraser, Okebukola, & Jegede, 1992).

2.3.2 Current Trends and Future Directions

McRobbie and Fraser (1993) reported promising recent areas of classroom environment study that are still in progress. The links between classroom, school, family and other environments on students' outcomes are being explored (Moos, 1991). Classroom environment has been incorporated as one factor in a multifactor model of educational productivity (Fraser, Walberg, Welch, & Hattie, 1987). Researchers have begun exploring ways in which classroom environment instruments and ideas can be used by school psychologists (Burden & Fraser, in press) and incorporated into teacher education (Fisher & Fraser, 1991a). Recent studies have focused on changes in classroom environment during the transition from primary to high school (Midgley, Eccles, & Feldlaufer, 1991) and incorporating the evaluation of classroom environment in teacher assessment schemes (Heroman, Loup, Chauvin, & Evans, 1991).

In research which originated in The Netherlands, a learning environment questionnaire was developed to enable teacher educators to give preservice and inservice teachers advice about the nature and quality of the interaction between teachers and students (Wubbels, Brekelmans & Hooymayers, 1991). Drawing upon Leary's theoretical model of proximity (Cooperation-Opposition) and influence (Dominance-Submission), the *Questionnaire on Teacher Interaction (QTI)* was developed to assess student perceptions of the eight behaviour aspects of Leadership, Helpful/Friendly, Understanding, Student Responsibility and Freedom, Uncertain, Dissatisfied, Admonishing and Strict behaviour. The QTI has 77 items altogether (approximately 10 per scale), and each item is responded to on a five-point scale ranging from Never to Always. Typical items are "S/he gives us a lot of free time" (Student Responsibility and Freedom behaviour) and "S/he gets angry" (Admonishing behaviour). The QTI has been found to be valid and reliable in studies among secondary school students in The Netherlands and the USA (Wubbels & Levy, 1993), as well as in Australia (Fisher, Fraser, & Wubbels, 1993).

According to Fraser and Tobin (1991), another contemporary trend and desirable future direction involves combining of qualitative and quantitative methods in classroom environment research. For example, a team of 13 Australian researchers was involved in over 500 hours of intensive classroom observation of 22 exemplary teachers and a comparison group of non-exemplary teachers (Fraser & Tobin, 1989). The main data collection methods were based on interpretive research methods and involved classroom observation, interviewing of students and teachers, and the construction of case studies. But, a distinctive feature was that the qualitative information was complemented by quantitative information obtained from questionnaires assessing student perceptions of classroom psychosocial environment. These instruments furnished a useful picture of life in exemplary teachers' classrooms as seen through the students' eyes. The results obtained from the use of the qualitative and quantitative data collection methods provided considerable evidence suggesting that, first, exemplary and non-exemplary teachers can be differentiated in terms of the psychosocial environments of their classrooms as seen

through their students' eyes and, second, that exemplary teachers typically create and maintain environments that are markedly more favourable than those of non-exemplary teachers (Fraser & Tobin, 1989). For example, relative to a comparison group of non-exemplary teachers, the students of an exemplary biology teacher perceived their class as having a much more favourable environment, especially in terms of Involvement, Teacher Support, and Order and Organisation (Fraser & Tobin, 1989).

In another study, which focused on the elusive goal of higher-level cognitive learning, a team of six researchers intensively studied the grade 10 science classes of two teachers (Peter and Sandra) over a 10-week period (Tobin, Kahle, & Fraser, 1990). Each lesson was observed by several researchers, interviewing of students and teachers took place on a daily basis, and students' written work was examined. The study also involved quantitative information from questionnaires assessing student perceptions of classroom psychosocial environment. An important finding was that students' perceptions of the learning environment within each class were consistent with the observers' field records of the patterns of learning activities and engagement in each classroom. For example, the high level of Personalisation perceived in Sandra's classroom matched the large proportion of time that she spent in small-group activities during which she constantly moved about the classroom interacting with students. The lower level of Personalisation perceived in Peter's class was associated partly with the larger amount of time spent in the whole-class mode and the generally public nature of his interactions with students.

Potentially, there is a major problem with nearly all existing classroom environment instruments when used to identify differences between subgroups within a classroom (e.g., boys and girls) or in the construction of case studies of individual students. The problem is that items are worded in such a way that they elicit an individual student's perceptions of the class as a whole, as distinct from that student's perceptions of his/her own role within the classroom. For example, items in the traditional Class form of classroom environment instruments might seek students' opinions about

whether "The work of the class is difficult" or whether "The Teacher is friendly towards the class". In contrast, a Personal form of the same items would seek opinions about whether "*I* find the work of the class difficult" or whether "The teacher is friendly toward *me*".

A vivid example of the way in which certain subgroups of students within a science class perceived different subenvironments because of the teacher's differential treatment of them is provided by a study of target students (i.e., pupils who monopolise the verbal interaction during whole-class activities) (see Fraser, 1994). It was found that target students perceived significantly greater levels of involvement and rule clarity than non-target students, which was consistent with classroom observations showing that the teachers directed more questions at target students and allowed them (and not other students) to call out answers without being asked. Similarly, in another study combining qualitative and quantitative methods (Tobin, Kahle, & Fraser, 1990), case studies of individual students revealed that meaningful differences in classroom environment perceptions existed between certain students, and that those differences were consistent with the teacher's expectations of and attitudes towards individuals. The findings of these two studies highlight the need for a new generation of classroom environment instruments which are more capable of detecting the differences in perceptions between individuals or subgroups within the class.

Fraser, McRobbie and Giddings (in press) have developed and validated parallel Class and Personal forms of both an actual and preferred version of the *Science Laboratory Environment Inventory (SLEI)*. Three uses of the new personal form of the SLEI were reported by Fraser, McRobbie, and Giddings (in press). First, students' scores on the class form were found to be systematically more favourable than their scores on the personal form, perhaps suggesting that students have a more detached view of the environment as it applies to the class as a whole. Second, an investigation of gender differences in student perceptions of science/laboratory classes suggested that, as hypothesised, gender differences in perceptions were somewhat larger on the personal form than on the class form. Third, although a study

of associations between student outcomes and their perceptions of the science laboratory environment revealed that the magnitudes of associations were comparable for class and personal forms of the SLEI, commonality analyses showed that each form accounted for appreciable amounts of outcome variance which was independent of that explained by the other form. This finding serves to justify the decision to evolve separate class and personal forms because they do appear to measure different, albeit overlapping, aspects of the science laboratory classroom environment.

2.4 INSTRUMENTS FOR ASSESSING CLASSROOM ENVIRONMENT

2.4.1 Overview of Six Instruments

Reviews devoted to the conceptualisation, measurement and investigation of perceptions of classroom psychosocial environment characteristics of the classrooms at the primary, secondary and higher education levels (Chavez, 1984; Fraser, 1986a, 1989, 1994; Fraser & Walberg, 1991; MacAuley, 1990) indicate that six instruments have been used extensively in several countries in past research. These are the *Learning Environment Inventory (LEI)* (Fraser, Anderson, & Walberg, 1982), the *Classroom Environment Scale (CES)* (Moos & Trickett, 1974, 1987), the *Individualised Classroom Environment Questionnaire (ICEQ)* (Fraser, 1990), the *My Class Inventory (MCI)* (Fisher & Fraser, 1981; Fraser, Anderson, & Walberg, 1982; Fraser & O'Brien, 1985), the *College and University Classroom Environment Inventory (CUCEI)* (Fraser & Treagust, 1986; Fraser, Treagust, & Dennis, 1986) and the *Science Laboratory Environment Inventory (SLEI)* (Fraser, Giddings, & McRobbie, 1992; Fraser, McRobbie, & Giddings, 1993).

Table 2.1 lists the names of the scales contained in each of these six questionnaires, and shows that the LEI contains 7 items per scale, the CES and ICEQ contain 10 items per scale, the MCI contains 6-9 items per scale, and the CUCEI and SLEI contain 7 items per scale.

Table 2.1 Overview of Scales Contained in Six Classroom Environment Instruments (LEI, CES, ICEQ, MCI, CUCEI and SLEI)

Instrument	Level	Items per Scale	Scales Classified According to Moos's Scheme		
			Relationship Dimensions	Personal Development Dimensions	System Maintenance and Change Dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisation Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order and Organisation Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Elementary	6-9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalisation Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualisation
Science Laboratory Environment Inventory (SLEI)	Senior Secondary, Higher Education	6-7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment

Table 2.1 also shows the classification of each scale according to Moos's (1974) scheme for classifying human environments. The three major types of dimensions proposed by Moos are *relationship dimensions* (which identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support and help each other), *personal development dimensions* (which assess basic directions along which personal growth and self-enhancement tend to occur), and *system maintenance and change dimensions* (which involve the extent to which the environment is orderly, clear in expectations, maintains control, and is responsive to change).

The initial development and validation of a preliminary version of the *Learning Environment Inventory (LEI)* began in the late 1960s in conjunction with the evaluation and research on Harvard Project Physics (Walberg & Anderson, 1968). The LEI's 15 climate dimensions include scales whose concepts were identified as good predictors of learning, relevant to social psychological theory and research, similar to those in theory and research in education, or intuitively judged as relevant to the social psychology of the classroom. The final version of the LEI contains a total of 105 statements (seven per scale) which describe typical school classes. The respondent indicates extent of agreement or disagreement with each statement using a four-point scale with response alternatives of Strongly Disagree, Disagree, Agree and Strongly Agree. The scoring polarity is reversed for negatively worded items. An item contained in the Cohesiveness scale is: "All students know each other very well". An item from the Speed scale is: "The pace of the class is rushed".

The *Classroom Environment Scale (CES)* was developed by Rudolf Moos at Stanford University as part of a comprehensive research program involving perceptual measures of a variety of human environments including psychiatric hospitals, prisons, university residences and work milieus (Moos, 1974). After a trial of the items in 22 classrooms and items analysis, the number of items was reduced to 208. This version then was administered in 45 classrooms and modified to form the final 90-item version of the CES. These items

were evaluated statistically to ascertain whether they discriminated significantly between the perceptions of students in different classrooms and whether they correlated highly with their scale scores. The final version of the CES contains nine scales with 10 items of True-False response format in each scale. Some items in the CES are: "The teacher takes a personal interest in the students" (Teacher Support) and "There is a clear set of rules for students to follow" (Rule Clarity).

The *Individualised Classroom Environment Questionnaire (ICEQ)* assesses those dimensions (e.g., Personalisation, Participation) which distinguish individualised classrooms from conventional ones. The initial development of the long form of the ICEQ (Rentoul & Fraser, 1979) was guided by several criteria: dimensions chosen characterised the classroom learning environment described in the literature of individualised and open education; extensive interviewing of teachers and secondary school students confirmed that the ICEQ's dimensions and individual items were considered salient by teachers and students; items were written and subsequently modified after obtaining responses from selected experts, teachers, and junior high school students; and data collected during field testing were subjected to item analyses in order to identify items whose removal would enhance scale statistics. The final version of the ICEQ (Fraser, 1990) contains 50 items with an equal number of items belonging to each of the five scales. Each item is responded to on a five-point scale with the alternatives of Almost Never, Seldom, Sometimes, Often and Very Often. The scoring polarity is reversed for many of the items. Some items are "The teacher considers students' feelings" (Personalisation) and "Different students use different books, equipment and materials" (Differentiation).

Because of an interest in the present study in individualisation in Nigerian agricultural science classrooms, selected scales from the ICEQ were selected for use.

The *My Class Inventory (MCI)* is a simplification of the LEI suitable for children in the 8 to 12 years age range (Fisher & Fraser, 1981; Fraser,

Anderson & Walberg, 1982; Fraser & O'Brien, 1985). Initially developed specifically for primary school children, the MCI has been found useful with junior high school students, especially those who might experience reading difficulties with the LEI. The MCI contains only five of the LEI's original 15 scales, and a two-point (Yes – No) response format. The final form of the MCI contains 38 items altogether. Typical items are: 'Children are always fighting with each other' (Friction) and 'Children seem to like the class' (Satisfaction)..

The *College and University Classroom Environment Inventory (CUCEI)* was developed for higher education classroom environments which is parallel to the classroom environment research at the secondary and primary school levels. Although some notable prior work focused on the institutional-level or school-level environment in colleges and universities (e.g., Halpin & Croft, 1963; Pace & Stern, 1958; Stern, 1970), the CUCEI provides the first instrument similar to those being used at the secondary school level. The CUCEI is meant for small classes commonly referred to as 'seminars' or 'tutorials'; it is not suitable for use in lectures or laboratory classes (Fraser & Treagust, 1986; Fraser, Treagust, & Dennis, 1986). The final form of the CUCEI contains seven seven-items scales. Each item has four responses (Strongly Agree, Agree, Disagree, Strongly Disagree) and the polarity is reversed for approximately half of the items. Typical items are: "Activities in this class are clearly and carefully planned" (Task Orientation) and "Teaching approaches allow students to proceed at their own pace" (Individualisation).

The *Science Laboratory Environment Inventory (SLEI)* is an instrument specifically suited to assessing the environment of science laboratory classes at the senior high school or higher education levels (Fraser, Giddings, & McRobbie, 1992; Fraser, McRobbie, & Giddings, 1993). The SLEI assesses the five dimensions of Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment. The response alternatives for each item are Almost Never, Seldom, Sometimes, Often and Very Often. Typical items include "Students in this laboratory class get along well as a group" (Student Cohesiveness)

and "We know the results that we are supposed to get before we commence a laboratory activity" (Open-Endedness).

An important feature of most of the classroom environment instruments in Table 2.1 is that they have separate 'actual' and 'preferred' forms. The preferred (or ideal) forms are concerned with goals and value orientations and measure perceptions of the classroom environment ideally liked or preferred. Item wording is not identical for actual and preferred forms for most instruments. For example, the item "Children seem to like the class" in the actual form would read "Children would seem to like the class" in the preferred version. The preferred form includes the word 'would'. Also different instructions for answering each are used. Having different actual and preferred forms has enabled these instruments to be used for a range of new research applications described later.

Table 2.2 provides a scale description for the same six instruments described above, namely, the LEI, CES, ICEQ, MCI, CUCEI and SLEI.

2.4.2 Validity Information for Classroom Environment Instruments

Fraser (1986a) discusses stages in the development and validation of classroom environment instruments: identification of salient dimensions; item writing; and field testing, item analysis and refinement. Instruments using this strategy have been termed 'intuitive-rational' scales (Hase & Goldberg, 1967). The validity of intuitive scales rests heavily on the subjective opinions of the investigators and other experts. Other types of scales delineated by Hase and Goldberg (1967) include intuitive theoretical, factor analytic and empirical group discriminative scales.

Fraser (1977) and Murphy and Fraser (1978) describe the steps in the development of classroom environment scales. The first step is the identification of a tentative list of the salient individual dimensions which characterise classroom environments. The identification of scales is based on literature reviews and the opinions of the researchers, educationists, teachers and/or students. The second stage

Table 2.2 Scale Description for the Individual Dimensions in LEI, CES, ICEQ, MCI, CUCEI and SLEI

Scale	Scale Description
1. *Learning Environment Inventory (LEI) (Secondary school level)*	
Cohesiveness	Extent to which students know, help and are friendly towards each other
Diversity	Extent to which differences in students' interests exist and are provided for
Formality	Extent to which behaviour within the class is guided by formal rules
Speed	Extent to which class work is covered quickly
Material Environment	Availability of adequate books, equipment, space and lighting
Friction	Amount of tension and quarrelling among students
Goal Direction	Degree of goal clarity in the class
Favouritism	Extent to which the teacher treats certain students more favourably than others
Difficulty	Extent to which students find difficulty with the work of the class
Apathy	Extent to which the class feels no affinity with the class activities
Democracy	Extent to which students share equally in decision-making related to the class
Cliqueness	Extent to which students refuse to mix with the rest of the class
Satisfaction	Extent of enjoyment of class work
Disorganisation	Extent to which classroom activities are confusing and poorly organised
Competitiveness	Emphasis on students competing with each other

(cont.)

Table 2.2 Scale Description for the Individual Dimensions in LEI, CES, ICEQ, MCI, CUCEI and SLEI (continued)

Scale	Scale Description
2. *Classroom Environment Scale (CES) (Secondary school level)*	
Involvement	Extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class
Affiliation	Extent to which students help each other, get to know each other easily and enjoy working together
Teacher Support	Extent which the teacher helps, befriends, trusts and is interested in students
Task Orientation	Extent to which it is important to complete activities planned and to stay on the subject matter
Competition	Emphasis placed on students competing with each other for grades and recognition
Order & Organisation	Emphasis on students behaving in an orderly, quiet and polite manner, and on the overall organisation of classroom activities
Rule Clarity	Emphasis on clear rules, on students knowing the consequences for breaking rules, and on the teacher dealing consistently with students who break rules
Teacher Control	The number of rules, how strictly rules are enforced, and how severely rule infractions are punished
Innovation	Extent to which the teacher plans new, unusual and varying activities and techniques, and encourages students to contribute to classroom planning and to think creatively

(cont.)

Table 2.2 Scale Description for the Individual Dimensions in LEI, CES, ICEQ, MCI, CUCEI and SLEI (continued)

Scale	Scale Description
3. *Individualised Classroom Environment Questionnaire (ICEQ) (Secondary school level)*	
Personalisation	Emphasis on opportunities for individual students to interact with the teacher and on concern for the personal welfare and social growth of the individual
Participation	Extent to which students are encouraged to participate rather than be passive listeners
Independence	Extent to which students are allowed to make decisions and have control over their own learning and behaviour
Investigation	Emphasis on the skills and processes of enquiry and their use in problem-solving and investigation
Differentiation	Emphasis on the selective treatment of students on the basis of ability, learning style, interests and rate of working
4. *My Class Inventory (MCI) (Primary school level)*	
Cohesiveness	Extent to which students know, help and are friendly towards each other
Friction	Amount of tension and quarrelling among students
Difficulty	Extent to which students find difficulty with the work of the class
Satisfaction	Extent of enjoyment of class work
Competitiveness	Emphasis on students competing with each other

(cont.)

Table 2.2 Scale Description for the Individual Dimensions in LEI, CES, ICEQ, MCI, CUCEI and SLEI (continued)

Scale	Scale Description
5. *College and University Classroom Environment Inventory (CUCEI) (Tertiary level)*	
Personalisation	Emphasis on opportunities for individual students to interact with the instructor and on concern for students' personal welfare
Involvement	Extent to which students participate actively and attentively in class discussions and activities
Student Cohesiveness	Extent to which students know, help and are friendly towards each other
Satisfaction	Extent of enjoyment of classes
Task Orientation	Extent to which class activities are clear and well organised
Innovation	Extent to which the instructor plans new, unusual class activities, teaching techniques and assignments
Individualisation	Extent to which students are allowed to make decisions and are treated differently according to ability, interest and rate of working
6. *Science Laboratory Environment Inventory (SLEI) (Senior high school or tertiary levels)*	
Student Cohesiveness	Extent to which students know, help and are supportive of one another
Open-Endedness	Extent to which the laboratory activities emphasise an open-ended, divergent approach to experimentation
Integration	Extent to which the laboratory activities are integrated with non-laboratory and theory classes
Rule Clarity	Extent to which behaviour in the laboratory is guided by formal rules
Material Environment	Extent to which the laboratory equipment and materials are adequate

is the writing of questionnaire items to measure individual dimensions. Items then are scrutinised and revised by a group of people with expertise in educational measurement, classroom learning environments or both. This group provides its opinions about each item's face validity, potential readability for the target population, scale allocation, and freedom from various item faults and ambiguities outlined in standard educational measurement texts (e.g., Mehrens & Lehmann, 1984). The next phase is field testing, followed by item analysis aimed at identifying faulty items whose removal would enhance the overall scale characteristics.

Classroom instrument validation serves to enhance confidence in an instrument among researchers or teachers wishing to use that instrument in the future. Two important scale validation indices are *internal consistency* and *discriminant validity*. The common index of internal consistency used with most classroom environment instruments is the alpha coefficient (Cronbach, 1951). A convenient scale statistic used commonly to indicate the discriminant validity is the intercorrelation between scales, or the mean correlation of a scale with the other scales (Rentoul & Fraser, 1978). Another validity index of the student actual form of a classroom environment instrument is its ability to differentiate between classrooms. This characteristic can be investigated using a one-way ANOVA with class membership as the main effect. That is, students within the same class should view the classroom environment similarly, while mean classroom perceptions should vary from class to class.

Fraser (1986a) advised that, as some instruments have more than one form (e.g., an actual and a preferred form), validation data available for only one form strictly cannot be used to infer the validity of other forms of the same instrument. Consequently, it would be desirable to report separate validation data for the student actual and student preferred forms. Further, it is desirable to have scale statistics available for each unit of analysis. Scale reliability and structure can vary somewhat depending on which unit of analysis is adopted (Sirotnik, 1980).

Fraser (1994) summarised validation information for the student actual form of the LEI, CES, ICEQ, MCI, CUCEI and SLEI with the unit of analysis being the individual student. Table 2.3 provides information about each scale's internal consistency reliability (alpha coefficient), discriminant validity (using the mean correlation of a scale with the other scales as a convenient index), and ability to differentiate between classrooms (significance level and the eta^2 statistic from ANOVA). The validation data were based on sample sizes of 1 048 students for the LEI (with exception of mean correlations which were based on 149 class means as data were not available for individual students), 1 083 students for the CES, and 1 849 students for the ICEQ, 2 305 students for the MCI, 372 students for the CUCEI and 3 727 students for the SLEI. Data in Table 2.3 were reported originally by Fraser, Anderson and Walberg (1982) for the LEI, Fisher and Fraser (1983c) for the CES, and Fraser (1990) for the ICEQ, Fisher and Fraser (1981) for the MCI, Fraser, Treagust and Dennis (1986) for the CUCEI, and Fraser, McRobbie and Giddings (1993) for SLEI. Alpha coefficients in Table 2.3 range from 0.54 to 0.85 for the LEI, from 0.51 to 0.75 for the CES, from 0.68 to 0.79 for the ICEQ, from 0.62 to 0.78 for MCI, from 0.70 to 0.78 for CUCEI, and from 0.70 to 0.83 for SLEI. Fraser (1986a) suggested that these values are satisfactory for scales containing only 7 to 10 items. Thus, each of the six instruments has acceptable internal consistency reliability for use in its student actual form with the individual as the unit of analysis.

Table 2.3 also indicates that discriminant validity indices (mean correlation of a scale with the other scales) ranged from 0.08 to 0.40 for the LEI, from 0.09 to 0.40 for the CES, from 0.07 to 0.28 for the ICEQ, from 0.10 to 0.26 for the MCI, from 0.34 to 0.47 for the CUCEI, and from 0.07 to 0.37 for the SLEI. An inspection of the scale intercorrelation matrix for each instrument revealed that every correlation between a pair of scales was appreciably smaller than the square root of the product of the corresponding scale reliability coefficients, which is the value representing perfect conceptual equivalence (Block, 1963) and was low enough to indicate that scales do not measure the same thing (Kroger, 1968). The relatively small values of the mean correlation of a scale with the other scales indicate that each of these instruments has

Table 2.3 **Internal Consistency (Alpha Reliability), Discriminant Validity (Mean Correlation of a Scale with Other Scales) and ANOVA Results for Class Membership Differences (*Eta2* Statistic and Significance Level) for Student Actual Form of Six Instruments Using Individual as Unit of Analysis**

Scale	Alpha Rel.	Mean Correl. with Other Scales	ANOVA Results *Eta*^{2}
Learning Environment Inventory (LEI)	(N=1 048 students)	(N=149 classes)	
Cohesiveness	0.69	0.14	-
Diversity	0.54	0.16	-
Formality	0.76	0.18	-
Speed	0.70	0.17	-
Material Environment	0.56	0.24	-
Friction	0.72	0.36	-
Goal Direction	0.85	0.37	-
Favouritism	0.78	0.32	-
Difficulty	0.64	0.16	-
Apathy	0.82	0.39	-
Democracy	0.67	0.34	-
Cliqueness	0.65	0.33	-
Satisfaction	0.79	0.39	-
Disorganisation	0.82	0.40	-
Competitiveness	0.78	0.08	-
Classroom Environment Scale (CES)	(N=1 083 students)		
Involvement	0.70	0.40	0.29*
Affiliation	0.60	0.24	0.21*
Teacher Support	0.72	0.29	0.34*
Task Orientation	0.58	0.23	0.25*
Competition	0.51	0.09	0.18*
Order and Organisation	0.75	0.29	0.43*
Rule Clarity	0.63	0.29	0.21*
Teacher Control	0.60	0.16	0.27*
Innovation	0.52	0.19	0.26*
Individualised Classroom Environment Questionnaire (ICEQ)	(N=1 849 students)		
Personalisation	0.79	0.28	0.31*
Participation	0.70	0.27	0.21*
Independence	0.68	0.07	0.30*
Investigation	0.71	0.21	0.20*
Differentiation	0.76	0.10	0.43*
My Class Inventory (MCI)	(N=2 305 students)		
Cohesiveness	0.67	0.20	0.21*
Friction	0.67	0.26	0.31*
Difficulty	0.62	0.14	0.18*
Satisfaction	0.78	0.23	0.30*
Competitiveness	0.71	0.10	0.19*
College and University Classroom Environment Inventory (CUCEI)	(N=372 students)		
Personalisation	0.75	0.46	0.35*
Involvement	0.70	0.47	0.40*
Student Cohesiveness	0.90	0.45	0.47*
Satisfaction	0.88	0.45	0.32*
Task Orientation	0.75	0.38	0.43*
Innovation	0.81	0.46	0.41*
Individualisation	0.78	0.34	0.46*
Science Laboratory Environment Inventory (SLEI)	(N=3 727 students)		
Student Cohesiveness	0.77	0.34	0.21*
Open-Endedness	0.70	0.07	0.19*
Integration	0.83	0.37	0.23*
Rule Clarity	0.75	0.33	0.21*
Material Environment	0.75	0.37	0.21*

*$p<0.01$
Based on Fraser (1994)

adequate discriminant validity (at least in their student actual form). It appears that each instrument measures distinct although somewhat overlapping aspects of classroom environment.

With the exception of LEI, the figures in the last column in Table 2.3 provide data about the ability of each scale to differentiate between the perceptions of students in different classes. ANOVA results indicate that every scale in the CES, ICEQ, MCI, CUCEI and SLEI differentiated significantly ($p<0.01$) between classrooms. The eta^2 statistic—which is the ratio of 'between' to 'total' sums of squares and indicates the proportion of variance explained by class membership—ranged from 0.18 to 0.43 for the CES, and from 0.20 to 0.43 for the ICEQ, from 0.18 to 0.31 for the MCI, from 0.32 to 0.47 for the CUCEI, and from 0.19 to 0.23 for the SLEI. Because the purpose of Table 2.3 is to provide an overview of a limited number of statistics for all scales contained in these classroom environment instruments, it is restricted to the student actual form of scales and to the use of the individual student as the unit of analysis.

2.4.3 Individualisation and Constructivism in the Science Learning Environment

Because there was particular interest in the degree of individualisation and constructivism in agricultural science classes in the present study, this section reviews literature relevant to these two themes. Many contemporary science curricula emphasise student-centred approaches which allow the student to participate actively and for which different students within the same class simultaneously work on different topics and proceed at their own rates (Cohen & Fraser, 1987). In an attempt to assess the extent of individualisation in a classroom environment, Fraser (1990) designed the *Individualised Classroom Environment Questionnaire (ICEQ)* to assess characteristics such as personalisation, participation, independence, investigation and differentiation (see Section 2.4.2). Because student-centred teaching approaches are not common in Nigeria, it was considered desirable to incorporate some of the ICEQ's dimension into the instrument used in the present study.

Until recently, the common model for science instruction has been based on the hidden assumption that knowledge can be transferred intact from the mind of the teacher to the mind of the learner (i.e., teacher-centred instruction). Resnick (1983) discussed the *constructivist model of knowledge* as an attempt to answer the primary question of epistemology (i.e, how do we come to know what we know?) and summarised this model as meaning that knowledge is constructed in the mind of the learner. The traditional view of knowledge was based on a realist perspective which assumes that we come into the world as discoverers who build copies of reality in our minds. Von Glaserfeld (1984) stated that teaching and learning are not synonymous; we can teach, and teach well, without having the students learn. He summarised the constructivist model as a procedure in which learners construct understanding. They do not simply mirror and reflect what they are told or what they read. Learners look for meaning and try to find regularity and order in the events of the world even in the absence of full or complete information.

In the present research in agricultural science classes, it was considered important that the classroom environment instrument used provide a measure of the extent to which the classroom was constructivist-oriented. Therefore, an instrument designed by Taylor and Fraser (1991) was considered for adoption and adaptation for this study in Nigeria.

Fraser and Tobin (1991) observed teachers interacting with active students and reported that they learn more than passive students. Teachers therefore should reject a model in which the student is more or less a recipient of knowledge and replace it by an active learner model. A problem with constructivism could be the logical consequences of the assumption that knowledge is constructed in the mind of the learner. Von Glasersfeld (1984) described the construction of knowledge as a search for a fit rather than a match with reality. But there are possibilities that keys with different shapes can open a given lock. It is the difference between the concepts of fit and match that indicate how radically constructivism differs from the traditional view

of knowledge. The constructivist model is an instrumentalist view of knowledge; knowledge is good if and when it works and achieves the goals.

Von Glaserfeld (1984) outlined a radical constructivist model of knowledge and describes how this model relates to Piaget's theory of intellectual development. Wood (1976) reported that Piaget was not a developmental psychologist but, rather, an epistemological psychologist. He studied the development of thought in children and devised a model of intellectual development, which explains age domains and corresponding intelligence or cognitive development stages. Piaget proposed four stages in intellectual development. The first stage is the Sensorimotor stage (0-2 years) when the infant is bounded by what s/he can perceive and do immediately. The extent of Piaget's commitment to constructivism is reflected in Piaget's (1967) description of the period between birth and the acquisition of knowledge. At 18 months or two years, this sensorimotor assimilation of the immediate external world effects a miniature Copernican revolution. At the starting point of this development, neonates grasp everything to themselves, in precise terms, to their own body whereas, at the termination of this period (i.e., when language and thought begin), for all practical purposes they are but one element or entity among others in a universe that they gradually have constructed themselves, and which thereafter they will experience as external to themselves. At the second stage or the Pre-operational stage (at 2 to 7 or 8 years), the child displays static imagery; s/he can perform no mental operations (Piaget, 1972; Piaget & Inhelder, 1969).

But, Bruner (Bruner 1966, 1971; Bruner, Olver, & Greenfeld, 1966) argued that what differentiates infantile from mature thought is not a different set of mental operations or mental structures, but different skill in extracting the necessary information from events and in recognising what is most appropriate in order to solve problems (i.e., failures of attention, representation and coding rather than a lack of logical abilities). The third stage is the Concrete operational stage (about 8 years) when the child, now adept in the transformation of certain types of mental representations, can perform such operations

upon the representations of real or 'concrete' events (such as the dimensions of a volume of liquid). The child as yet cannot afford similar treatment to abstract, formal material. At the fourth stage or Formal operational stage (10 and above years), Piaget pointed out that children could enter the stage of full intellectual maturity. Now children can think about and operate upon abstractions; s/he can argue in terms of abstract postulates and suppositions and construct hypothetical possibilities which never can exist in reality; s/he can start to understand the logician, the philosopher and the moralist.

Piaget believed that knowledge is acquired as the result of a life-long constructive process in which we try to organise, structure and restructure our experiences in light of the existing schemes or thought, and gradually modify and expand these schemes. He defined knowledge as "invariance under transformation", but considered that it has no meaning outside the constructivist perspective. He argued that objects appear permanent or invariant as the result of the individual's coordination of experiential data and the subsequent projection of these coordinations onto the world that lies beyond our senses. Piaget was the first contemporary theorist to present a full and coherent view of intellectual development. Bruner postulates three modes of representation for knowledge, namely, in action (enactive), in images (iconic) and in various (symbolic) media. In this respect, his views resemble those of Piaget, who employed a similar set of distinctions.

According to Tobin (1990), constructivism is a theory of learning that assumes that knowledge cannot exist outside the bodies of cognising beings. Von Glaserfeld (1988) traced persistent constructivism epistemology to an eighteenth century statement by Giambattista in 1710 who deliberately and explicitly renounced the traditional contention that knowledge should reflect the world in an 'objective' ontological way and declared further that human reason could (and should) contemplate and govern the world of human experience and not the world as God might have made it.

Tobin (1990) claimed that constructivism recognises a reality that exists independently of cognising beings (i.e., the universe continues to exist in a physical sense when there are no longer persons to think about its existence). However, the experiences of cognising beings are constructs that are shaped by what is known and understood by an individual. Tobin further explains that experience involves an interaction of an individual with events, objects or phenomena in the universe (i.e., an interaction of the senses with reality). Personal construction is the result of experience or an image of reality, which fits the external reality but is not a match. All experiences are therefore subjective, as the senses are not conduits to the external world through which truths are conducted, but rather the senses of humans are embodied. Objectivity, which is an assumed part of epistemologies such as logical positivism, is not possible for cognising beings. Knowledge is a construction of reality, one that is viable in the sense that it allows an individual to survive in his/her environment. Unviable knowledge will result in unintended consequences causing a perturbation to be resolved. Subsequent thoughts and actions can eliminate the perturbation by adopting existing knowledge to accommodate discrepant experiences. Thus, knowledge is constructed and adopted as a result of successive experiences and reflections. Whereas objectivism would want knowledge to match the reality or truths about the universe, constructivism assumes that the truth will be elusive forever. Tobin (1990) reported that the constructivist goal of science is not to discover truths of the universe in which we live (i.e., to match what we know and understand with truths), but to construct viable models to fit with current understandings and experience.

Children develop ideas about natural phenomena before they are taught science in school (Driver, Guesne, & Tiberghien, 1985; Gentner & Stevens, 1983; Helm & Novak, 1983; Jung, Pfundt, & Rhoneck, 1982; Pfundt & Duit, 1985). These ideas have been described variously as 'preconceptions', 'misconceptions', 'intuitions' and 'alternative conceptions'. It was reported that, in many cases, there are significant differences between children's notions and school science. Surveys carried out in various countries have identified commonalities in children's ideas, and developmental studies give insights into the

characteristic ways in which ideas progress during the childhood years (Carey, 1985; Strauss & Stavy, 1982). Investigations have indicated that such ideas are more than misinformation. But, children construe events and phenomena which are coherent within their domains of experience, yet which can differ substantially from the scientific view. According to Viennot (1979), these notions can persist in the child to adulthood despite formal learning.

Driver (1991) described an epistemological basis of children's ideas or conceptions about the world that could be interpreted from a constructivist perspective. Children's ideas are mental representations (i.e., a process by which human beings construct mental models of their environment and new experiences are interpreted and understood in relation to existing mental models or schemes). Researchers (Anderson, 1984; Schank & Abelson, 1977; Strauss, 1981; von Glaserfeld, 1984) describe mental representation as adaptive in that the learner is an architect of the knowledge and constraints are internal (i.e., capacity of the mind) and external (i.e., physical environment and culture). With problem solving in highly organised domains of knowledge, the learner constructs a representation (inferences) of the 'problem space' as a basis for deductions (Greeno, 1978; Newell & Simon, 1972). Von Glasersfeld (1983, 1988) has argued that our experiences test the viability of our knowledge in much the same way in which Darwin's theory of evolution tests the viability of an organism. Natural selection eliminates organisms that do not fit by operating on a single criterion. Either the organism fits the constraints of its environment or it does not. In much the same way, knowledge is viable as long as it works, as long as it stands up to the constraints of our experiences.

Driver (1991) listed three aspects of the process of knowledge construction in science: personal construction; interpersonal construction; and the public construction of scientific knowledge. In the classroom, each student has developed ideas about the natural world and, in the process of learning in the classroom through talk, demonstrations and listening, personally-constructed ideas get modified. Discussion with an adult (teachers/parents) could lead to

the understanding of publicly-constructed knowledge. A constructivist approach also reflects Kuhn's (1970) views of how science progresses, and that ideas are recognised only if considered acceptable by the science community (in this case, students).

Taylor and Fraser (1991) developed a new instrument to investigate constructivist aspects of the classroom learning environment. Four scales were developed to measure important aspects of a constructivist classroom learning environment. The Negotiation scale measures perceptions of the extent to which there are opportunities for students to interact, negotiate meaning and build consensus. The Autonomy scale measures perceptions of the degree to which there are opportunities for students to exercise meaningful and deliberate control over their learning activities, and think independently of the teacher and other students. The Prior Knowledge scale measures perceptions of the extent to which there are opportunities for students meaningfully to integrate their prior knowledge and experiences with their newly-constructed knowledge. The Student-Centredness scale measures perceptions of the extent to which there are opportunities for students to experience learning as a process of creating and resolving personally problematic experiences.

The four dimensions of this version of the CLES were selected for inclusion in the classroom environment instrument in the present study. (It should be noted, however, that a revised version of the CLES was produced by Taylor, Fraser, & White, 1994, after the present study had been conducted.) Before using the CLES in the present study, all items were checked for their suitability for Nigerian agricultural science classes, and modified if necessary. Furthermore, based on item analyses described in Section 4.4, some of the items in the CLES were removed prior to other data analyses.

Taylor and Fraser (1991) describe learning as a process of making sense of experience in terms of prior knowledge. Making sense implies that the learner will reflect on the experience and what s/he already knows. Sense making in this context is deliberative and personal. In a classroom environment, sufficient time is needed for individuals to

work out what is happening and to resolve any perturbations. Prior knowledge is used to make sense of experience and, as a consequence, teachers could give close attention to the prior knowledge of each student in the class. However, prior knowledge might be available in verbal form or it might only be available as an image (i.e., knowledge to which language has not yet been assigned). Even so, images have the potential to influence behaviour and future learning. Accordingly, all forms of prior knowledge need to be considered in the process of learning.

Taylor and Fraser (1991) asked how teachers can assume responsibilities such as are implied by 'autonomy', 'prior knowledge', 'negotiation' and 'student-centredness'. They explained that, because learning involves personal constructions of individuals, the ultimate responsibility for learning must rest with the learner. Individuals working alone or collaborating with peers, therefore, provide a way for learners to deal with their own prior knowledge as they learn new concepts. Taylor and Fraser (1991) describe the social dimension of constructivist learning and defined language as a social construction, which reflects on what is done and known. As a result of interactions and negotiations with members of the community, an individual comes to understand the meanings of, and use of, language. They further elaborate that the conventions of a culture are learned by living in that culture, by experiencing the customs, myths, taboos and beliefs, and by negotiating the meanings of the extant symbols and signs.

In conclusion, learning of science is only possible because of the development of language and symbols to represent the concepts of science. At the heart of the curriculum is negotiation of meaning (Taylor & Fraser, 1991; Taylor, Fraser, & White, 1994). They recommended that students need to be given opportunities to make sense of what is learned by negotiating meaning, comparing what is known to new experiences, and resolving discrepancies between what is known and what seems to be implied by new experiences, thus reaching equilibrium and removing curiosity. Negotiation also can occur between individuals in a classroom. The process involves discussion and attentive listening, making sense of the points of views

of others, comparing personal meanings to those embedded within the theories of peers, and finally consensus. Students can learn to compare knowledge constructed in class with knowledge constructed by the community of scientists, following the process of accessing other learning resources such as books, videotapes and practising scientists. By engaging in such a process, students can realise what is regarded as a viable theory.

Consistent with a constructivist approach to teaching science, the classroom environment should encourage the process of personal and interpersonal construction of knowledge in order to enable students to recognise public scientific knowledge as a product of social processes and that learning science requires students to be initiated into a scientific culture which is distinct from everyday culture. The teacher must be prepared to stand back and let the students construct and evaluate ideas as commitment and enthusiasm come with the ownership of ideas.

Because individualised and constructivist approaches are uncommon in Nigeria, it was thought to be timely to include in this study a focus on the use of individualised and constructivist approaches in agricultural science classroom environments in Nigeria. The classroom environment questionnaire used in the present study is discussed further in Section 3.3.1 and 4.4.

2.5 EFFECTS OF CLASSROOM ENVIRONMENT ON STUDENT OUTCOMES

Whereas Section 2.3 provided a broad review of past classroom environment research in science, the next two sections review two specific aspects of past research on classroom environment that are central to the aims of the present study. The particular focus of the present section is on past research on associations between student outcomes and the nature of the classroom environment. In contrast, Section 2.5 focuses on past research on determinants of classroom learning environment. These two topics are reviewed in separate

sections because they formed major areas of investigation in the present study.

Much past classroom environment research has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classrooms (Haertel, Walberg, & Haertel, 1981). Fraser and Fisher's (1982b) study illustrates some of the methodological complexity involved in rigorous studies of the effects of classroom environment on student outcomes. Three cognitive and six affective measures were administered both at the beginning and end of the same school year, while classroom environment was assessed by administering the CES and ICEQ at mid-year. In addition, information was gathered about student general ability. In order to permit comparison with results from methodologically diverse past studies, data were analysed in six different ways (namely, simple, multiple and canonical correlation analyses performed separately for raw posttest scores and residual posttest scores adjusted for corresponding pretest and general ability). Separate methods of analysis yielded consistent support for the existence of outcome-environment relationships and led to no major conflicts when explicating the specific form of such relationships in terms of particular outcomes and environment dimensions. Most research programs revealed that student perceptions account for appreciable amounts of variance in learning outcomes, often beyond that attributable to background student characteristics. The implication is that student outcomes might be improved by creating classroom environments found empirically to be conducive to learning (Fraser, 1986a).

Table 2.4 lists a set of 43 past studies in which the effects of classroom environment on student outcomes were investigated. Studies are grouped according to whether they involved use of the LEI, CES, ICEQ or another instrument. Also studies in developing countries are grouped together. The table shows that studies of associations between outcome measures and classroom environment perceptions have involved a variety of cognitive and affective outcome measures, a

Table 2.4 Details of Studies of Associations Between Student Outcomes and Classroom Environment

Study	Outcome Measures	Sample
Studies Involving LEI		
Anderson & Walberg (1968); Walberg & Anderson (1968); Anderson (1970); Walberg (1969a, 1969b, 1972)	Selected from: achievement; understanding of nature of science; science processes; participation in physics activities; science interest; attitudes	Various samples (maximum of 144 classes) of senior high school physics students mainly in USA, but with some in Canada
Walberg & Anderson (1972)	Examination results	1 600 Grade 10 and 11 students in various subject areas in 64 classes in Montreal, Canada
Lawrenz (1976)	Science attitudes	238 senior high school science classes in midwest USA
Fraser (1978a, 1979a)	Enquiry skills; attitudes; understanding of nature of science	531 students in 20 Grade 7 science classes in Melbourne, Australia
Power & Tisher (1975, 1979)	Achievement; attitudes; satisfaction	315 junior high school students in 20 science classes in Melbourne, Australia
Hofstein *et al.* (1979)	Attitudes	400 Grade 11 students in 12 chemistry classes in Israel
Haladyna, Olsen & Shaughnessy (1982); Haladyna, Shaughnessy & Redsun (1982a, 1982b); Haladyna, Shaughnessy & Shaughnessy (1983)	Attitudes	5 804 science, mathematics and social studies students in 277 Grade 4, 7, and 9 classes in Oregon, USA

(cont.)

Table 2.4 Details of Studies of Associations Between Student Outcomes and Classroom Environment (continued)

Study	Outcome Measures	Sample
Studies Involving CES		
Trickett & Moos (1974)	Satisfaction and mood criteria	608 students in 18 classes in USA
Moos & Moos (1978)	Absences; grades	19 high school classes in one school in USA
Moos (1979)	Indexes of student reactions	241 secondary school classes in various subject areas
Fisher & Fraser (1983b)	Enquiry skills; attitudes	116 Grade 8 and 9 science classes throughout Tasmania, Australia
Galluzi *et al.* (1980)	Psychological outcomes	414 Grade 5 students in USA
Humphrey (1984)	Self-control	750 Grade 4 and 5 children in 36 classes in USA
Keyser & Barling (1981)	Academic self-efficacy beliefs	504 Grade 6 children in South Africa
Studies Involving ICEQ		
Rentoul & Fraser (1980)	Enquiry skills; enjoyment	285 junior high school students in 15 science and social science classes in Sydney, Australia
Wierstra (1984)	Attitudes; achievement	398 15-16 year-old students in 9 classes in The Netherlands

(cont.)

Table 2.4 Details of Studies of Associations Between Student Outcomes and Classroom Environment (continued)

Study	Outcome Measures	Sample
Wierstra *et al.* (1987)	Attitudes; achievement	1 105 secondary school students in 66 classes involved in Dutch option of Second International Science Study
Fraser (1981c); Fraser & Butts (1982)	Attitudes	Maximum of 712 students in 30 junior high school science classes in Sydney, Australia
Fraser, Nash & Fisher (1983)	Anxiety	116 Grade 8 and 9 science classes throughout Tasmania, Australia
Fraser & Fisher (1982b)	Enquiry skills; attitudes	116 Grade 8 and 9 science classes throughout Tasmania, Australia
Studies Involving MCI		
Fraser & Fisher (1982a, 1982c)	Enquiry skills; understanding of nature of science; attitudes	2 305 Grade 7 science students in 100 classes in Tasmania, Australia
Payne *et al.* (1974-75); Ellett *et al.* (1977); Ellett & Walberg (1979)	Achievement; school attendance	6 151 Grade 4 students in 89 schools in Georgia, USA
Fraser & O'Brien (1985)	Word knowledge; comprehension	758 Grade 3 students in 32 classes in Sydney, Australia

(cont.)

Table 2.4 Details of Studies of Associations Between Student Outcomes and Classroom Environment (continued)

Study	Outcome Measures	Sample
Lawrenz (1988)	Energy knowledge; two energy attitude scales	Approximately 1 000 Grade 4 and 7 students in 34 classes in Arizona, USA
Studies Involving Other Instruments		
Kelly (1980)	Achievement	41 657 students in 1 735 schools in 14 developed countries involved in an IEA science study
Johnson *et al.* (1981); Johnson *et al.* (1986); Slavin (1983a, 1983b)	Different studies included: achievement; cross-ethnic relationships; cross-handicap relationships	Various samples involved in studies of cooperative learning strategies in various subjects, especially in USA
Fraser & Treagust (1986)	Satisfaction; locus of control	372 higher education students in 34 classes in various subject areas
Talton (1983)	Attitude; achievement	1 456 Grade 10 biology students in 70 classes in 4 schools in North Carolina
Perkins (1978)	Basic skills	3 703 Grade 4 students in 42 elementary schools in a SE state in USA
Brookover & Schneider (1975); Brookover *et al.* (1978, 1979)	Achievement	8 078 Grade 4 and 5 students in Michigan, USA

(cont.)

Table 2.4 Details of Studies of Associations Between Student Outcomes and Classroom Environment (continued)

Study	Outcome Measures	Sample
Gardner (1974, 1976)	Attitudes	1 014 Grade 11 physics students in 58 classes in Melbourne, Australia
Payne *et al.* (1974-75); Ellett & Walberg (1979)	Achievement	3 350 elementary and 3 613 secondary students in various subject areas and 1 200 teachers in Georgia, USA
Wubbels *et al.* (1988) Brekelmans *et al.* (1990)	Achievement; attitudes	1 105 secondary school students in 66 classes involved in Dutch option of Second International Science Study
McRobbie & Fraser (1993)	Cognitive; affective	1 594 senior high school chemistry students in 92 classes in Queensland, Australia
Wong & Fraser (1994)	Affective	1 592 Grade 10 chemistry students in 56 classes in Singapore
Henderson, Fisher & Fraser (1994)	Attitudes; achievement; practical performance	489 senior secondary students in 28 biology classes
Studies in Developing Countries		
Walberg, Singh & Rasher (1977)	Achievement	3 000 Grade 10 science and social science students in 150 classes in Rajasthan, India

(cont.)

Table 2.4 Details of Studies of Associations Between Student Outcomes and Classroom Environment (continued)

Study	Outcome Measures	Sample
Schibeci, Rideng & Fraser (1987)	Attitudes	250 Grade 11 biology students in six classes in Indonesia
Paige (1978, 1979)	Achievement; individual modernity	1 621 Grade 6 students in 60 schools in East Java, Indonesia
Holsinger (1972, 1973)	Information learning; individual modernity	2 533 Grade 3-5 students in 90 classes in Brazil
Persaud (1976)	Noncognitive outcomes including social development and aspiration levels	1 277 Grade 3 and 6 students in 18 schools in Jamaica
Chatiyanonda (1978)	Attitudes	989 Grade 12 physics students in 31 classes in or near Bangkok, Thailand
Akindehin (1993)	Attitudes	1 382 students in 32 schools in Ondo State, Nigeria

Based on Fraser (1994)

variety of classroom environment instruments, and a variety of samples (ranging across numerous countries and grade levels).

In general, past research suggests that better achievement on a variety of outcome measures was found consistently in classes perceived as having greater Cohesiveness, Satisfaction and Goal Direction, and less Disorganisation and Friction (Haertel, Walberg, & Haertel, 1981). Separate methods of analysis yielded consistent support for the

existence of outcome-environment relationships and led to no major conflicts when explicating the specific form of such relationships in terms of particular outcomes and learning environment dimensions. In particular Fraser and Fisher's (1982b) study yielded some important tentative implications for educators wishing to enhance students' achievement of particular outcomes by creating classroom environments found empirically to be conducive to achievement. Fraser and Fisher reported that practitioners are likely to find useful the finding that Order and Organisation seemed to have a positive influence on student achievement of a variety of aims.

One of the major aims of the present study was to investigate associations between the nature of the classroom environment in Nigerian agricultural science classes and several student outcomes (namely, attitudes, enquiry skill proficiency and practical performance). In designing this research and choosing methods of analysis, guidance was obtained from the research reviewed in this section (see Table 2.4).

In contrast to this section's focus on research on the use of classroom environment assessments as independent variables (the effects of environment), the next section is devoted to studies which involved classroom environment dimensions as dependent variables (determinants of environment).

2.6 DETERMINANTS OF CLASSROOM ENVIRONMENT, ESPECIALLY SCHOOL ENVIRONMENT

McRobbie and Fraser (1993) note that classroom environment perceptions have been employed not only as predictor variables in research on the effects on classroom environment. Also, many past studies have involved the use of classroom environment scales as criterion variables in studies of determinants of classroom environment. Fraser (1986b) divided research that involved the use of classroom environment dimension as dependent variables into (1) curriculum evaluation studies (2) investigations of differences between student and teacher perceptions of actual and preferred environment, and (3) studies involving other independent variables.

Classroom environment instruments have been used as a source of process criteria in curriculum evaluation (Fraser, 1981a; Walberg, 1975). Studies involving the Australian Science Education Project (ASEP) (Fraser, 1979a) and Harvard Project Physics (Welch & Walberg, 1972) revealed that classroom environment variables differentiated revealingly between alternative curricula when measures of student achievement of cognitive and attitudinal goals have shown little sensitivity.

Similarly, Fraser, Williamson and Tobin (1987) used classroom environment dimensions as criteria in evaluating alternative high schools. More recently, Teh and Fraser (in press, a, b) used a classroom environment questionnaire in evaluating computer-assisted learning (CAL) in Singapore. They found that, relative to a control group, the CAL group perceived their classes significantly more positively in terms of gender equity, investigation, innovation and resource adequacy. Effect sizes (i.e., the difference between experimental and control groups expressed in standard deviations) ranged from 1.0 to 1.9 for different scales.

Studies in the United States (Moos, 1979), Australia (Fisher & Fraser, 1983a; Fraser, 1982), the Netherlands (Wubbels, Brekelmans, & Hooymayers, 1991) and Israel (Hofstein & Lazarowitz, 1986; Raviv, Raviv, & Reisel, 1990) compared students' and teachers' perceptions and found that, first, both students and teachers preferred a more positive classroom environment than they perceived as being actually present and, second, teachers tended to perceive the classroom environment more positively than did their students in the same classrooms. These results replicate findings in other settings such as hospital wards and work milieus (e.g., Moos, 1974, 1979). These studies indicate that students and teachers are likely to differ in the way in which they perceive the actual environment of the same classrooms, and that the environment preferred by students commonly differs from that actually present in classrooms.

Fraser (1994) has provided a table which summarises studies aimed in identifying how the classroom environment varies with such factors

as teacher personality, subject matter, and the type of school. For example, in a study involving students' preferences for different types of classroom environments, girls were found to prefer cooperation more than boys, but boys preferred both competition and individualisation more than girls (Owens & Straton (1980). In other studies, it was found that classroom environment varies with school type (Trickett, 1978), class size (Anderson & Walberg, 1972), and grade level (Welch, 1979), and between schools of different types (Trickett, Trickett, Castro, & Schaffner, 1982) and between Catholic and government schools (Dorman, Fraser, & McRobbie, 1994).

Another determinant of classroom environment which is highly relevant to the present study in Nigeria is school environment. School-level environment involves psychosocial aspects of whole schools (Anderson, 1982; Fraser & Rentoul, 1982; Genn, 1984). Although they have common development and logical linkages, the fields of classroom-level and school-level environment have remained remarkably independent. School climate research owes much in theory, instrumentation and methodolology to earlier work on organisational climate in business contexts (Anderson, 1982). School-level environment is associated specifically with the field of educational administration and is based on the assumption that schools can be viewed as formal organisations. The environment is a set of factors which "give each school a personality, a spirit, a culture" (Tye, 1974). Indeed, attention to school environment can contribute to school improvement.

Fisher & Fraser (1990) traced school environment instrument development to 1958. Moos, in the early 1970s, worked in a variety of human environments including hospital wards, school classrooms, prisons, military companies, university residences and 'ordinary' workplaces (Moos, 1974). He found three general psychosocial dimensions in these environments: relationship dimensions (e.g., peer support); personal development dimensions (e.g., professional interest); and system maintenance and system change dimensions (e.g., innovation). Moos (1981) developed a questionnaire about work environments which was called the *Work Environment Scale.*

Another instrument, called the *School Level Environment Questionnaire (SLEQ)* (Fisher & Fraser, 1990) was developed to characterise important aspects in the school environment, such as relationships among teachers and between teachers and students and the organisational structure of the school. The SLEQ also covers Moos's three general categories of relationship, personal development and system maintenance and system change dimensions. The SLEQ's validity was explored through extensive interviews with teachers to ensure that dimensions and individual items covered what teachers saw as salient, and that only material which was specifically relevant to the school was included. The SLEQ achieves economy by having a relatively small number of reliable scales, each containing a fairly small number of items (namely seven).

The SLEQ contains seven scales. Two scales measure the Relationship Dimension (Student Support, Affiliation), one measures the Personal Development Dimension (Professional Interest) and four measure the System Maintenance and System Change Dimension (Staff Freedom, Participatory Decision Making, Innovation and Resource Adequacy). To complete the view of the school environment, an eighth scale named Work Pressure was added recently. In the present research into agricultural science, school environment was assessed with an instrument based on the SLEQ (see Sections 3.3.2 and 4.7).

Only a limited number of past studies has attempted to investigate whether the nature of the school-level environment affects the classroom environments within a school. Using the SLEQ, Fraser and Rentoul (1982) investigated associations using scales from the *Individualised Classroom Environment Questionnaire,* while Fisher, Fraser and Wubbels (1993) researched relationships using dimensions assessed by the *Questionnaire of Teacher Interaction.* The present study in Nigeria is distinctive in that it is one of the few studies to incorporate assessments of both classroom environment and school environment (as assessed with a version of the SLEQ) within the same investigation.

Section 3.3.2 in the methodology chapter provides further information about the SLEQ and reports validity data for three samples from past research.

2.7 SUMMARY AND CONCLUSIONS

The review of literature in this chapter reveals that agricultural science occupies a prominent position in Nigeria's educational history. The agriculture sector was the main source of Nigeria's revenue prior to the late 1970s. At present, the rollback economic policy and the functional education policy are efforts to bring agriculture to its previous status. Because of the central place of agricultural science in the Nigerian school curriculum, the decision to focus the present research on Nigerian agricultural science classes was timely.

A review of past classroom environment research showed that numerous instruments for assessing student perceptions of learning environment have been developed, validated and used in research. Because student-centred teaching is uncommon in Nigerian schools, it was decided that a useful instrument for the present study would be one that included modified versions of scales adapted from the *Individualised Classroom Environment Questionnaire* (Fraser, 1990) and the *Constructivist Learning Environment Survey* (Taylor & Fraser, 1991).

The literature suggests that the most common line of classroom environment research has involved the effects of learning environment on student outcomes (Haertel, Walberg, & Haertel, 1981). In line with this trend, an aspect of the present research involved investigating associations between student-perceived classroom environment in Nigerian agricultural science classrooms and several student outcomes (namely, attitudes, enquiry skills and practical performance).

In contrast to research on the effects of classroom environment on student outcomes, other past research has involved investigating determinants of classroom environment (i.e., learning environment

dimensions as dependent variables) (see Fraser, 1986b). It was decided that the present research would involve investigation of two classroom environment determinants, namely, the school environment and geographical location.

Chapter 3

METHODOLOGY

3.1 INTRODUCTION

Whereas the previous chapter was devoted to a review of literature relevant to the present study, the purpose of this chapter is to describe the methodology followed in the present research into the effects and determinants of the psychosocial environment of agricultural science classes in Nigeria. In Chapter 4, the results of the study are reported.

In this chapter on methodology, some of the major topics considered are:

- the sample (Section 3.2);
- an instrument for assessing classroom environment (Section 3.3.1);
- an instrument for assessing school environment (Section 3.3.2);
- an instrument for assessing attitudes (Section 3.3.3);
- an instrument for assessing enquiry skills (Section 3.3.4);
- an instrument for assessing performance skills (Section 3.3.5);
- procedures followed, including data analysis (Section 3.4).

3.2 SAMPLE

The study involved the representative sample of 20 schools described in Table 3.1. Of the 20 schools, 13 were in urban areas and 7 were from rural areas. In terms of location, 11 schools were from Northern States, 7 were from Southern States and 2 were from the Federal Capital. (In fact, location of schools was one of the variables included

in the present study.) Overall eight states were represented, in addition to the Federal Capital. The location of the eight states involved and the Federal Capital are shown in Figure 1.1 in Chapter 1.

Each school was approached directly and asked to provide at least two agricultural science classes to participate in the study. In fact, 1 175 students in 50 classes (45 at the junior high school level and 5 at the senior high school level) participated in the study by providing responses to the classroom environment and outcome measures. In addition, the teachers of the two classes in each school, together with any other interested agricultural science teachers, were asked to respond to the school environment instrument. Altogether, 64 agricultural science teachers in these 20 schools were involved in the study.

Table 3.1 Description of the Sample

States	Location	Number of Schools	
		Urban	Rural
Anambra	Southern State	1	1
Bauchi	Northern State	1	1
Enugu	Southern State	1	
Federal Capital (Abuja)	Nigeria's Capital	2	
Kaduna	Northern State	2	1
Kwara	Northern State	1	1
Osun	Southern State	1	1
Rivers	Southern State	1	1
Sokoto	Northern State	3	1
		13	7

3.3 ASSESSMENT INSTRUMENTS

The five instruments included in the study were a classroom environment instrument, a school-level environment instrument,

and three instruments assessing student outcomes (a science attitude questionnaire, an enquiry skills test, and a performance skills test). Each of these is described in detail below in Sections 3.3.1 to 3.3.5.

The initial development of the two environment instruments was guided by four criteria. First, literature reviews were carried out to identify dimensions that could be considered important in these educational environments. Second, dimensions chosen provided coverage of the three general categories of dimensions identified by Moos (1974) for conceptualising all human environments (see further details in Section 2.4). Third, by interviewing in Western Australia 10 science teachers and 30 students at the upper secondary level and 5 educators at the university level and asking them to comment on draft versions of a set of items, an attempt was made to ensure that the assessment instruments' dimensions and individual items were considered salient by teachers and students. Fourth, to achieve economy in terms of the time needed for answering and scoring, the environment instruments were designed to have a relatively small number of reliable scales, each containing a fairly small number of items.

To permit investigation of relationships between classroom environment perceptions and learning outcomes in the present study, the agricultural science teachers administered three outcome measures (attitudes, enquiry skills, practical performance) discussed in Sections 3.3.3 to 3.3.5.

3.3.1 *Learning Environment Scale (LES)*

As discussed previously, it was decided that this study would focus on constructivist and individualised aspects of classroom environment. Consequently, the trial version of a classroom environment instrument (called the *Learning Environment Scale, LES)* included scales selected from the *Constructivist Learning Environment Survey (CLES)* (Taylor & Fraser, 1991) and the *Individualised Classroom Environment Questionnaire (ICEQ)* (Fraser, 1990). The four scales from the CLES are called Negotiation, Prior Knowledge, Autonomy

and Student Centredness. The two scales chosen from the ICEQ for use in the present study were Investigation and Differentiation.

The version of the LES administered in this investigation contained 48 items altogether, with 7 items in each of the four CLES scales and 10 items each in the two ICEQ scales. (However, as explained later in Section 4.3, the whole Prior Knowledge scale and several other original items were omitted after item analysis procedures to form a final version of the LES containing 32 items). The five response categories for each item were Almost Never, Seldom, Sometimes, Often and Very Often. Also each item was checked for its relevance and suitability for Nigerian agricultural science classes before using it in the present study.

Table 3.2 provides some descriptive information for each of the five remaining LES scales, including a scale description, a sample item and its classification according to Moos's (1974) scheme for characterising all human environments.

Students responded to both an 'actual' version of the LES (what the class currently is like) and a 'preferred' version (how students would prefer the class to be). Appendix I contains the actual form of the LES, while Appendix II contains the separate answer sheet for the actual form. The preferred form of the LES and answer sheet are provided, respectively, in Appendices III and IV.

Items 1-42 in Appendix I are arranged in cyclic order so that the first, second, third, fourth, fifth and sixth items in each block assess, respectively, Negotiation, Prior Knowledge, Autonomy, Student Centredness, Investigation and Differentiation. For Items 43-48, odd-numbered items assess Investigation while even numbered items assess Differentiation. Information provided at the beginning of Appendix I shows how the 32 items in the final version of the LES are allocated to scales and scored

Table 3.2 Scale Description and Sample Item for Scales in the Learning Environment Scale (LES)

Scale Name	Description of Scale	Sample Item	Scoring Direction
Negotiation	Extent to which students interact socially for the purpose of negotiating meaning and building consensus.	In this class, I talk with other students about the most sensible way of solving a problem.	+
Autonomy	Extend to which students control their learning and think independently.	In this class, I do investigations in my own way.	+
Student-Centredness	Extent to which students experience learning as a personally problematic experience.	In this class, I learn the teacher's method for doing investigations.	-
Investigation	Emphasis on the skills and processes of enquiry and their use in problem solving and investigation.	Students find out the answers to questions and problems from the teacher rather than from investigations.	-
Differentiation	Emphasis on the selective treatment of students on the basis of ability, learning style, interests and rate of working.	Different students use different books, equipment and materials.	+

Items designated (+) are scored 1, 2, 3, 4 and 5, respectively for the responses Almost Never, Seldom, Sometimes, Often and Very Often. Items designated (-) are scored in the reverse manner. Omitted or invalid responses are scored 3.

Table 3.3 provides some information about the internal consistency reliability (Cronbach alpha coefficient) and discriminant validity (mean correlation of a scale with the other scales) for LES scales as obtained in past research. The individual was used as the unit of analysis, and statistics are presented separately for actual and preferred versions. The data in Table 3.3 are taken from Taylor and Fraser (1991) and Fraser (1990).

Table 3.3 Internal Consistency Reliability (Alpha Coefficient) and Discriminant Validity (Mean Correlation of a Scale with other Scales) for Actual and Preferred Version of LES Scales (Individual as Unit of Analysis) from Past Research

Scale	No. of Items	Form	Alpha Reliability	Mean Correlation with Other Scales
Negotiation [a]	7	Actual	0.79	0.17
		Preferred	0.85	0.19
Autonomy[a]	7	Actual	0.72	0.19
		Preferred	0.73	0.20
Student Centredness[a]	7	Actual	0.61	0.10
		Preferred	0.73	0.12
Investigation[b]	10	Actual	0.71	0.21
		Preferred	0.75	0.27
Differentiation[b]	10	Actual	0.76	0.10
		Preferred	0.75	0.16

[a] Sample consisted of 508 students in 26 Grade 8-12 classes in 12 schools in Western Australia.

[b] Sample consisted of 1 849 students in 150 secondary classes in New South Wales and Tasmania.

3.3.2 *School Level Environment Questionnaire (SLEQ)*

The distinction between classroom-level and school-level environments has been recognised in the literature (e.g., Fraser & Rentoul, 1982) and was discussed in Section 2.6. Fisher and Fraser (1991b) developed an instrument to assess teachers' perceptions concerning school environment called the *School Level Environment Questionnaire (SLEQ)*. Six of the SLEQ's eight original scales (Affiliation, Professional Interest, Participatory Decision Making, Innovativeness, Resource Adequacy and Work Pressure) were chosen for the present study as being relevant to school environments in Nigeria.

The form of the SLEQ used in the present research incorporated 44 items altogether, with 7 items in each of the six scales except for Innovativeness which had 9 items. The 44 items of the SLEQ are shown in Appendix V (actual form) and Appendix VII (preferred form). However, following item analysis procedures described later, only 35 of the original 44 items identified in Appendix V were retained in the form of the SLEQ used in all analyses reported in this thesis. The Work Pressure Scale was eliminated altogether. The response sheets are provided in Appendices VI and VIII. Each SLEQ item has a five-point Likert response format with responses of Strongly Disagree, Disagree, Not Sure, Agree and Strongly Agree. The front page of Appendix V shows the scale allocation and scoring direction for each item in the SLEQ.

Table 3.4 provides further information about the version of the SLEQ used in the present study. This table provides, for each of the six scales, a scale description, a sample item and the classification according to Moos's (1974) scheme.

Table 3.5 provides statistics from past research for a version of the SLEQ with 7 items in every scale. Internal consistency reliability and the discriminant validity both are reported. Information is provided separately for actual and preferred forms, for three separate samples, and using the individual teacher as the unit of statistical analysis.

Table 3.4 Description of Scales in the SLEQ and their Classification According to Moos's Scheme

Scale Name	Description of Scale	Sample Item	Scoring Direction	Moos's General Category
Affiliation	Teachers can obtain assistance, advice and encouragement and are made to feel accepted by colleagues.	I feel that I could rely on my colleagues for assistance if I should need it.	+	Relationship
Professional Interest	Teachers discuss professional matters, show interest in their work and seek further professional development.	Teachers frequently discuss teaching methods and strategies with each other.	+	Personal Development
Participatory Decision Making	Teachers have the opportunity to participate in decision making.	Teachers are frequently asked to participate in decisions concerning administrative policies and procedures.	+	System Maintenance
Innovativeness	The school is in favour of planned change and experimentation, and fosters classroom openness and individualisation.	Teachers are encouraged to be innovative in this school.	+	
Resource Adequacy	Support personnel, facilities, finance, equipment and resources are suitable and adequate.	The supply of equipment and resources is inadequate.	-	

Items designated (+) are scored by allocating 5, 4, 3, 2 and 1, respectively, for the responses Strongly Agree, Agree, Not Sure, Disagree and Strongly Disagree. Items designated (-) are scored in the reverse manner. Omitted or invalid responses are given a score of 3.

Table 3.5 Internal Consistency (Alpha Coefficient) and Scale Independence (Mean Correlation of Scale with other Scales) for each SLEQ Scale for Three Samples from Past Research

Scale	Number of Items	Form	Alpha Reliability			Mean Correlation with Other Scales		
			Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Affiliation	7	Actual	0.87	0.85	0.84	0.34	0.18	0.38
		Pref			0.77			0.42
Professional Interest	7	Actual	0.86	0.81	0.81	0.29	0.29	0.36
		Pref			0.77			0.43
Participatory Decision Making	7	Actual	0.80	0.69	0.82	0.34	0.22	0.34
		Pref			0.74			0.28
Innovativeness	7	Actual	0.84	0.78	0.81	0.38	0.22	0.42
		Pref			0.77			0.31
Resource Adequacy	7	Actual	0.81	0.80	0.65	0.22	0.19	0.35
		Pref			0.64			0.44
Sample Size			83	34	109	83	34	109

Note: No validation data for the new Work Pressure Scale are available yet .

Source: Fisher and Fraser (1991b)

The SLEQ has been used in exploring differences between the climates of elementary and high schools (Fisher & Fraser, 1991b) among a sample of the 109 teachers in 10 schools in Tasmania. The most striking pattern of findings was that the climate in elementary schools emerged as more favourable than the environment of high schools on most of the SLEQ scales. In particular, relative to high school teachers, elementary school teachers perceived their school climates considerably more favourably in terms of greater Affiliation, Professional Interest, Staff Freedom, Participatory Decision Making, Innovation and Resource Adequacy. Also, the SLEQ was used successfully by teachers to assess their school environment and to use this information as a basis for improving their school environment (Fisher & Fraser, 1991b).

3.3.3 *Test of Science Related Attitudes (TOSRA)*

One of the main aims of the present study was to investigate associations between the nature of the classroom environment and several student outcome measures. The outcome criteria were students' attitudes as assessed with a version of the *Test of Science Related Attitudes (TOSRA)* (this section), enquiry skill proficiency as assessed by a version of the *Test of Enquiry Skills (TOES)* (see Section 3.3.4) and a measure of students' practical performance (see Section 3.3.5).

In order to implement the aspect of the study involving an investigation of relationships between classroom environment and students' attitudes, it was necessary to select, modify and validate an appropriate attitude instrument. In fact, one of this study's contributions was developing and validating a generally useful questionnaire which can be used in the future in Nigeria by researchers and teachers wishing to assess student attitudes towards agricultural science. The purpose of the discussion in this section is to describe the background and nature of this study's attitude questionnaire.

Various definitions of 'attitude' have been proffered. Moore and Sutman (1970) defined attitude as "an opinion or position taken with respect to a psychological object in the field of science". Combs (1971) considers attitude as a regulator of all behaviour. Behaviours at any given time are not causes but consequences of what is going on within the individual. Attitudes determine external behaviours. Gagné (1977) defined attitude as an internal state that influences (or moderates) the personal actions of an individual. Attitudes are organised through experience and assert a directive influence upon individuals. Attitude could originate from discrepancies of beliefs and ideas or emotional states. Attitudes determine external behaviours.

Alao (1985) discussed attitude components and conditions for its change. Attitudes have cognitive, affective and behavioural components. The cognitive aspect pertains to the ideas or propositions that express the relation between situations and attitudinal objects. The affective component pertains to the emotions and feelings that accompany the encounter, while the behavioural component pertains to a predisposition of readiness for action.

Some internal and external conditions exist that must be satisfied before attitudes are learnt or changed. The internal conditions are the intellectual skills and a certain amount of relevant information which the learner must possess about the concept of the class of object, event or person to which the new attitude will be directed. The external conditions are mainly the human model's appeal, its credibility and the learner's recall of the situations to which the object of the attitude is applicable. Thus, while the learner's attitude to a subject can be influenced by both internal and external factors as mentioned above, learners' choice of (or reaction to) the subject could be influenced by the attitude to the subject. Alao reported that attitude to science is positively correlated to performance in the science subjects.

Various attempts have been made at measuring attitudes. According to Pearl (1974), the problem of attitude measurement could be solved when an adequate definition is devised to determine the abstract and emotional nature of attitudes. Edwards and Fisher (1977) also

discussed the abstract and emotional nature of attitudes. Prominently, Wilson's *Science Attitude Questionnaire (SAQ)* (reported in Alao, 1985) and Moore and Sutman's (1970) *Scientific Attitude Inventory (SAI)* were developed to measure the scientific attitudes of high school students. Moore and Sutman concluded that a good instrument must (1) specify the particular attitudes to be assessed, (2) use several items to assess each attitude, (3) provide an opportunity for the respondent to indicate the extent of his/her acceptance or rejection of an attitude statement, and (4) cover both intellectual and emotional attitudes. A major criticism of these instruments is that they did not measure scientific attitude as such but rather a mixture of attitude concerning science, sociology of science, and the nature of science.

The whole area of attitude assessment in science education has been reviewed by Schibeci (1984). Recently, Ebenezer and Zoller (1993) studied the attitudes towards science of tenth grade students in Canada and Koballa (1992) reviewed strategies for changing attitudes.

Klopfer (1971) identified six distinct components of scientific attitudes: attitude towards science and scientists; attitude towards scientific inquiry; adoption of scientific attitudes such as open-mindedness; enjoyment of science learning experiences; interest in science apart from learning experiences at school; and interest in a scientific career. Fraser (1978b, 1981b) used Klopfer's framework in developing the *Test Of Science Related Attitudes (TOSRA).*

Table 3.6 lists TOSRA's seven attitudinal dimensions: Social Implications of Science; Normality of Scientists; Attitudes Towards Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science. It also provides the classification of the aim measured by each scale according to Klopfer's scheme. This table indicates that, while two separate TOSRA scales have been included to measure two separate aims in category H.I, each of the other five TOSRA scales measures aims in one of the remaining categories, namely, H.2 to H.6.

Table 3.6 Name and Classification of Each Scale in TOSRA

TOSRA Scale Name	Klopfer (1971) Classification	
Social Implications of Science Normality of Scientists	H.1:	Manifestation of favourable attitudes towards science and scientists
Attitude to Scientific Inquiry	H.2:	Acceptance of scientific inquiry as a way of thought
Adoption of Scientific Attitudes	H.3:	Adoption of 'scientific attitudes'
Enjoyment of Science Lessons	H.4:	Enjoyment of science learning experiences
Leisure Interest in Science	H.5:	Development of interest in science and science-related activities
Career Interest in Science	H.6:	Development of interest in pursuing a career in science

Because category H.1 (Manifestation of favourable attitudes towards science and scientists) embraces two somewhat distinct sub-categories, namely, manifestation of favourable attitudes towards science and manifestation of favourable attitudes towards scientists, a separate measure of each was included in TOSRA. However, although both of these sub-categories cover a range of related attitudes, the test battery was restricted to a reasonable size by including a measure of a single aspect of each sub-category. The Social Implications of Scale in TOSRA measures one aspect of manifestation of favourable attitudes towards science which has been afforded importance in the science education

literature (Fraser, 1977; Zoller & Watson, 1974), namely, attitude towards the social benefits and problems which accompany scientific progress. The normality of scientists scale in TOSRA measures one aspect of manifestation of favourable attitudes towards scientists given prominence in science education, namely, an appreciation that scientists are normal people rather than the eccentrics often depicted in the mass media (Fraser, 1977; Mead & Métraux, 1957).

The third scale listed in Table 3.6, the Attitude to Scientific Inquiry scale, measures attitude to scientific experimentation and inquiry as ways of obtaining information about the natural world: this attitude is similar in meaning to category H.2. The fourth scale in TOSRA, the Adoption of Scientific Attitudes scale, measures an attitudinal aim identical in meaning to category H.3. Furthermore a major merit of this scale is that the specific attitudes (e.g., open-mindedness, willingness to revise opinions, etc.) included as desirable ones were selected from those consistently rated by a group of eminent scientists as being of considerable importance in their work as scientists (Cohen, 1971). The meaning of the aims measured by the last three scales listed in Table 3.6 is identical to the meaning of categories H.4 to H.6 and is reflected in the titles of these three scales, namely, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science.

Fraser (1981b) discussed the three main stages in the development of TOSRA. First, a version of each scale was assembled, based on the existing instruments and reactions from teachers and experts in educational measurement about each item's clarity, readability, face validity and scale allocation. Second, a revised version was assembled, based on evidence from analysis of data collected during the field testing of the first version of the scales with a sample of 165 Year 7 students. Third, the revised version of each scale was field tested with a large sample of 1 158 Year 7 students and was shown to have satisfactory reliability.

TOSRA was developed from a previous battery of five attitude scales, which was extended and improved in four ways. First, two new scales, Normality of Scientists and Career Interest in Science, were added. Second, whereas the previous battery involved three different sets of administration instructions and answering formats, TOSRA was designed with a single set of instructions and answering format. Third, while different scales in the previous battery contained different numbers of items, TOSRA was designed with the same number of items (namely, 10) in each scale in order to facilitate ready comparison between performance on different scales. Fourth, whereas the original battery was field tested and validated using only samples of students at the Year 7 level, the field testing and validation of TOSRA involved students at all four junior high school grade levels (Years 7-10).

The final form of TOSRA was obtained after refining preliminary versions in two successive stages. The first stage involved modifying a pool of items in the light of reactions solicited from a group of science teachers and experts in educational measurement. The second stage involved the field testing of a version of TOSRA containing 14 items per scale and the subsequent use of the item analysis techniques described in Fraser (1977) to reduce the length of each scale to 10 items.

The internal consistency reliability (the extent to which items in a given scale measure the same attitude) was reported for each TOSRA scale in past research using the Cronbach alpha coefficient (Cronbach, 1951). Table 3.7 shows, separately for different grade levels, the alpha coefficient for each TOSRA scale obtained in previous research (Fraser, 1981b). The values of the alpha reliability coefficient ranged from 0.64 to 0.93 for the different samples. These values for the reliability coefficient are generally high for scales whose length is only 10 items, and all values are large enough to indicate that each TOSRA scale had quite good internal consistency reliability at each grade level.

In addition to internal consistency reliability coefficients, Table 3.7 contains estimates from past research of the test-retest reliability of TOSRA scales. These calculations were based on data from a

Table 3.7 Reliability and Discriminant Validity (Mean Correlation with Other Scales) of Each TOSRA Scale From Past Research

Scale	Alpha Reliability in Years				Test-retest Reliability[a]	Mean Correlation with Other Scales
	7	8	9	10		
Social Implication of Science	0.81	0.82	0.75	0.82	0.76	0.39
Normality of Scientists	0.72	0.70	0.72	0.78	0.69	0.27
Attitude to Inquiry	0.81	0.82	0.81	0.86	0.79	0.13
Adoption of Scientific Attitudes	0.66	0.64	0.69	0.67	0.75	0.33
Enjoyment of Science Lessons	0.93	0.92	0.92	0.93	0.78	0.39
Leisure Interest in Science	0.88	0.85	0.87	0.89	0.82	0.39
Career Interest in Science	0.90	0.88	0.88	0.91	0.84	0.40

Each scale contains 10 items.

The sample sizes at different levels ranged from 324 to 340.

[a] Test-retest coefficients were estimated for a sub-sample of 238 students from Years 8 and 9, drawn from the original sample.

subsample of 238 students comprising the Year 8 and Year 9 classes in four of the schools (two coeducational government high schools, one independent Catholic girls school and one independent non-Catholic boys school) in the original sample. These students responded to TOSRA a second time approximately two weeks after the first administration. Table 3.7 shows that test-retest coefficients ranged from 0.69 to 0.84 with a mean of 0.78, thus indicating that all TOSRA scales displayed quite good test-retest reliability.

Intercorrelations among TOSRA scales were calculated as indices of discriminant validity (the extent to which a given scale measures a unique attitude not measured by other scales in the battery). It was found that, for the total sample of 1 337 students, TOSRA scale intercorrelations generally were fairly low and ranged from 0.10 to 0.59. The average correlation of each TOSRA scale with the other six scales was calculated and these values are recorded in Table 3.7. This table shows that the mean correlation of a given scale with the other six scales had moderately low values ranging from 0.13 for the Attitude to Inquiry scale to 0.40 for the Career Interest in Science scale.

It is noteworthy that the highest scale intercorrelations (values of 0.53, 0.58 and 0.59) occurred between the three scales of Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. Although these three attitudes are conceptually distinct, one generally would expect them to be moderately well correlated among students because there would be a tendency for a student who enjoys science lessons to be more likely to have a leisure and career interest in science. Furthermore, as all values of the scale intercorrelation were smaller than the square root of the product of the corresponding scale reliabilities, which is the value representing perfect conceptual equivalence (Block, 1963), it was considered justifiable to maintain all seven TOSRA scales as separate dimensions.

TOSRA items involve a response format, first described by Likert, which requires students to express their degree of agreement with each statement on a five-point scale consisting of the responses Strongly Agree (SA), Agree (A), Not sure (N), Disagree (D) and Strongly

Disagree (SA). Scoring involves allotting 5, 4, 3, 2 and 1 for the responses SA, A, N, D and SD, respectively, for items designated as positive (+) and allotting 1, 2, 3, 4 and 5 for the responses SA, A, N, D and SD, respectively, for items designated as negative (-). Omitted or invalid responses are scored 3.

For the sake of economy of testing time in the present study in Nigeria, only 20 out of TOSRA's 70 items were chosen for use in this study. The items which were chosen were considered important in Nigerian agricultural science class (Idiris, 1988). The items chosen provided coverage of the ideas encompassed by most of TOSRA's seven science-related attitudes. 'Agricultural science' and 'agricultural scientist' were used as substitutes for 'science' and 'scientist' in the original form of TOSRA. To enhance accuracy and economy in terms of the time needed for answering, the Nigerian version of TOSRA has responses beside each item. Each item has a five-point Likert response format with responses of Strongly Agree, Agree, Not Sure, Disagree and Strongly Disagree as shown in Appendix IX. This appendix shows that 15 of the items in the 20-item version of TOSRA survived the item analysis and were used in the analyses reported in this thesis. Fraser (1981b) argued that, as long as TOSRA is not used for grading, there would be little point in students faking responses and therefore reasonable confidence could be placed in student responses. Teachers involved in the present study made it clear to students that results were not for grading.

3.3.4 *Test of Enquiry Skills (TOES)*

The cognitive outcome used in the present study was enquiry skill proficiency. Fraser (1979b) reported that the *Test Of Enquiry Skills (TOES)* was designed to measure enquiry skills among junior high school students studying science or social science. Fraser listed the stages in the development of TOES. First, a comprehensive literature review was used to identify the enquiry skills considered most important by experts in the literature. Second, an initial pool of items was developed and then rewritten in the light of reactions from teachers and experts in educational measurement about each item's

clarity, readability, face validity and scale allocation. Third, items were assembled to form a first version which was administered to a sample of Year 7 students. Fourth, a revision was assembled, based on evidence obtained from statistical analyses of data and student interviews associated with the first field trial, and then this version was administered to a sample of Year 7 students. Fifth, a third and final version of TOES was formed by deleting from the second version those items identified as faulty in the analysis of data from the second administration.

Table 3.8 illustrates the scope of TOES. The first group of two scales (Part A) measures skills related to using reference materials such as dictionaries, encyclopaedias and library catalogues (Skill 1), or a book's index and table of contents (Skill 2). The second group of four scales (Part B) measures the following skills related to interpreting and processing information: reading various scales (Skill 3), calculating averages, percentages and proportions (Skill 4), interpreting charts and tables (Skill 5) and using graphical materials (Skill 6). The third group of four scales (Part C) measures three critical thinking-in-science skills, namely, comprehension of science reading material (Skill 7), design of experimental procedures in science (Skill 8), and the ability to draw valid conclusions and generalisations from data (Skill 9).

Table 3.8 shows that the average number of items per scale is a little less than 10 and that the whole TOES battery contains 87 items in all. Fraser (1979b) reported that all nine skills and all 87 items are clearly relevant to science teaching.

In past research (Fraser, 1979b), the internal consistency reliability was estimated for TOES scales using the Kuder-Richardson Formula 20 (KR-20). Table 3.8 shows the KR-20 coefficient for each TOES scale found for several grade levels in past research. The values of KR-20 reliability ranged from 0.61 to 0.79 for a Year 7 sample, from 0.57 to 0.83 for a Year 8 sample, from 0.53 to 0.77 for a Year 9 sample, and from 0.50 to 0.75 for a Year 10 sample. It should be noted that, as would be anticipated, some decrease in the sizes of the KR-20 reliabilities occurred with year level. Nevertheless, the values of the KR-20

Table 3.8 Reliability of Each TOES Scale at Four Year Levels in Past Research

TOES Scale	No. of Items	KR-20 Reliability in Year				Test-retest Reliability[a]
		7	8	9	10	
Part A—Using Reference Materials						
Skill 1: Library usage	10	0.65	0.62	0.58	0.54	0.74
Skill 2: Index and table of contents	9	0.79	0.70	0.62	0.51	0.82
Part B—Interpreting and Processing Information						
Skill 3: Scales	10	0.77	0.76	0.73	0.60	0.78
Skill 4: Averages, percentages and proportions	8	0.78	0.80	0.75	0.64	0.78
Skill 5: Charts and tables	11	0.72	0.66	0.57	0.57	0.65
Skill 6: Graphs	10	0.79	0.83	0.77	0.75	0.80
Part C—Critical Thinking in Science						
Skill 7: Comprehension of science reading	10	0.69	0.62	0.60	0.55	0.70
Skill 8: Design of experimental procedures	10	0.61	0.57	0.53	0.50	0.66
Skill 9: Conclusions and generalisations	9	0.69	0.75	0.65	0.62	0.67

[a] Test-retest reliability coefficients were estimated for different scales using samples of 100-104 Year 7 students.

Year 7 statistics are the means of statistics obtained at the beginning and end of a school year.

The Year 7 and 8 data were collected in Melbourne while the Year 9 and 10 data were collected in Sydney.

reliability coefficients are generally quite good for scales whose lengths range from only 8 to 11 items, and all values are sufficiently high to indicate satisfactory internal consistency reliability for all TOES scales at each level.

The last column of figures in Table 3.8 provides data about the test-retest reliability obtained for each TOES scale when different scales were administered to samples of Year 7 students on two separate occasions two weeks apart. The table shows that these values ranged from 0.65 to 0.82 for different scales, thus indicating that all TOES scales displayed quite good test-retest reliability. Fraser (1979b) also reported data for the discriminant validity (the extent to which a given scale measures a unique skill not measured by other scales in the battery) of TOES scales calculated for the Year 7 sample. It was found that scale intercorrelations (averaged over two administrations) ranged from 0.30 to 0.56. Although some of these scale intercorrelations are reasonably large, all values are still somewhat smaller than the square root of the product of the corresponding scale reliabilities, which would be the value representing perfect conceptual equivalence (Block, 1963).

For the sake of economy in testing time in this study in Nigeria, only 18 out of TOES's 87 items were used. The number of items drawn from the scales consist of four from Library usage (Skill 1), five from Index and table of contents (Skill 2), two from Scales (Skill 3), one from Averages, percentages and proportions (Skill 4), one from Charts and tables (Skill 5), one from Graphs (Skill 6), one from Comprehension of science reading (Skill 7), two from Design of experimental procedures (Skill 8), one from Conclusions and generalisations (Skill 9). Each item has a multiple-choice response format with either four or five response options, but only one correct response. Students fill in their responses on a separate answer sheet.

Appendix X contains the 18-item version of TOES used in the present study in Nigeria. However, Appendix X shows that only 14 of the original 18 items survived item analysis procedures described in Chapter 4. The separate answer sheet is given in Appendix XI.

3.3.5 *Performance Skills Test*

The Performance Skills Test makes use of the 'I Can' format (Mehrens & Lehmann, 1984). Three types of school subjects assessment are oral, paper-and-pencil and performance measures (Mehrens & Lehmann, 1984). The Performance Skills Test used in this study in Nigeria evaluated students' actual laboratory equipment usage skills and cognitive outcomes related to soil content (Okure, Idiris, Ogu & Igbokwe, 1991). The data were derived from information obtained from measurement devices built by teachers and standardised tests obtained from the Junior Secondary School agricultural science examinations.

The version of the Performance Skills Test administered in this study contained the 27 items shown in Appendix XII. The first group of skills, laboratory usage, is assessed with eight items measuring skills related to using laboratory equipment. The second, third, fourth and fifth groups of skills involved items that measure skills related to soil content identification procedures. The second, third and fourth groups of skills contains four items, while the fifth group of skills contains seven items. Each item has a 'yes' or 'no' response for the teachers to provide.

The Performance Skill Test involved the teacher's ratings. That is, for each student in a particular class, the agricultural science teacher provided a response to each of the 27 items shown in Appendix XII. However, following item analysis, only the 23 items identified on the front page of Appendix XII were used in the analyses reported in this thesis.

3.4 PROCEDURES AND DATA ANALYSIS

The sample, described in Section 3.2 and Table 3.1, encompassed 1 175 students in 50 classes in 20 schools. These 20 schools were spread over 8 different states plus the Federal Capital Territory as shown in Figure 1.1. As well, 64 agricultural science teachers responded to a school environment questionnaire.

The data collection was somewhat complex and time-consuming. Each student responded to several instruments discussed in Section 3.3: an actual and a preferred form of a classroom environment instrument; an attitude questionnaire; and an enquiry skills test. In addition, teachers responded to an actual and a preferred form of a school environment instrument and an instrument for rating students' practical performance.

Because of the relative complexity of the data collection exercise, the researcher spent several months in Nigeria organising and being involved in data collection. All questionnaires were printed at Curtin University and shipped to Nigeria. The researcher visited every school in the study on several occasions in order to explain the purposes of the study to teachers and to clarify data collection procedures.

Although it was possible for the researcher to administer the instruments to some classes himself, the magnitude of the task made it necessary to leave packages of questionnaires at most schools and request the teachers to administer them to their classes. It took three class periods to administer all of the instruments. Each teacher administered the instruments in accordance with instructions supplied by the researcher. At the end of data collection in each school, the researcher visited the school to collect the completed response sheets and to interview both teachers and students to check that data collection had proceeded as desired and that students had understood the directions for answering the questionnaires.

Separate answer sheets (see Appendices II, IV, VI, VIII and XI) were used in all cases to reduce the volume of paper that needed to be shipped back to Curtin University for data analysis.

In order to validate the classroom environment instrument that was adapted for use with Nigerian agricultural science classes in this study (see Section 3.3.1), item and factor analyses were conducted. Cronbach's alpha coefficient was used as an index of internal consistency reliability and the mean correlation of a scale with the

other scales was used as a convenient index of discriminant validity. Reliability and discriminant validity statistics were calculated separately for two different units of analysis, the individual student score and the school mean. A series of analyses of variance was carried out in order to find out if the actual version of each scale was able to differentiate significantly between the perceptions of students in different schools. These procedures led to a modified 32-item classroom environment questionnaire assessing the five scales of Negotiation, Autonomy, Student Centredness, Investigation and Differentiation (see Appendix I).

To investigate the relationships between classroom environment perceptions and student outcomes, two main methods of analysis were used: simple correlational analyses of relationships between individual outcome scores and individual environment scales; and multiple regression analyses of relationships between each outcome scale and the set of environment scales as a whole. All analyses were conducted once using the individual student score as the unit of statistical analysis, and repeated using the school mean as the unit of analysis. The student outcomes considered were attitudes, enquiry skill proficiency, and practical performance.

The part of the study involving determinants of classroom environment focussed on the two variables of school environment and geographic region. Teachers' perceptions of the nature of their school environments were assessed using a 35-item questionnaire covering the five scales of Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy (see Section 3.3.2). This instrument was refined and validated using methods analogous to those described above in relation to the classroom environment instrument. Geographic region was defined in terms of whether schools were located in forest or savanna areas.

Associations between school climate and classroom environment perceptions were investigated via a simple correlational analysis involving the school mean as the unit of analysis. Differences

between forest and savanna schools in terms of their classroom and school environments were investigated using a series of *t* tests, again using the school mean as the unit of analysis. Because the smallness of the sample for school means (N = 18 or 20) did not permit a meaningful multivariate analysis, the results of the simple correlational analysis need to be regarded as preliminary.

3.5 SUMMARY

The purpose of this chapter has been to describe the procedures used in the present study of agricultural science classroom environments in Nigeria.

The sample involved in the research involved 1 175 students in 50 agricultural science classes (mainly at the junior high school level) in 20 schools in 9 states/territories. Also, 64 agricultural science teachers from the same schools were involved in the study. Given the size of the sample and the range of instruments involved, it was necessary for the researcher to travel to Nigeria for several months to organise and supervise the data collection.

Student perceptions of aspects of constructivism and individualisation in the classroom environment were assessed using the *Learning Environment Scale (LES)*, which contains the scales of Negotiation, Autonomy, Student Centredness, Investigation and Differentiation. Teachers' perceptions of their school climate were assessed with the *School Level Environment Questionnaire (SLEQ)* which includes the dimensions of Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy. Student outcomes were assessed with sets of items selected and adapted from the *Test of Science Related Attitudes (TOSRA), Test of Enquiry Skills (TOES)* and a performance skills rating scale (which was filled in for each student by the teacher).

As reported in the next chapter, the data collected from the sample of students and teachers were analysed to shed light on three questions. First, the cross-cultural validity of the environment instruments was

explored in terms of each scale's internal consistency reliability, discriminant validity and ability to differentiate between schools. Second, simple and multiple regression analyses, using both the individual and the school mean as the unit of analysis, were used to investigate the effects of classroom environment on student outcomes. Third, simple correlations and *t* tests for school means were used in exploring determinants of classroom environment (namely, school environment and geographic region).

Chapter 4

RESULTS

4.1 INTRODUCTION

The purpose of this chapter is to report the findings from the present study of agricultural science classroom environments in Nigeria. In organising this discussion of findings, the chapter is structured around the study's three major aims of (1) validating a classroom environment instrument specifically for use in agricultural science classes in Nigeria, (2) investigating associations between student outcomes and classroom environment and (3) investigating some determinants of classroom environment (namely, school environment and geographical region). In addition, this chapter includes a summary of the research methods for various aspects of the study (as outlined previously in Chapter 3), together with some descriptive statistics for the classroom environment instrument, including a preliminary comparison of Nigerian classroom environments with those in some other countries. Also, because a major aspect of the study involved investigation of associations between environment and outcomes, a short section is devoted to reporting the reliability of outcome measures used. Similarly, a section is devoted to descriptive and validation information for the school environment instrument.

Overall, the ensuing discussion is structured in the following way:

- a summary of research methods (Section 4.2);
- descriptive statistics for the classroom environment instrument, (Section 4.3);
- item analysis and validation of the classroom environment instrument (Section 4.4);

- reliability of outcome measures (Section 4.5);
- associations between student outcomes and classroom environment (Section 4.6);
- descriptive and validation information for the school environment instrument (Section 4.7);
- associations between school and classroom environments (Section 4.8);
- differences between the classroom and school environments of forest and savanna schools (Section 4.9).

4.2 SUMMARY OF RESEARCH METHODS

In Section 3.2, it was established that the sample consisted of 1 175 students in 45 junior secondary and 5 senior secondary agricultural science classes in 20 different schools in 8 states, as well as in Abuja, the Federal Capital Territory of Nigeria. The sample was representative of schools from the northern and southern states, and of urban and rural areas. Table 3.1 in Chapter 3 provides a more detailed description of the sample, and Figure 1.1 shows the location of the 8 states on a map of Nigeria.

Following item analysis of the classroom environment instrument, several items with low item-total correlations were removed to produce a refined version with better statistical characteristics. For each refined scale, Cronbach's alpha coefficient was calculated as an index of internal consistency and the mean correlation of a scale with the other scales was used as a convenient index of discriminant validity. These analyses were calculated using two different levels of analysis: the individual student; and the class mean. Finally, analysis of variance was used to determine whether each scale differentiated between the perceptions of students in different schools.

In investigating relationships between student outcomes (attitudes, enquiry skills and practical performance) and classroom environment, use was made of both simple correlational and multiple regression analyses. Again analyses involving the student as the level of analysis were repeated with the class mean as the unit of analysis.

In investigating determinants of classroom environment, associations between school environment and classroom environment were analysed using simple correlations for school means, whereas differences between forest and savanna schools in terms of classroom and school environment were investigated via *t* tests using the school mean as the unit of analysis. Because of the smallness of the sample of school means, these analyses need to be viewed as exploratory.

4.3 DESCRIPTIVE INFORMATION FOR THE CLASSROOM ENVIRONMENT INSTRUMENT

Subsection 3.3 discusses in detail the classroom environment instrument used in this study. Student perceptions of classroom environment were assessed with an instrument which initially encompassed the four scales of Negotiation, Prior Knowledge, Autonomy and Student-Centredness from the *Constructivist Learning Environment Survey* (Taylor & Fraser, 1991) and the two scales of Investigation and Differentiation from the *Individualised Classroom Environment Questionnaire* (Fraser, 1990). However, the whole Prior Knowledge scale and several items from other scales were dropped following item and factor analysis procedures. Also, prior to using these scales in the Nigerian study, each classroom environment scale was amended somewhat to maximise its suitability for use in agricultural science classes in Nigeria. Both an actual and a preferred form of the instrument were administered.

Appendices I-IV contains the actual and preferred versions of the *Learning Environment Survey* and the separate response sheets. The front page of Appendix I shows that, from the original 48-item version, a total of 16 items (including all of the original Prior Knowledge scale) were omitted after item analysis in order to improve scale statistics.

Table 4.1 shows the mean and standard deviation for the Nigerian sample for each of the five scales remaining in the instrument after performing item and factor analyses. Because the number of items which survived the item and factor analysis procedures differed from scale to scale (from 5 to 7 items), the descriptive information reported in Table 4.1 is based on item statistics (i.e., the scale mean or standard deviation divided by the number of items contained in that scale) rather than statistics based on scale totals.

Data in Table 4.1 are reported separately using the individual student and the school mean as units of analysis. Because the mean score was approximately the same for both units of analysis, only a single column of means is reported in Table 4.1. As expected, the standard deviation for all scales was larger with the school mean as the unit of analysis than with the individual as the unit of analysis.

The mean scores for the Nigerian sample shown in Table 4.1 are provided graphically in Figure 4.1. Several patterns are evident from Table 4.1 and Figure 4.1. First, the higher mean scores on the actual form occurred in Nigeria for the Negotiation, Autonomy and Investigation scales, whereas the lowest mean scores occurred on the Student Centredness and Differentiation scales. This suggests that Nigerian agricultural science classes tend to be teacher centred and that there is relatively little differential provision for different students simultaneously to undertake different topics and experiments and to proceed at different speeds.

The second pattern evident in Figure 4.1 is the consistent differences existing between actual and preferred mean scores for the four scales of Negotiation, Autonomy, Investigation and Differentiation. Preferred means are higher than actual means by at least one standard deviation for class means for these four scales. That is, students would prefer to have more opportunities to negotiate meaning, to be given autonomy, to investigate, and to have differential provisions for different students than currently is perceived to be present in the classroom. This pattern, in which Nigerian students would prefer a more positive classroom environment than the one actually present, replicates past

research in Australia (Fisher & Fraser, 1983a), the USA (Moos, 1979) and Israel (Hofstein & Lazarowitz, 1986). However, it is interesting to note that, for Student Centredness (which is a scale with a low mean on the actual form), the actual environment already is just the way that students would prefer it to be. Not only is the level of Student Centredness low in Nigerian agricultural science classes, but students also prefer it to be at that low level.

Table 4.1 Item Mean and Item Standard Deviation for Classroom Learning Environment Survey for Two Units of Analysis

Scale	No. of Items	Form	Item Mean [a]	Item Standard Deviation	
				Individual	School Mean
Negotiation	5	Actual	3.1	0.65	0.35
		Preferred	3.4	0.59	0.33
Autonomy	7	Actual	3.0	0.73	0.49
		Preferred	3.4	0.57	0.26
Student Centredness	7	Actual	2.6	0.92	0.35
		Preferred	2.6	0.63	0.32
Investigation	8	Actual	2.9	0.62	0.34
		Preferred	3.5	0.59	0.34
Differentiation	5	Actual	2.6	0.87	0.37
		Preferred	2.8	0.72	0.33

[a] The mean was approximately the same whether the individual student or the school mean was used as the unit of analysis.

The Nigerian sample consisted of 1 175 students in 20 schools.

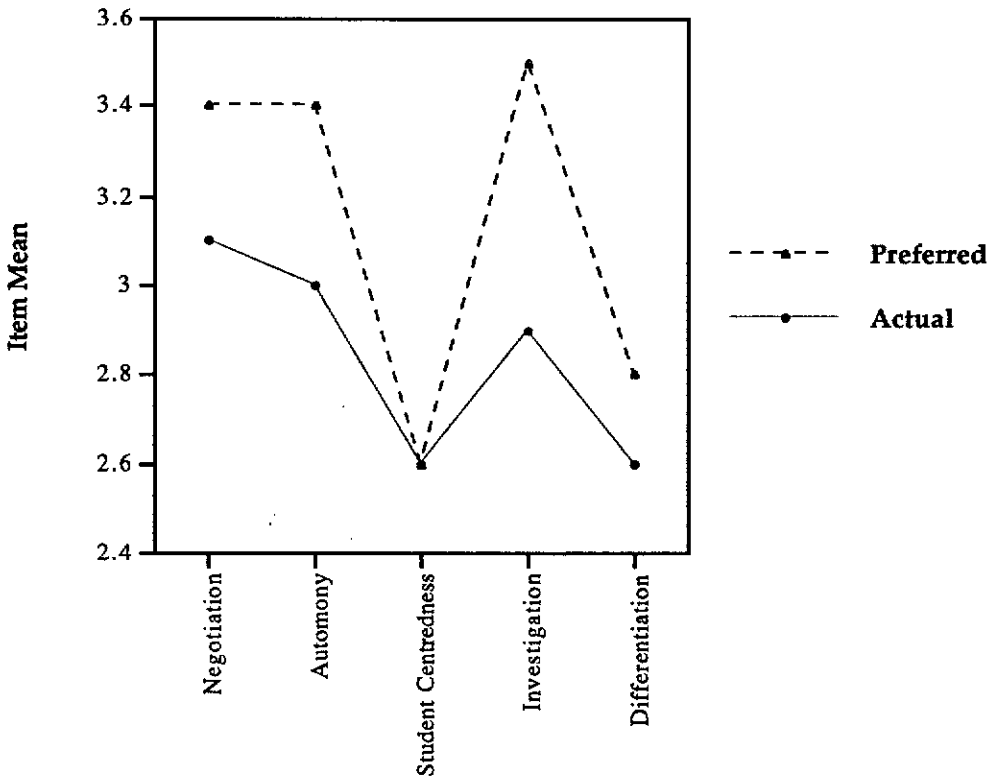


Figure 4.1 Actual and Preferred Item Means for Classroom Environment Scales for Nigerian Sample

4.4 ITEM ANALYSIS AND VALIDATION OF THE CLASSROOM ENVIRONMENT INSTRUMENT

Section 2.4 discusses in detail the classroom environment instrument used in this study and how each classroom environment scale was amended to maximise its suitability for use in agricultural science classes in Nigeria. Table 4.2 reports validation information, separately for the actual and the preferred forms of the classroom environment instrument, for the 32 items in 5 scales which survived the item and factor analysis procedures described in Section 2.4 and 4.3.

The alpha reliability coefficient was used as the index of scale internal consistency, while the mean correlation of a scale with the other four scales was used as a convenient index of scale discriminant validity. Analyses are reported separately for two units of analysis (the individual student and the school mean) in Table 4.2.

The figures reported in Table 4.2 generally suggest that each scale has satisfactory reliability for scales containing relatively small numbers of items (from 5 to 8). For example, the reliability of different scales in the actual form ranged from 0.55 to 0.82 with the individual as the unit of analysis and from 0.71 to 0.96 with the school mean as the unit of analysis. Comparable reliability values emerged for the preferred form. As expected, higher reliabilities were obtained when the school mean was used as the unit of statistical analysis.

Factor analyses with the student as the unit of analysis suggested that the factor structure obtained previously in other nations was replicated to a large extent, with the exception of only a few items, with the Nigerian samples. The sample size of 20 schools was not large enough to permit a meaningful factor analysis with the school as the unit of analysis

The mean correlation of a scale with the other four scales (i.e., the index of discriminant validity) when the individual was used as the unit of analysis ranged from 0.12 to 0.37 for the preferred form, and was comparable for the actual form (0.24 to 0.39). As expected, discriminant validity indices were a little higher when the school mean was used as the unit of analysis These figures are sufficiently low to indicate acceptable discriminant validity, and to suggest that the instrument assesses somewhat overlapping dimensions of classroom environment.

Another desirable characteristic of the actual form of any classroom environment instrument is that it can differentiate between the

Table 4.2 **Internal Consistency Reliability (Cronbach Alpha Coefficient) and Discriminant Validity (Mean Correlation with Other Scales) for Actual and Preferred Versions for Two Units of Analysis, and Ability to Differentiate Between Schools (ANOVA Results) for Classroom Learning Environment Survey**

Scale	No. of Items	Unit of Analysis	Alpha Reliability		Mean Correlation with Other Scales		ANOVA Results Eta^2
			Actual	Preferred	Actual	Preferred	Actual
Negotiation	5	Individual	0.55	0.50	0.24	0.12	0.32*
		School Mean	0.71	0.73	0.49	0.31	
Autonomy	7	Individual	0.73	0.60	0.37	0.31	0.45*
		School Mean	0.96	0.91	0.49	0.46	
Student Centredness	7	Individual	0.82	0.59	0.37	0.37	0.14*
		School Mean	0.91	0.74	0.33	0.42	
Investigation	8	Individual	0.64	0.59	0.39	0.27	0.31*
		School Mean	0.94	0.90	0.48	0.43	
Differentiation	5	Individual	0.59	0.50	0.28	0.27	0.16*
		School Mean	0.82	0.75	0.38	0.37	

* $p<0.001$

The sample consisted of 1 175 students in 20 schools.

Eta^2 is the ratio of 'between' to 'total' sums of squares and represents the proportion of variance in scale scores accounted for by school membership.

perceptions of students in different schools. That is, students within the same school should perceive the environment relating similarly, while mean environment perceptions should vary from school to school. The analyses of variance reported in the last column of Table 4.2 confirm that the actual version of each scale differentiated significantly ($p<0.001$) between the perceptions of students in different schools in this sample. The eta^2 statistic (which is the ratio of 'between' to 'total' sums of squares and represents the proportion of variance in scale scores accounted for by school membership) ranged from 0.14 to 0.45 for different scales.

Overall, the various analyses reported in this section attest to the internal consistency reliability and discriminant validity of the classroom environment instrument for use in either its actual or preferred form and with either the individual student or the school mean as the unit of analysis. Further analyses involving the actual form and the individual as the unit of analysis supported the instrument's factorial validity and ability to differentiate between the perceptions of students in different schools. In fact, a major contribution of the present study is that it has provided researchers and teachers with an instrument of known reliability and validity that can be used to assess classroom environment in Nigeria.

4.5 RELIABILITY OF OUTCOME MEASURES

Sections 3.3.3 and 3.3.4 discuss the outcome measures used in this study. Following item analysis procedures, five items with low item-total correlations were removed to enhance scale internal consistency reliability.

The form of the instrument used to assess students' attitudes towards the learning of agricultural science involved the 20 items shown in Appendix IX. These were adapted from the *Test of Science Related Attitudes* (*TOSRA*; Fraser, 1981b). The front page of Appendix IX shows that only 15 of the original attitude items survived item analysis procedures and were retained in further analyses.

The original form of the test to assess student achievement of enquiry skills was an 18-item instrument based on the *Test of Enquiry Skills* (*TOES*; Fraser, 1979b) shown in Appendix X. However, the first page of Appendix X shows only 14 of these items survived the item analysis and were used in subsequent analyses.

Table 4.3 reports that, for the present sample, the alpha reliability coefficient for the attitude measure was 0.63 and 0.83, respectively, with the individual and the school mean as the unit of analysis. The corresponding reliability figures for the enquiry skill instrument were 0.66 and 0.87, respectively.

Section 3.3.5 describes a *Performance Skills Test (PST)* that also was used in the present study to assess students' skill in performing agricultural science experiments. The PST involved the use of an adapted 'I can' format (Mehrens & Lehmann, 1984). The version of the PST used in this study originally contained 27 items altogether. However, following item analysis, only 23 of these items were retained when conducting other statistical analyses.

The alpha reliability for the PST was found to be 0.63 with the individual as the unit of analysis and 0.81 with the school mean as the unit (see Table 4.3). Although the reliability data in Table 4.3 are reported for the full sample of 1 175 students in 20 classes for the attitude and enquiry skills measures, the practical constraints involved in having teachers rate the performance skill level of individual students meant that it was feasible only to obtain a sample of 113 students (in the same 20 schools) with a score available on the performance instrument.

An important incidental contribution made by the present study is that it has provided teachers with several instruments which can be used to provide a reliable assessment of the important student outcomes of attitude towards science, enquiry skills and practical performance.

Table 4.3 Internal Consistency Reliability (Alpha Coefficient) for Three Outcome Measures for Two Units of Analysis

Outcome	No. of Items*	Unit of Analysis	Sample Size	Alpha Reliability
Attitude to Science	15	Individual	1 175	0.66
		School Mean	20	0.87
Enquiry Skills	14	Individual	1 175	0.63
		School Mean	20	0.83
Performance Skills	23	Individual	113	0.63
		School Mean	20	0.81

* These figures represent the number of items remaining after application of item analysis procedures. See Appendices IX to XII for a copy of these instruments assessing student outcomes.

4.6 ASSOCIATIONS BETWEEN STUDENT OUTCOMES AND CLASSROOM ENVIRONMENT

Section 3.3.3 reviews a variety of past studies involving students' perceptions of classroom environment, including research on associations between student learning and classroom environment. The analysis of outcome-environment associations in the present study involved the methods which are discussed in Sections 2.5 and 3.4 and which have been used in numerous past research studies (Fraser, 1994).

Table 4.4 reports associations between the two student outcome measures (namely, attitudes and enquiry skills) and the five classroom environment scales. (Although analogous analyses were carried out for the performance skill outcome, no statistically significant results

Table 4.4 Significant Results from Simple Correlational and Stepwise Multiple Regression Analyses for Associations Between Classroom Environment Scales and Student Outcomes[a] for Two Units of Analysis

Scale	Unit of Analysis	Attitude		Enquiry Skills	
		r	*β*	*r*	*β*
Negotiation	Individual	0.22*		0.45**	0.33**
	School Mean			0.79**	
Autonomy	Individual	0.26**	0.26*	0.59**	0.51**
	School Mean			0.72**	0.80**
Student Centredness	Individual	0.24*			
	School Mean			0.49*	0.61**
Investigation	Individual	0.21*		0.50**	
	School Mean			0.56**	
Differentiation	Individual				
	School Mean			0.67**	
Multiple Correlation *R*	Individual		0.26*		0.67**
	School Mean				0.94**

* $p<0.05$

** $p<0.01$

The sample size was 1 175 students in 20 schools.

[a] For the performance skills outcome, no significant results emerged.

emerged for inclusion in Table 4.4.) Analyses were performed separately for two units of analysis (the individual student score and the school mean score) and only statistically significant associations ($p<0.05$) are reported in Table 4.4. The first type of analysis reported in Table 4.4 is a simple correlation analysis between each outcome and each environment scale. Because the simple correlation analysis is likely to be associated with a relatively high Type I error rate for the study as a whole, stepwise multiple regression analyses were conducted to provide a more conservative test of the associations between an outcome measure and a specific environment scale when all other environment scales preceding it in the stepwise analysis were mutually controlled.

The simple correlation analysis reported in Table 4.4 shows that the number of statistically significant associations ($p<0.05$) between attitude scores and an environment scale was 4 with the individual as the unit of analysis (16 times that expected by chance) and none with the school mean as the unit of analysis. For the enquiry skills outcome, the number of significant associations was 3 with the individual as the unit of analysis (12 times that expected by chance) and 5 with the school mean as the unit of analysis (20 times that expected by chance). For the performance skills measure, no significant associations with environment scales emerged. Consequently, no results are included in Table 4.4 for this outcome.

The bottom of Table 4.4 shows that the multiple correlation was significantly greater than zero for the attitude outcome with the individual as the unit of analysis, and for the enquiry skill outcome with either the individual or the school mean as the unit of analysis.

Table 4.4 reports the regression weight (β) for those environment scales which accounted for a significant increment in outcome variance beyond that accounted for by the other environment scales preceding that scale in the stepwise analysis. The stepwise multiple regression analyses revealed a significant independent relationship between attitude and Autonomy with the individual as the unit of analysis, between enquiry skills and both Negotiation and Autonomy

with the individual as the unit of analysis, and between enquiry skills and both Autonomy and Student Centredness with the school mean as the unit of analysis (Table 4.4).

The present results replicate considerable research in numerous countries which has established consistent relationships between student outcomes and student perceptions of the classroom environment (Fraser & Fisher, 1982b; Haertel, Walberg, & Haertel, 1981; McRobbie & Fraser, 1993). Interestingly, the classroom environment dimensions included in the present study were associated more strongly with the enquiry skill outcome than with the attitude outcomes. Moreover, in every case, higher scores on environment scales were associated with more positive attitudes and higher enquiry skill scores. Every classroom environment dimension was significantly related to at least one outcome measure for at least one level of analysis.

4.7 DESCRIPTIVE AND VALIDATION INFORMATION FOR THE SCHOOL ENVIRONMENT INSTRUMENT

Whereas the previous section described the aspect of the study involving an investigation of the effects of classroom environment on student outcomes, another major aspect of the research was an investigation of two determinants of classroom environment (namely, school climate and geographic region). Before discussion turns to reporting results for the investigation of determinants of classroom environment, this section focuses on descriptive and validation information for the school environment instrument.

Sections 2.6 and 3.3.2 discuss in detail the school environment instrument used in this study. Teachers' perceptions of school environment were assessed with an instrument which originally encompassed the six scales of Affiliation, Professional Interest, Participatory Decision Making, Innovation, Resource Adequacy and Work Pressure adapted from the *School Level Environment Questionnaire* (*SLEQ*; Fisher & Fraser, 1991b; Rentoul & Fraser, 1983).

Scales and items were modified as appropriate to maximise their suitability for use in agricultural science classes in Nigeria.

Separate actual and preferred versions of this instrument (see Appendices V-VIII) were developed and administered to 64 agricultural science teachers in the same 20 schools from which the data were collected from students. The sample was drawn from 8 states, in addition to Abuja, the Federal Capital Territory of Nigeria. The sample was representative of agricultural science teachers in schools of the northern and southern states (savanna and forest areas) and of urban and rural areas. Table 3.1 in Chapter 3 provides a more detailed description of the teacher sample.

Item and factor analysis procedures, which were analogous to those used with the students' classroom environment data, were applied to the teachers' school environment data. The procedures led to the omission of one of the SLEQ's original scales (namely, Work Pressure) and two other individual items to form a 35-item version (namely, Items 1 and 29). The item number and scoring direction for each of the 35 items in the final version of the SLEQ are shown on the front page of Appendix V.

4.7.1 Descriptive Information for SLEQ

Table 4.5 shows the mean and standard deviation for the Nigerian teacher sample for the five scales and 35 items that survived the items and factor analysis procedures. Because different scales contain a different number of items, Table 4.5 reports item statistics (i.e., scale means or standard deviations divided by the number of items in a scale) instead of whole-scale statistics. Standard deviations are reported separately using the individual teacher and the school mean as the unit of analysis (but means were approximately the same for the two units of analysis).

Two patterns are evident from the means reported in Table 4.5. First, the scale with the lowest mean on the actual form was Resource Adequacy. Clearly, Nigerian teachers feel that the material resources in

Table 4.5 Item Mean and Standard Deviation for School Level Environment Questionnaire for Two Units of Analysis

Scale	No. of Items	Form	Item Mean[a]	Item Standard Deviation	
				Individual	School Mean
Affiliation	6	Actual	2.6	0.95	0.87
		Preferred	3.8	0.24	0.24
Professional Interest	7	Actual	2.4	1.10	0.88
		Preferred	4.3	0.42	0.28
Participatory Decision-Making	7	Actual	2.2	0.67	0.55
		Preferred	3.5	0.34	0.17
Innovativeness	9	Actual	2.3	0.91	0.78
		Preferred	3.9	0.42	0.26
Resource Adequacy	6	Actual	1.5	0.57	0.26
		Preferred	3.8	0.74	0.45

The sample consisted of 64 teachers in 20 schools.

[a] The mean was approximately the same for the two units of analysis.

their schools are inadequate. Second, there are quite large differences between the preferred level of each school environment dimension and the level perceived to be actually present. (As the small standard deviations in Table 4.5 show, there was high agreement among teachers concerning preferred school environment for most dimensions). Clearly, these teachers would prefer their schools to have considerably higher levels of Affiliation, Professional Interest,

Participatory Decision-Making, Innovativeness and Resource Adequacy. This pattern in which teachers would prefer to have a more positive school environment than what is perceived to be present is consistent with prior research (Fraser, 1994).

4.7.2 Cross-Validation of SLEQ in Nigeria

Table 4.6 reports validation information for the SLEQ analogous to that reported previously in Table 4.2 for the classroom environment measure. Data are reported for two units of analysis—the individual teacher's score and the school mean score—and separately for actual and preferred forms. The statistics reported for each scale are the alpha reliability (internal consistency), mean correlation of a scale with the other scales (discriminant validity) and ANOVA results for school membership differences (ability to differentiate between schools).

The figures reported in Table 4.6 generally suggest that each scale has satisfactory reliability for scales containing relatively small numbers of items (ranging from 6 to 9). For example, the reliability of different scales in the actual form ranged from 0.77 to 0.94 with the individual as the unit of analysis and from 0.60 to 0.96 with the school mean as the unit of analysis. As expected, higher reliabilities were obtained when the school mean was used as the unit of statistical analysis. Generally the reliability figures are high for the actual form, but somewhat lower for the preferred form of the SLEQ for both units of analysis. The low reliabilities for the preferred form are to be expected because of the very low standard deviations (i.e., very high agreement among teachers) for the preferred form of scales, as shown in Table 4.5.

The mean correlations of a scale with the other scales suggest adequate discriminant validity but, clearly, these scales overlap. The ANOVA results confirm the ability of each SLEQ scale to differentiate significantly ($p<0.001$) between the perceptions of teachers in different schools.

The statistics reported in Table 4.6 for the first use of the SLEQ in Nigeria provide researchers and teachers with a certain degree of confidence in using the actual and preferred forms of the SLEQ in further work in Nigeria. However, it would be desirable to undertake further validation studies involving the use of the SLEQ with a larger sample of teachers in Nigeria.

Table 4.6 Internal Consistency Reliability (Alpha Coefficient), Discriminant Validity (Mean Correlation with Other Scales) and Ability to Differentiate Between Schools for the School Level Environment Questionnaire for Two Units of Analysis

Scale	No. of Items	Unit of Analysis	Alpha Reliability		Mean Correlation with Other Scales		ANOVA Results Eta^2
			Actual	Preferred	Actual	Preferred	Actual
Affiliation	6	Individual	0.94	0.50	0.53	0.35	0.75*
		School Mean	0.96	0.51	0.56	0.45	
Professional Interest	7	Individual	0.93	0.63	0.50	0.48	0.77*
		School Mean	0.96	0.73	0.52	0.53	
Participatory Decision-Making	7	Individual	0.78	0.52	0.45	0.40	0.69*
		School Mean	0.88	0.53	0.49	0.45	
Innovativeness	9	Individual	0.92	0.70	0.55	0.49	0.73*
		School Mean	0.95	0.73	0.56	0.59	
Resource Adequacy	6	Individual	0.77	0.79	0.41	0.53	0.47*
		School Mean	0.60	0.69	0.42	0.59	

* $p<0.001$

The sample consisted of 64 teachers in 20 schools.

4.8 ASSOCIATIONS BETWEEN SCHOOL AND CLASSROOM ENVIRONMENTS

This section reports findings for the research question in the present investigation involving a determinant (namely, school environment) of classroom environment. It is noteworthy that, with some exceptions (Fisher, Fraser, & Wubbels, 1993; Fraser & Rentoul, 1982), very little past research has attempted to establish links between school-level and classroom-level environments. Consequently, the present exploratory attempt to probe links between school climate and classroom environment in Nigeria made a contribution to this emerging and worthwhile line of research.

Table 4.7 reports associations between students' perceptions of classroom-level environment and teachers' perceptions of school-level environment. Simple correlations are reported for the sample of 20 school means. The smallness of the sample of school means precluded being able to perform more sophisticated analyses; therefore the present study should be regarded as exploratory and the finding as tentative.

It is interesting to note from the exploratory analyses reported in Table 4.7 that all five dimensions of school-level environment (i.e., Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy) appear to affect significantly the level of classroom Negotiation, Autonomy and Investigation. On the other hand, none of the school environment variables were related significantly to the amount of classroom Student Centredness and Differentiation. That is, it appears that a more positive school environment (in terms of greater Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy) could promote classroom environments which provide more opportunities in the classroom for student Negotiation, Autonomy and Investigation. On the other hand, the school environment appears to have little influence on the levels of Student Centredness and Differentiation, which also happen to be the two classroom environment dimensions with low mean scores relative to the other scales (see Figure 4.1).

Although little prior research has attempted to establish links between school-level and classroom-level environment, the pattern of results emerging from this study generally replicate two prior studies conducted in Australia using the SLEQ (Fisher, Fraser, & Wubbels, 1993; Fraser & Rentoul, 1982). Nevertheless, because of the preliminary and exploratory nature of this aspect of the present investigation, the fascinating patterns of findings should be considered tentative until further replication studies have been carried out in Nigeria.

Table 4.7 Correlations Between Classroom and School Environment Scales Using School Mean as Unit of Analysis

Classroom Environment Scale	Correlation with School Environment Scale				
	Affiliation	Professional Interest	Participatory Decision-Making	Innovativeness	Resource Adequacy
Negotiation	0.55*	0.61**	0.60**	0.60**	0.63**
Autonomy	0.57**	0.63**	0.62**	0.61**	0.57**
Student Centredness	-0.04	0.01	0.07	0.02	0.06
Investigation	0.58**	0.62**	0.64**	0.60**	0.54**
Differentiation	0.22	0.21	0.17	0.18	0.27

* $p<0.05$

** $p<0.01$

The sample size was 20 school means.

4.9 DIFFERENCES BETWEEN THE CLASSROOM AND SCHOOL ENVIRONMENTS OF FOREST AND SAVANNA SCHOOLS

Whereas the previous section considered school climate as a determinant of classroom environment, this section reports a preliminary investigation of geographic region as another determinant of classroom environment. However, the question has been broadened somewhat also to include school climate differences between forest and savanna schools.

As discussed previously in Section 1.1, there are geographic regions in Nigeria that are defined by two distinct vegetation zones (forest and savanna). One aim of the present study was to investigate any differences that might exist in the nature of agricultural science learning environments in Nigeria between schools in these two regions (Okure, Idiris, Ogu, & Igbokwe, 1991). Because of the distinctiveness of schools in forest and savanna regions, it was thought that there could exist some interesting differences between the classroom and school environments of schools from these two vegetation regions.

In order to explore differences between the classroom and school environments of forest and savanna schools, a *t* test for independent sample was conducted for each of the five scales in the classroom environment instrument and each of the five scales in the school environment instrument. The school mean was chosen as the appropriate unit of analysis in each case. There were 7 schools from forest regions and 11 schools from savanna regions, while the remaining two schools are located in the federal capital. Because of the smallness of the sample size for school means (N = 18), it would not have been meaningful to conduct multivariate analyses.

Table 4.8 shows the scale mean and standard deviation obtained by forest and savanna schools for each classroom and school environment scale. The result of a *t* test for differences between the two types of school on each dimension also is reported in Table 4.8. This table indicates that significant differences ($p<0.05$) between forest

and savanna schools emerged for three classroom environment dimensions (Negotiation, Student Centredness and Differentiation) and for all five school environment scales. The magnitude of all significant differences exceeds one standard deviation.

An interesting pattern in the results in Table 4.8 is that the direction of the differences between forest and savanna schools is consistently in the same direction for all classroom and school environment dimensions. In terms of both classroom and school environment, savanna schools were perceived significantly more positively than forest schools on all nine dimensions.

The above finding of consistently more favourable classroom and school environments in savanna schools than in forest schools is fascinating and warrants further research aimed at replicating and explaining this pattern. Given that the main thrust of the present study was the development of environment instruments and their use in a large-scale investigation of the effects and determinants of classroom environment, it was not possible also (within the scope of the study) to conduct an intensive qualitative investigation which could illuminate the reasons for specific quantitative findings. Therefore, in order to explain the differences in the environments of savanna and forest schools, a combination of qualitative and quantitative methods is recommended in future research.

Although the same national curriculum is used in agricultural science classes in savanna and forest regions, the implementation of the common curriculum is necessarily different in the two regions because of the geographical differences. For example, whereas livestock such as cattle and sheep are common in savanna regions, they are scarce in forest regions. Consequently, the relevance of aspects of the curriculum dealing with cattle, and the opportunity for schools to have cattle available for practical work, are different for savanna and forest schools. It is possible that some of the observed differences in the climates of savanna and forest schools could be attributed to these differences in the way in which the national curricula is implemented in the two regions.

Table 4.8 Differences between Forest and Savanna Schools on Classroom and School Environment Scales

Scale	Scale Mean		Scale SD		Difference
	Forest	Savanna	Forest	Savanna	*t*
Classroom Environment					
Negotiation	16.8	19.6	2.0	1.3	-3.6**
Autonomy	19.1	22.1	4.2	2.1	-2.0
Student Centredness	16.5	19.0	1.5	2.5	-2.3*
Investigation	22.8	24.2	3.3	2.1	-1.1
Differentiation	11.5	13.6	2.0	1.3	-2.7*
School Environment					
Affiliation	8.5	15.2	3.9	5.3	-2.9**
Professional Interest	12.9	19.9	5.0	5.5	-2.7*
Participatory Decision-Making	13.2	17.4	3.1	3.6	-2.4*
Innovativeness	16.5	23.8	6.0	6.4	-2.5*
Resource Adequacy	6.6	9.1	1.5	2.0	-2.8*

* $p<0.05$

** $p<0.01$

The analyses are based on a sample of 18 school means.

4.10 SUMMARY

This chapter reported five main aspects of the results of the present study of Nigerian agricultural science classroom environments. First, an examination of the profiles of mean environment scores showed that, relative to scores on Negotiation, Autonomy and Investigation, Nigerian agricultural science classroom environments were perceived to have low levels of Student Centredness and Differentiation. Also, past research (e.g., Fisher & Fraser, 1983a) was replicated in that

students generally preferred a more positive classroom environment than the one perceived to be actually present.

Second, data supported the cross-cultural validity of the classroom environment scales when used for the first time in Nigeria. In particular, each scale was found to display satisfactory internal consistency reliability and discriminant validity when either the student score or the school mean score was used as the unit of statistical analysis. Also, the actual form of each scale differentiated significantly between the perceptions of students in different classrooms.

Third, when simple and multiple correlation analyses were used to investigate associations between classroom environment and student outcomes, significant relationship emerged for two units of analysis (the student and the school mean) for both the attitude and enquiry skills outcome. However, no significant findings occurred for the performance skills outcome measure. The present study generally replicates considerable past research (e.g., McRobbie & Fraser, 1993) into the effects of classroom environment on student outcomes.

Fourth, in order to investigate associations between students' perceptions of classroom environment and teachers' perceptions of school environment, it was necessary to cross-validate a five-scale version of the School-Level Environment Questionnaire. This instrument was found to have adequate reliability and discriminant validity for two units of analysis (the teacher and the school mean) and to differentiate between the perceptions of teachers in different schools. When simple correlations were calculated between classroom and school environment dimensions using the school mean of the unit of analysis, it was found that all school environment dimensions (namely, Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy) were linked with greater levels of Negotiation, Autonomy and Investigation within the classroom environment).

Fifth, differences in both the classroom environments and school environments of forest and savanna schools were investigated using *t* tests and with the school mean as the unit of analysis. It was found that savanna schools had consistently more favourable classroom and school environments than did forest schools. However, because of the smallness of the sample of school means, caution is needed in interpreting findings for the investigation of associations between classroom and school environment and of differences between the environments of forest and savanna schools.

Chapter 5

SUMMARY, LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

5.1 INTRODUCTION

The main aims of the present study were (1) to develop and validate a classroom environment instrument specifically for use in agricultural science classes in Nigeria, (2) to investigate associations between the nature of the learning environment of agricultural science classes and three student outcomes (namely, attitudes, enquiry skills and practical performance skills), and (3) to investigate some determinants of classroom environment (namely, school environment and geographical region).

The purposes of this concluding chapter are to provide a brief summary of previous chapters (Section 5.2), to discuss the present study's limitations (Section 5.3), to draw implications from the study for improving agricultural science education in Nigeria (Section 5.4), and to make recommendations for desirable future research directions (Section 5.5).

5.2 SUMMARY OF THESIS

A review of literature in Chapter 2 indicated that agricultural science occupies a prominent position in Nigeria's educational history, and that agriculture was the main element of Nigeria's economy prior to late 1970. The central place of agricultural science in the Nigerian school curriculum justifies the decision to conduct the present research into Nigerian agricultural science classroom environments.

The review of past classroom environment research in Chapter 2 showed that, although numerous instruments for assessing student perceptions of learning environment have been developed, validated and used in research, there was a need to develop/adapt and validate classroom environment scales specifically for Nigerian agricultural science classes.

Because student-centred teaching is uncommon in Nigerian schools, it was decided that the instrument used in the present study would include modified versions of scales adapted from the Individualised Classroom Environment Questionnaire (Fraser, 1990) and the Constructivist Learning Environment Survey (Taylor, Fraser, & White, 1994).

The literature review of Chapter 2 also showed that the two most common lines of classroom environment research involved, first, the effects of learning environment on student outcomes and, second, determinants of classroom environment. In line with past traditions, the present research involved investigating not only associations between student-perceived classroom environment in Nigerian agricultural science classrooms and several student outcomes (namely, attitudes, enquiry skills and practical performance), but also two determinants of classroom environment (namely, the school environment and geographical location).

Chapter 3 considered methodological issues. The sample involved 1 175 students in 50 agricultural science classes (mainly at the junior high school level) in 20 schools in 9 Nigerian states/territories. Also, 64 agricultural science teachers from the same schools were involved. Given the size of the sample and the range of instruments involved, it was necessary for the researcher to travel to Nigeria for several months to organise and supervise the data collection.

Student perceptions of aspects of constructivism and individualisation in the classroom environment were assessed using the Learning Environment Scale (LES), which contains the scales of Negotiation, Autonomy, Student Centredness, Investigation and Differentiation. Teachers' perceptions of their school climate were assessed with a version of the School Level Environment Questionnaire (SLEQ) which includes the dimensions of Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy. Student outcomes were assessed with sets of items selected and adapted from the Test of Science Related Attitudes (TOSRA), Test of Enquiry Skills (TOES) and a performance skills rating scale (which was filled in for each student by the teacher).

In Chapter 4, the results of five sets of data analyses were reported. First, relative to scores on Negotiation, Autonomy and Investigation, Nigerian agricultural science classroom environments were perceived by students to have low levels of Student Centredness and Differentiation. Also, past research (e.g., Fisher & Fraser, 1983a) was replicated in that students generally preferred a more positive classroom environment than the one perceived to be actually present.

Second, the cross-cultural validity of the classroom environment scales was established for their first use in Nigeria. Each scale displayed satisfactory internal consistency reliability and discriminant validity with either the student score or the school mean score as the unit of statistical analysis. Also, the actual form of each scale differentiated significantly between the perceptions of students in different classrooms.

Third, when simple and multiple correlation analyses were used to investigate associations between classroom environment and student outcomes, significant relationship emerged for two units of analysis (the student and the class mean) for both the attitude and enquiry skills outcome, thus replicating considerable past research (Fraser, 1994).

Fourth, before exploring associations between students' perceptions of classroom environment and teachers' perceptions of school environment, it was necessary to cross-validate a five-scale version of the School-Level Environment Questionnaire to ensure its reliability and discriminant validity in the Nigerian context. Simple correlations between classroom and school environment dimensions using the school mean of the unit of analysis revealed that all school environment dimensions (namely, Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy) were linked with greater levels of Negotiation, Autonomy and Investigation within the classroom environment.

Fifth, *t* tests involving the school mean as the unit of analysis revealed that savanna schools had consistently more favourable classroom and school environments than did forest schools.

5.3 LIMITATIONS OF THE RESEARCH

Given that the present study was the first to focus on Nigerian agricultural science classroom environments, and therefore could not build on the contributions of previous studies, it is not surprising that the research had some limitations in terms of its scope and other aspects.

Because the sample encompassed 50 classes in 20 schools spread over 9 states/territories, and because the researcher was undertaking his doctoral studies in Australia, it was necessary to hand over to teachers much of the time-consuming task of administering the various instruments to students. However, the researcher visited Nigeria for several months and made at least two visits to every school involved in the study to explain the study's purposes, clarify instrument administration procedures, and collect completed questionnaires. The researcher also interviewed numerous teachers and students and was assured that students had understood the directions for answering the questionnaires. Nevertheless, because the researcher did not administer the instruments personally, there is a chance that the data collection was imperfect in some respects.

The present study is like most prior classroom environment research in that it was correlational in nature. That is, studies have investigated associations between outcomes and actual environment in naturally occurring classrooms. Consequently, causal conclusions cannot be drawn. What is needed in future research, then, are experimental studies in which the environment is changed deliberately in specific ways in order to establish more clearly the causal effects of these changes on students' outcomes.

This study's methodology was predominantly quantitative, although useful qualitative components were involved during instrument development (in that the opinions about preliminary version were sought from various experts, teachers and students) and in the instrument administration phase (in that the researcher travelled to Nigeria and interviewed teachers and students to check that administration had proceeded as intended). Because of the pioneering nature of this study in

Nigeria, much effort was needed to develop/adapt and validate a wide range of instruments (for assessing classroom environment, school environment, attitudes, enquiry skills and practical performance) and to administer them to a large sample of agricultural science students drawn from a range of states/territories in Nigeria. Given the demands of quantitative aspects of this study, it was outside the scope of the present research also to include an intensive qualitative component. However, it is fully acknowledged that a qualitative component would have complemented the quantitative component in the useful ways described by Fraser and Tobin (1991). If time and resources had permitted the inclusion of qualitative procedures, it is likely that greater understanding would have emerged concerning the reasons for some of the findings (particularly the differences found between the environments of savanna and forest schools; associations between classroom environment and student outcomes).

5.4 IMPLICATIONS FOR IMPROVING AGRICULTURAL SCIENCE EDUCATION IN NIGERIA

Whereas Section 5.5 addresses the implications of the present study for future research, this section briefly considers some implications of the research for improving agricultural science education in Nigeria. The implications are discussed in terms of the study's three main aims: to develop and validate several instruments; to investigate the effects of classroom environment on student outcomes; and to investigate some determinants of classroom environment.

In this study, considerable energy was devoted to adapting, developing and validating numerous instruments for various purposes. As a result of this study, other educators in Nigeria now have at their disposal validated instruments to assess student perceptions of classroom environment, teacher perceptions of school environment, and three student outcomes (namely, attitudes, enquiry skills and practical performance). The first practical implication from this study is that teachers should make use of each of these instruments to enlarge their repertoires of evaluation instruments and to obtain information which can form the basis for the improvement of teaching and student achievement of important

outcomes. In particular, the present study's findings of the prevalence of low levels of Student Centredness and Differentiation in the classroom environment should encourage both attempts to transform classrooms to give greater emphasis to these dimensions and the use of the new classroom environment instrument to monitor the success of attempts to transform classroom environment.

The aspect of research involving associations between classroom environment and student outcomes provides practical guidance about how to improve student outcomes by creating types of classroom environments found empirically to be conducive to improved student outcomes. The present study suggests that teachers are likely to be able to improve their students' attitudes and enquiry skills by changing their classroom environments to provide greater emphasis on Negotiation and Autonomy.

Finally, the part of the present study involving determinants of classroom environment revealed some interesting differences between the classroom environments of schools with different school environments. Educators wishing to improve classroom environment should exploit this link between school and classroom environments. The present research suggests that greater emphasis on each of the school environment dimensions assessed (namely, Affiliation, Professional Interest, Participatory Decision-Making, Innovativeness and Resource Adequacy) are likely to lead to more positive classroom environments in terms of the level of student Negotiation, Autonomy and Investigation.

5.5 DIRECTIONS FOR FUTURE RESEARCH

The present research was pioneering in that it represents the first study of the environments associated with agricultural science classes in Nigeria. Consequently, in terms of future research directions, it is desirable that the instruments developed and validated especially for this study receive widespread use for a variety of future research purposes. Also, there is scope to replicate and extend the specific lines of research pursued in the present investigation.

While this study successfully drew on the Constructivist Learning Environment Survey (CLES) and the Individualised Classroom Environment Questionnaire (ICEQ) in developing and validating a classroom environment instrument for use in Nigeria, it still would be desirable in future research to conduct further cross-validation studies for these scales. Moreover, there is considerable scope to adopt, adapt and validate other existing classroom environment instruments for use in the Nigerian context. Consequently, in future research, it would be desirable to explore the cross-cultural usefulness and validity of instruments such as the Classroom Environment Scale (CES; Moos & Trickett, 1987), the Learning Environment Inventory (LEI) and My Class Inventory (MCI; Fraser, Anderson, & Walberg, 1982; Fraser & O'Brien, 1985), the College and University Classroom Environment Inventory (CUCEI; Fraser & Treagust, 1986) and the Questionnaire on Teacher Interaction (QTI; Wubbels & Levy, 1993). In particular, because of its focus on a unique classroom environment which is highly relevant in science teaching, the Science Laboratory Environment Inventory (SLEI; Fraser, Giddings, & McRobbie, 1992) is likely to be of special interest among science education researchers in future research in Nigeria.

The present study replicated past research in that classroom environment, as assessed by the Learning Environment Survey, was related to two student outcomes, namely, attitudes and enquiry skills. There is scope in future research both to replicate the present study and to extend it to the use of other classroom environment measures, to a broader range of student outcome measures (e.g., achievement, critical thinking, qualitative understanding), and to other Nigerian samples (that extend beyond agricultural science classes at the junior high school level). Furthermore, by including students' scores on both an actual and a preferred form of a classroom environment scale within the same analyses involving student outcomes, past person-environment-fit research (Fraser & Fisher, 1983b) could be replicated in an attempt to ascertain whether student outcomes are enhanced when students are in their preferred classroom environment.

Although attention in the present research was restricted to involving only classroom environment as a predictor of student outcomes, it would

be desirable in future work in Nigeria to incorporate other factors along with classroom environment when investigating student outcomes. For example, Moos (1991) has established links between classroom, school, family and other environments on student outcomes. There is scope in Nigeria to make use of classroom environment as one factor in a multi-factor model of educational productivity (Fraser, Walberg, Welch & Hattie, 1987).

The present research included the investigation of two determinants (namely, school climate and geographic region) of classroom environment. In fact, the present study provided one of the few examples of studies which attempted to link classroom-level and school-level environment. However, because of the smallness of the sample of school means (N = 20) in this research, it was not possible to employ multivariate techniques of statistical analysis. Therefore, there is scope in future research to replicate the present research into determinants of classroom environment using larger samples and multivariate statistical analyses.

In addition, it is desirable to replicate other lines of past research in which classroom environment dimensions have been employed as dependent variables. For example, based on the fruitfulness of incorporating classroom environment measures into evaluations of Harvard Project Physics (Welch & Walberg, 1972), the Australian Science Education Project (Fraser, 1979a), alternative high school (Fraser, Williamson & Tobin, 1987) and computer-assisted learning (Teh & Fraser, in press, a), it is suggested that evaluations in Nigeria include classroom environment dimensions as criteria of effectiveness. Furthermore, it could be beneficial in Nigeria to replicate past studies which have employed classroom environment dimensions as independent variable in investigating differences between students' and teachers' perceptions of the same classrooms (Raviv, Raviv, & Reisel, 1990), differences between the environments of primary and secondary schools (Docker, Fraser, & Fisher, 1989), of Catholic and government schools (Dorman, Fraser, & McRobbie, 1994), of coeducational and single-sex schools (Trickett et al., 1982), of classes of different sizes (Anderson & Walberg, 1972) and of classes at different grade levels (Welch, 1979).

As discussed in Section 5.3, the heavy demands involved in developing such a range of new instruments (classroom environment, school environment, attitudes, enquiry skills and practical performance) and administering them to a large number of students dispersed throughout nine different Nigerian states/territories meant that it was not feasible also to add an intensive qualitative component to the study. Because of the advantages of combining qualitative and quantitative methods in learning environment research (Fraser & Tobin, 1991), a desirable direction in future research in Nigeria would be to employ qualitative research methods as well as quantitative ones.

The unit-of-analysis question has proved to be vexatious in classroom and school environment research (Fraser, 1994). The solution adopted in the present research involved performing analyses twice—once with the individual student as the unit of analysis and again with the school mean as the unit of analysis. Recent advances in methodology now make it possible to consider different levels of analysis simultaneously. Therefore, in future classroom environment research in Nigeria, it is recommended that hierarchical or multilevel analysis of data (Cheung et al., 1990; Goldstein, 1987; Raudenbush, 1988) be employed to give appropriate consideration to individual and class/school levels when exploring associations between classroom environment and student outcomes.

Potentially useful lines of past classroom environment research which could be worth replicating in Nigeria include studies of changes in classroom environment during the transition between primary and secondary schools (Midgley, Eccles, & Feldlaufer, 1991), incorporating the evaluation of classroom environment in teacher assessment schemes (Heroman et al., 1991), identifying distinct typologies of classroom environments (Moos, 1978), investigating the climates of exemplary teachers' classrooms (Fraser & Tobin, 1989), and developing and using a 'personal' form of classroom environment scales (Fraser, McRobbie, & Giddings, in press).

Now that a classroom environment instrument (the Learning Environment Survey) has been developed and validated specifically for

use in Nigeria, it is highly desirable that teachers make use of the new questionnaire as a basis for guiding improvements in their classrooms. Fraser and Fisher (1986) have outlined a simple five-step procedure—involving assessment of actual and preferred environment, feedback to the teacher, reflection and discussion, intervention and reassessment—for improving classroom environments. Various case studies (e.g., Thorpe, Burden, & Fraser, in press) attest to the usefulness of teachers employing classroom environment instruments to provide meaningful information about their classrooms and a tangible basis to guide improvements. It is recommended that teacher-researchers in Nigeria use these methods with the Learning Environment Survey in attempts to improve classroom environments.

5.6 CONCLUSION

The research reported in this thesis generally consolidates a rich tradition of past research into the assessment, effects and determinants of classroom psychosocial environment (Fraser, 1994). However, this study of agricultural science classroom environments in Nigeria was unique in several ways. Although the study of learning environments has spanned many different countries, this line of research has been almost nonexistent in Nigeria. Also it appears that previously no learning environment study has been conducted specifically in agricultural science classrooms in any country. A secondary but important contribution of the present study is that it resulted in the development of some widely-applicable, valid and reliable instruments that can be used in future research to assess classroom environment, school environment and student outcomes (especially attitudes and enquiry skills) in Nigerian schools.

REFERENCES

Agada, D. (1988). *The relationships between classroom climate, science related attitudes and socio-cultural factors in the study of science at the junior secondary level.* Unpublished Master of Education thesis, Ahmadu Bello University, Zaria, Nigeria.

Ajeyalemi, D., & Baiyelo, T. D. (1990). Science and technology in perspective (Nigeria). In Ajeyalemi, D. (Ed.), *Science and technology education in Africa: Focus on seven sub-saharan countries.* Lagos, Nigeria: University of Lagos Press.

Akindehin, F. (1993). An investigation of some factors of psychosocial environment in some Nigerian secondary schools. *Research in Science and Technological Education, 11,* 117-126.

Akinyemi, K. (1983). Trends in development of primary education in Nigeria. In A. Segun (Ed.), *Nigeria education: Trends and issues.* Ife, Nigeria: University of Ife Press.

Alao, E. O. (1985). *A study of attitude to basic sciences and correlation to performance in the science subjects.* Unpublished PhD thesis, University of London, England.

Anderson, G. J. (1970). Effects of classroom social climate on individual learning. *American Educational Research Journal, 7,* 135-152.

Anderson, C. S. (1982). The search for school climate: A review of the research. *Review of Educational Research, 52,* 368-420.

Anderson, R. C. (1984). Some reflections on the acquisition of knowledge. *Educational Researcher, 13*(9), 5-10.

Anderson, G. J., & Walberg, H. J. (1968). Classroom climate and group learning. *International Journal of Educational Sciences, 2,* 175-180.

Anderson, G. J., & Walberg, H. J. (1972). Class size and the social environment of learning: A mixed replication and extension. *Alberta Journal of Educational Research, 18,* 277-286.

Block, J. (1963). The equivalence of measures and the correction for attenuation. *Psychological Bulletin, 60,* 152-156.

Brekelmans, M., Wubbels, Th., & Créton, H. (1990). A study of student perceptions of physics teacher behavior. *Journal of Research in Science Teaching, 27,* 335-350.

Brookover, W. B., Beady, C., Flood, P., Schweitzer, J., & Wisenbaker, J.

(1979). *School social systems and student achievement.* New York: Praeger.

Brookover, W. B., & Schneider, J. (1975). Academic environments and elementary school achievement. *Journal of Research and Development in Education, 9,* 83-91.

Brookover, W. B., Schweitzer, J. H., Schneider, J. M., Beady, C. H., Flood, P. K., & Wisenbaker J. M. (1978). Elementary school social climate and school achievement. *American Educational Research Journal, 15,* 301-318.

Bruner, J. S. (1966). *Toward a theory of instruction.* New York: Norton.

Bruner, J. S. (1971). *The relevance of education.* New York: Norton.

Bruner, J. S., Olver, R. R., & Greenfeld, P. M. (1966). *Studies in cognitive growth.* New York: John Wiley.

Burden, R., & Fraser, B. J. (in press). Use of classroom environment assessments in school psychology: A British perspective. *Psychology in the Schools.*

Burstein, L. (1978). Assessing differences between grouped and individual-level regression coefficients: Alternative approaches. *Sociological Methods and Research, 7,* 5-28.

Burstein, L., Linn, R. L., & Capell, F. J. (1978). Analyzing multilevel data in the presence of heterogeneous within-class regressions. *Journal of Educational Statistics, 3,* 347-383.

Carey, S. (1985). *Conceptual change in childhood.* Massachusetts: MIT Press.

Chatiyanonda, S. (1978). *An evaluation of the IPST physics curriculum in Thailand.* Unpublished doctoral thesis, Monash University, Perth.

Chavez, R. C. (1984). The use of high inference measures to study classroom climates: A review. *Review of Educational Research, 54,* 237-261.

Cheung, K. C., Keeves, J. P., Sellin, N., & Tsoi, S. C. (1990). The analysis of multilevel data in educational research: Studies of problems and their solutions. *International Journal of Educational Research, 14*(3), 215-319. (whole issue)

Cohen, D. (1971). Can scientific attitudes be evaluated? *Research 1971, 1,* 135-143.

Cohen, D., & Fraser, B. (1987). *The processes of curriculum development and evaluation: A retrospective account of the processes of the Australian Science Education Project.* Canberra, ACT: Curriculum Development Centre.

Combs, A. M. (1971). Affective education or none at all. In R. B. Sind & R. W. Bybee (Eds.), *Becoming a better elementary science teacher.* Columbus, OH: Charles E. Merrill & Company.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297-334.

Cronbach, L. J., & Snow, R. E. (1977). *Aptitudes and instructional methods: A handbook for research on interactions.* New York: Irvington.

Docker, J. G., Fraser, B. J., & Fisher, D. L. (1989). Differences in the psychosocial work environment of different types of schools. *Journal of Research in Childhood Education, 4,* 5-17.

Dorman, J., Fraser, B., & McRobbie, C. (1994, April). *Rhetoric and reality: A study of classroom environment in Catholic and government secondary schools.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Driver, R. (1991, April). *Constructivist approaches to science teaching.* Paper presented at the Seminar Series 'Constructionism in Education', Mathematics Education Department, University of Georgia.

Driver, R., Guesne, E., & Tiberghien, A. (1985). *Children's ideas in science.* London, England: Open University Press.

Dunkin, M. J., & Biddle, B. (1974). *The study of teaching.* New York: Holt, Rinehart and Winston.

Ebenezer, J. V., & Zoller, U. (1993). Grade 10 students' perceptions of and attitudes toward science teaching and school science. *Journal of Research in Science Teaching, 30,* 175-186.

Edwards, C. N., & Fisher, R. L. (1977). *Teaching elementary school science: A competency-based approach.* New York: Praeger Publishers.

Ellett, C. D., Payne, D. A., Masters, J. A., & Pool, J. E. (1977, April). *The relationship between teacher and student perceptions of school environment dimensions and school outcome variables.* Paper

presented at the annual meeting of the Southeastern Psychological Association, Miami, FL.

Ellett, C. D., & Walberg, H. J. (1979). Principals' competency, environment, and outcomes. In H. J. Walberg (Ed.), *Educational environments and effects: Evaluation, policy and productivity.* Berkeley, CA: McCutchan.

Fafunwa, A. B. (1974). *History of education in Nigeria.* London, England: Allen & Unwin.

Federal Ministry of Education. (1977). *National policy on education.* Lagos, Nigeria: Government Press.

Federal Ministry of Education. (1985). *National policy on education* (revised version). Lagos, Nigeria: Government Press.

Fisher, D. L., & Fraser, B. J. (1981). Validity and use of My Class Inventory. *Science Education, 65,* 145-156.

Fisher, D. L., & Fraser, B. J. (1983a). A comparison of actual and preferred classroom environment as perceived by science teachers and students. *Journal of Research in Science Teaching, 20,* 55-61.

Fisher, D. L., & Fraser, B. J. (1983b, April). *Use of Classroom Environment Scale in investigating effects of psychosocial milieu on science students' outcomes.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Dallas, TX.

Fisher, D., & Fraser, B. (1983c). Validity and use of Classroom Environment Scale. *Educational Evaluation and Policy Analysis, 5,* 261-271.

Fisher, D. L., & Fraser, B. J. (1990). *School climate: Assessing and improving school environments* (Set: Research Information for Teachers, Item 4). Melbourne, Australia: Australian Council for Educational Research.

Fisher, D. L., & Fraser, B. J. (1991a, April). *Incorporating learning environment ideas into teacher education: An Australian perspective.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Fisher, D. L., & Fraser, B. J. (1991b). School climate and teacher professional development. *South Pacific Journal of Teacher Education, 19*(1), 15-30.

Fisher, D., Fraser, B., & Wubbels, Th. (1993). Interpersonal teacher behavior and school environment. In Th. Wubbels & J. Levy (Eds.), *Do you know what you look like?: Interpersonal relationships in education* (pp. 103-112). London, England: Falmer Press.

Fraser, B. J. (1977). Selection and validation of attitudes scales for curriculum evaluation. *Science Education, 61,* 317-329.

Fraser, B. J. (1978a). Environmental factors affecting attitude toward different sources of scientific information. *Journal of Research in Science Teaching, 15,* 491-497.

Fraser, B. J. (1978b). Development of a test of science related attitudes. *Science Education, 62,* 509-515.

Fraser, B. J. (1979a). Evaluation of a science-based curriculum. In H. J. Walberg (Ed.), *Educational environments and effects: Evaluation, policy, and productivity.* Berkeley, CA: McCutchan.

Fraser, B. J. (1979b). *Test of Enquiry Skills.* Melbourne, Australia: Australian Council for Educational Research.

Fraser, B. J. (1980). Guest editor's introduction: Classroom environment research in the 1970's and 1980's. *Studies in Educational Evaluation, 6,* 221-223.

Fraser, B. J. (1981a). *Learning environment in curriculum evaluation: A review* (Evaluation in Education series). Oxford, England: Pergamon Press.

Fraser, B. J. (1981b). *Test of Science-Related Attitudes (TOSRA).* Melbourne, Australia: Australian Council for Educational Research.

Fraser, B. J. (1981c). Predictive validity of an individualized classroom environment questionnaire. *Alberta Journal of Educational Research, 27,* 240-251.

Fraser, B. J. (1982). Differences between student and teacher perceptions of actual and preferred classroom learning environment. *Educational Evaluation and Policy Analysis, 4,* 511-519.

Fraser, B. J. (1986a). *Classroom environment.* London, England: Croom Helm.

Fraser, B. J. (1986b). Determinants of classroom psychosocial environment: A review. *Journal of Research in Childhood Education, 1,* 5-19.

Fraser, B. J. (1989). Twenty years of classroom environment research: Progress and prospect. *Journal of Curriculum Studies, 21,* 307-327.

Fraser, B. J. (1990). *Individualised Classroom Environment Questionnaire.* Melbourne, Australia: Australian Council for Educational Research.

Fraser, B. J. (1991). Two decades of classroom environment research. In B. J. Fraser & H. J. Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences.* Oxford, England: Pergamon Press.

Fraser, B. J. (1994). Research on classroom and school climate. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 493-541). New York: Macmillan.

Fraser, B. J., Anderson, G. J., & Walberg, H. J. (1982). *Assessment of learning environments: Manual for Learning Environment Inventory (LEI) and My Class Inventory (MCI)* (third version). Perth, Australia: Western Australian Institute of Technology.

Fraser, B. J., & Butts, W. L. (1982). Relationship between perceived levels of classroom individualization and science-related attitudes. *Journal of Research in Science Teaching, 19,* 143-154.

Fraser, B. J., & Fisher, D. L. (1982a). Effects of classroom psychosocial environment on student learning. *British Journal of Educational Psychology, 52,* 374-377.

Fraser, B. J., & Fisher, D. L. (1982b). Predicting students' outcomes from their perceptions of classroom psychosocial environment. *American Educational Research Journal, 19,* 498-518.

Fraser, B. J., & Fisher, D. L. (1982c). Predictive validity of My Class Inventory. *Studies in Educational Evaluation, 8,* 129-140.

Fraser, B. J., & Fisher, D. L. (1983a). *Assessment of classroom psychosocial environment: Workshop manual* (Research Seminar and Workshop Series). Perth, Australia: Western Australian Institute of Technology.

Fraser, B. J., & Fisher, D. L. (1983b). Use of actual and preferred classroom environment scales in person-environment fit research. *Journal of Educational Psychology, 75,* 303-313.

Fraser, B. J., & Fisher, D. L. (1986). Using short forms of classroom climate instruments to assess and improve classroom

psychosocial environment. *Journal of Research in Science Teaching, 5,* 387-413.

Fraser, B., Giddings, G., & McRobbie, C. (1992). Assessment of the psychosocial environment of university science laboratory classrooms: A cross-national study. *Higher Education, 24,* 431-451.

Fraser, B. J., McRobbie, C. J., & Giddings, G. J. (1993). Development and cross-national validation of a laboratory classroom environment instrument for senior high school science. *Science Education, 77,* 1-24.

Fraser, B. J., McRobbie, C. J., & Giddings, G. J. (in press). Evolution and validation of a personal form of an instrument for assessing science laboratory classroom environment. *Journal of Research in Science Teaching.*

Fraser, B. J., Nash, R., & Fisher, D. L. (1983). Anxiety in science classrooms: Its measurement and relationship to classroom environment. *Research in Science and Technological Education, 1,* 201-208.

Fraser, B. J., & O'Brien, P. (1985). Student and teacher perceptions of the environment of elementary-school classrooms. *Elementary School Journal, 85,* 567-580.

Fraser, B., Okebukola, P., & Jegede, O. (1992). Assessment of the learning environment of Nigerian science laboratory classes. *Journal of the Science Teachers Association of Nigeria, 27*(2), 1-17.

Fraser, B., & Rentoul, A. (1982). Relationships between school-level and classroom-level environment. *Alberta Journal of Educational Research,* 28, 212-225.

Fraser, B. J., & Tobin, K. (1989). Student perceptions of psychosocial environments in classrooms of exemplary science teachers. *International Journal of Science Education, 11,* 19-34.

Fraser, B. J., & Tobin, K. (1991). Combining qualitative and quantitative methods in classroom environment research. In B. J. Fraser & H. J. Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences.* Oxford, England: Pergamon Press.

Fraser, B. J., & Treagust, D. F. (1986). Validity and use of an instrument

for assessing classroom psychosocial environment in higher education. *Higher Education, 15,* 37-57.

Fraser, B. J., Treagust, D. F., & Dennis, N. C. (1986). Development of an instrument for assessing classroom psychosocial environment at universities and colleges. *Studies in Higher Education, 11,* 43-54.

Fraser, B. J., & Walberg, H. J. (1981). Psychosocial learning environment in science classrooms: A review of research. *Studies in Science Education, 8,* 67-92.

Fraser, B. J., & Walberg, H. J. (Eds.). (1991). *Educational environments: Evaluation, antecedents and consequences.* Oxford, England: Pergamon Press.

Fraser, B. J., Walberg, H. J., Welch, W. W., & Hattie, J. A. (1987). Syntheses of educational productivity research. *International Journal of Educational Research, 11*(2), 145-252. (whole issue)

Fraser, B. J., Williamson, J. C., & Tobin, K. (1987). Use of classroom and school climate scales in evaluating alternative high schools. *Teaching and Teacher Education, 3,* 219-231.

Gagné, R. M. (1977). *The conditions of learning.* New York: Rinehart & Winston.

Galluzzi, E. G., Kirby, E. A., & Zucker, K. B. (1980). Students' and teachers' perceptions of classroom environment and self- and others-concepts. *Psychological Reports, 46,* 747-753.

Gardner, P. L. (1974). Pupil personality, teacher behaviour and attitudes to a physics course. In P. W. Musgrave (Ed.), *Contemporary studies in the curriculum.* Sydney, Australia: Angus and Robertson.

Gardner, P. L. (1976). Attitudes toward physics: Personal and environmental influences. *Journal of Research in Science Teaching, 13,* 111-125.

Garey, S. (1985) *Conceptual change in childhood.* Harvard, MA: Massachusetts Institute of Technology Press.

Genn, J. M. (1984). Research into the climates of Australian schools, colleges and universities: Contributions and potential of need-press theory. *Australian Journal of Education, 28,* 227-248.

Gentner, D., & Stevens, A. L. (Eds.). (1983). *Mental models.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Goldstein, H. (1987). *Multilevel models in educational and social*

research. London, England: Charles Griffin.

Greeno, J. G. (1978). A study of problem solving. In R. Glaser (Ed.), *Advances in instructional psychology.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Haertel, G. D., Walberg, H. J., & Haertel, E. H. (1981). Socio-psychological environments and learning: A quantitative synthesis. *British Educational Research Journal, 7,* 27-36.

Haladyna, T., Olsen, R., & Shaughnessy, J. (1982). Relations of student, teacher and learning environment variables to attitudes toward science. *Science Education, 66,* 671-687.

Haladyna T., Shaughnessy, J., & Redsun, A. (1982a). Correlates of attitudes toward social studies. *Theory and Research in Social Education, 10*(1), 1-26.

Haladyna, T., Shaughnessy, J., & Redsun, A. (1982b). Relations of student, teacher, and learning environment variables to attitudes toward social studies. *Journal of Social Studies Research, 6,* 36-44.

Haladyna, T., Shaughnessy, J., & Shaughnessy, J. M. (1983). A causal analysis of attitude toward mathematics. *Journal of Research in Mathematics Education, 14,* 19-29.

Halpin, A. W., & Croft, D. B. (1963). *Organizational climate of schools.* Chicago, IL: Midwest Administration Center, University of Chicago.

Hase, H. D., & Goldberg, L. R. (1967). Comparative validity of different strategies of constructing personality inventory scales. *Psychology Bulletin, 67,* 231-248.

Helm, H., & Novak, J. (1983). *Misconceptions in science and mathematics.* Paper presented at International Seminar at Cornell University, Ithaca, NY.

Henderson, D., Fisher, D., & Fraser, B. (1994, March). *Learning environments and student outcomes in senior high school biology classes.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Anaheim, CA.

Heroman, D., Loup, K., Chauvin, S., & Evans, L. (1991, April). *Student perceptions of the learning environment, on-the-job assessments of teaching and learning.* Paper presented at annual

meeting of American Educational Research Association, Chicago, IL.

Hofstein, A., Gluzman, R., Ben-Zvi, R., & Samuel, D. (1979). Classroom learning environment and attitudes towards chemistry. *Studies in Educational Evaluation, 5,* 231-236.

Hofstein, A., & Lazarowitz, R. (1986). A comparison of the actual and preferred classroom learning environment in biology and chemistry as perceived by high school students. *Journal of Research in Science Teaching, 23,* 189-199.

Holsinger, D. B. (1972). *The elementary school as an early socializer of modern values: A Brazilian study.* Unpublished doctoral dissertation, Stanford University, Palo Alto, CA.

Holsinger, D. B. (1973). The elementary school as modernizer: A Brazilian study. *International Journal of Comparative Sociology, 14,* 180-202.

Humphrey, L. L. (1984). Children's self-control in relation to perceived social environment. *Journal of Personality and Social Psychology, 46,* 178-188.

Idiris, S. A. (1988). *A study of the status of agricultural science in post-primary schools of Kaduna State.* Unpublished MEd thesis, Ahmadu Bello University, Nigeria.

Idiris, S. A. (1990, April). *Teacher factors in the teaching of agricultural science in Nigerian schools and colleges.* Paper presented at the 1990 STAN National Workshop on Agricultural Science, University of Calabar, Nigeria.

Ivowi, U. M. O. (1992, August). *STAN President address.* Presentation at the annual conference of the Science Teachers Association of Nigeria, University of Nigeria, Enugu Campus.

Jegede, O. (1990). The emergence of relevant biology education for Nigeria. *Australian Science Teachers Journal, 36*(2), 27-32.

Jegede, O., & Fraser, B. J. (1989). Influence of socio-cultural factors on secondary school students' attitude towards science. *Research in Science Education, 19,* 155-164.

Jegede, O., Fraser, B., Agada, D., & Okebukola, P. (in press). Junior secondary students' perception of science classroom climate relative to selected school demographic variables. *Abraka Journal of Education.*

Johnson, D. W., Johnson, R. T., Johnson Holubec, E., & Roy, P. (1986). *Circles of learning: Cooperation in the classroom* (2nd. ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Johnson, D., Maruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). The effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin, 89,* 47-62.

Jung, W., Pfundt, H., & Rhoneck, C. (1982). *Problems concerning students' representations of physics and chemistry knowledge.* Ludwigsburg, Germany: Padagogische Hochschule.

Kelly, A. (1980). Exploration and authority in science learning environments: An international study. *European Journal of Science Education, 2,* 161-174.

Keyser, V., & Barling, J. (1981). Determinants of children's self-efficacy beliefs in an academic environment. *Cognitive Therapy and Research, 5,* 29-40.

Klopfer, L. E. (1971). Evaluation of learning in science. In B. S. Bloom, J. T. Hastings, & G. F. Madaus (Eds.), *Handbook on summative and formative evaluation of student learning.* New York: McGraw-Hill.

Koballa, T. R., Jr. (1992). Persuasion and attitude change in science education. *Journal of Research in Science Teaching, 29,* 63-80.

Kroger, R. D. (1968). Conceptual and empirical independence in test validation: A note on Campbell and Fisher's 'discriminant validity'. *Educational and Psychological Measurement, 28,* 383-387.

Kuhn, T. S. (1970). The structure of scientific revolution. In I. Lakatos & A. Musgrave (Eds), *Criticism of the growth of knowledge.* London, England: Cambridge University Press.

Lawrenz, F. (1976). The prediction of student attitude toward science from student perception of the classroom learning environment. *Journal of Research in Science Teaching, 13,* 509-515.

Lawrenz, F. (1988). Prediction of student energy knowledge and attitudes. *School Science and Mathematics, 88,* 543-549.

Lewin, K. (1936). *Principles of topological psychology.* New York: McGraw.

Luecht, R. M., & Smith, P. L. (1989, April). *The effects of bootstrapping strategies on the estimation of variance components.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

MacAuley, D. J. (1990). Classroom environment: A literature review. *Educational Psychology, 10,* 239-253.

McRobbie, C. J., & Fraser, B. J. (1993). Association between student outcomes and psychosocial science environment. *Journal of Educational Research, 87,* 78-85.

Mead, M., & Métraux, R. (1957). Image of the scientist among high school students. *Science, 126,* 384-390.

Mehrens, W. A., & Lehmann, L. J. (1984). *Measurement and evaluation in education and psychology* (3rd ed.). New York: Holt, Rinehart and Winston.

Midgley, C., Eccles, J. S., & Feldlaufer, H. (1991). Classroom environment and the transition to junior high school. In B. J. Fraser & H. J. Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences.* Oxford, England: Pergamon Press.

Mohapelon, J. M. (1973). Education for frustration. *West African Journal of Education, 17,* 141-150.

Moore, R. W., & Sutman, F. X. (1970). The development, field-test and validation of an inventory of scientific attitudes. *Journal of Research in Science Teaching, 7,* 85-95.

Moos, R. H. (1968). The assessment of the social climates of correctional institutions. *Journal of Research in Crime and Delinquency, 5,* 174-188.

Moos, R. H. (1974). *The Social Climate Scales: An overview.* Palo Alto, CA: Consulting Psychologists Press.

Moos, R. H. (1978). A typology of junior high and high school classrooms. *American Educational Research Journal, 15,* 53-66.

Moos, R. H. (1979). *Evaluating educational environments: Procedures, measures, findings and policy implications.* San Francisco, CA: Jossey-Bass.

Moos, R. H. (1981). *Manual for Work Environment Scale.* Palo Alto, CA: Consulting Psychologist Press.

Moos, R. H. (1991). Connections between school, work, and family

settings. In B. J. Fraser and H. J. Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences.* Oxford, England: Pergamon Press.

Moos, R. H., & Houts, P. S. (1968). The assessment of the social atmospheres of psychiatric wards. *Journal of Abnormal Psychology, 73,* 595-604.

Moos, R. H., & Moos, B. S. (1978). Classroom social climate and student absences and grades. *Journal of Educational Psychology, 70,* 263-269.

Moos, R. H., & Spinrad, S. (1984). *The Social Climate Scales: Annotated bibliography 1979-1983.* Palo Alto, CA: Consulting Psychologists Press.

Moos, R. H., & Trickett, E. J. (1974). *Classroom Environment Scale manual (1st. ed.).* Palo Alto, CA: Consulting Psychologists Press.

Moos, R. H., & Trickett, E. J. (1987). *Classroom Environment Scale manual* (2nd. ed.). Palo Alto, CA: Consulting Psychologists Press.

Mosteller, F., & Tukey, J. W. (1977). *Data analysis and regression: A second course in statistics.* Reading, MA: Addison-Wesley.

Murphy, G., & Fraser, B. (1978). Intuitive-theoretical scales of content and context satisfaction. *Personnel Psychology, 31,* 485-494.

Murray, H. A. (1938). *Explorations in personality.* New York: Oxford University Press.

Na Allah, A., Nabate, B., & Mani, T. C. (1982). *The national policy on education and the classroom teachers.* Kano, Nigeria: Islamic Education Centre.

Newell, A., & Simon, H. A. (1972). *Human problem solving.* London, England: Prentice Hall.

Nigeria High Commission. (1992). *Information on Nigeria.* Canberra, Australia: High Commission.

Olaitan, S. O. (1984). Low status of agriculture. In O. C. Onazi (Ed.), *Agricultural education in the tropics.* London, England: Macmillan.

Okure, W. I. B., Idiris, S. A., Ogu, J., & Igbokwe, E. M. (1991). *STAN agricultural science for junior secondary schools: Books 1-3.* Lagos, Nigeria: Longman.

Owens, L. C., & Straton, R. G. (1980). The development of a

cooperative, competitive and individualized learning preference scale for students. *British Journal of Educational Psychology, 50,* 147-161.

Pace, C. R., & Stern, G. G. (1958). An approach to the measurement of psychological characteristics of college environments. *Journal of Educational Psychology, 49,* 269-277.

Paige, R. M. (1978). *The impact of classroom learning environment on academic achievement and individual modernity in East Java, Indonesia.* Unpublished doctoral dissertation, Stanford University, Palo Alto, CA.

Paige, R. M. (1979). The learning of modern culture: Formal education and psychosocial modernity in East Java, Indonesia. *International Journal of Intercultural Relations, 3,* 333-364.

Payne, D. A., Ellett, C. A., Perkins, M. L., Klein, A. E., & Shellinberger, S. (1974-75). *The verification and validation of principal competencies and performance indicators.* Unpublished final report of Results Oriented Management in Education (R.O.M.E.) Project, University of Georgia, Athens, GA.

Pearl, R. E. (1974). The present status of science attitude measurement: Theory and availability of measuring instruments. *School Science and Mathematics, 73,* 375-381

Perkins, M. L. (1978, April). *Predicting student performance from teachers' perceptions of the school environment.* Paper presented at the annual meeting of the American Educational Research Association, Toronto, Ontario.

Persaud, G. (1976). *School authority pattern and students' social development in selected primary schools in Jamaica.* Unpublished doctoral dissertation, Stanford University, Palo Alto, CA.

Pfundt, H., & Duit, R. (1985). *Bibliography: Students' alternative frameworks and science education.* Kiel, Germany: Institute for Science Education (IPN), University of Kiel.

Piaget, J. (1967). *Six psychological studies.* New York: Vintage.

Piaget, J. (1972). Intellectual evolution from adolescence. *Human Development, 15,* 1-12

Piaget, J., & Inhelder, B. (1969). *The psychology of the child.* London, England: Routledge & Kegan Paul.

Power, C. N., & Tisher, R. P. (1975, November). *Variations in the environment of self-paced science classrooms: Their nature, determinants, and effects.* Paper presented at the annual conference of the Australian Association for Research in Education, Adelaide, South Australia.

Power, C. N., & Tisher, R. P. (1979). A self-paced environment. In H. J. Walberg (Ed.), *Educational environments and effects: Evaluation, policy, and productivity.* Berkeley, CA: McCutchan.

Raudenbush, S. (1988). Educational applications of hierarchical linear models: A review. *Journal of Educational Statistics, 13*(2), 85-116.

Raudenbush, S., & Bryk, A. S. (1986). A hierarchical model of studying school effects. *Sociology of Education, 59,* 1-17.

Raviv, Amiram, Raviv, Alona, & Reisel, E. (1990). Teacher and students: Two different perspectives?! Measuring social climate in the classroom. *American Educational Research Journal, 27,* 141-157.

Rentoul, A. & Fraser, B. (1978). Measuring perceptions of open and inquiry learning environments. *Research in Science Education, 8,* 79-88.

Rentoul, A. J., & Fraser, B. J. (1979). Conceptualization of enquiry-based or open classrooms learning environments. *Journal of Curriculum Studies, 11,* 233-245.

Rentoul, A. J., & Fraser, B. J. (1980). Predicting learning from classroom individualization and actual-preferred congruence. *Studies in Educational Evaluation, 6,* 265-277.

Rentoul, A., & Fraser, B. (1983). Development of a school-level environment questionnaire. *Journal of Educational Administration, 21,* 21-39.

Resnick, L. B. (1983). Mathematics and science learning: A new conception. *Science, 220,* 477-478.

Rosenshine, B. (1970). Evaluation of classroom instruction. *Review of Educational Research, 40,* 279-300.

Rosenshine, B., & Furst, N. (1973). The use of direct observation to study teaching. In R. M. W. Travers (Ed.), *Second handbook of research on teaching.* Chicago, IL: Rand McNally.

Ross, K. N. (1978). *Sample design for educational survey research* (Evaluation in Education series). Oxford, England: Pergamon

Press.

Schank, R. C., & Abelson, A. (1977). *Scripts, plans, goals and understanding: An inquiry into human knowledge structures.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Schibeci, R. A. (1984). Attitudes to science: An update. *Studies in Science Education, 11,* 26-59.

Schibeci, R. A., Rideng, I. M., & Fraser, B. J. (1987). Effects of classroom environment on science attitudes: A cross-cultural replication in Indonesia. *International Journal of Science Education, 19,* 169-186.

Sitrotnik. K. A. (1980). Psychometric implications of the unit-of-analysis problem (with examples from the measurement of organizational climate). *Journal of Education Measurement, 17,* 245-282.

Slavin, R. E. (1983a). *Cooperative learning.* New York: Longman.

Slavin, R. E. (1983b). When does cooperative learning increase student achievement? *Psychological Bulletin, 94,* 429-445.

Stern, G. G. (1970). *People in context: Measuring person-environment congruence in education and industry.* New York: Wiley.

Stern, G. G., Stein, M. J., & Bloom, B. S. (1956). *Methods in personality assessment.* Glencoe, IL: Free Press.

Strauss, S. (1981). Cognitive development in school and out. *Cognition, 10,* 295-300.

Strauss, S., & Stavy, R. (1982). *U-shaped behavioral growth.* New York: Academic Press.

Taiwo, A. C. (1980). Educational development in Nigeria. In A. Segun (Ed.), *Nigeria education: Trends and issues.* Ife, Nigeria: University of Ife Press.

Talton, E. L. (1983, April). *Peer and classroom influences on attitudes toward science and achievement in science among tenth grade biology students.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Dallas, TX.

Taylor, P. C., & Fraser, B. J. (1991, April). *Development of an instrument for assessing constructivist learning environments.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Taylor, P., Fraser, B. & White, L. (1994, April). *CLES: An instrument for monitoring the development of constructivist learning environments.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Teh, G., & Fraser, B. (in press, a). An evaluation of computer-assisted learning in terms of achievement, attitudes and classroom environment. *Evaluation and Research in Education.*

Teh, G., & Fraser, B. (in press, b). Effect sizes associated with micro-PROLOG-based computer assisted learning. *Computers and Education: An International Journal.*

Thorpe, H., Burden, R., & Fraser, B. (in press). Assessing and improving classroom environment. *School Science Review.*

Tobin, K. (1990). Social constructivist perspectives on the reform of science education. *Australian Science Teachers Journal, 36*(4), 30-33.

Tobin, K. (Ed.). (1993). *The practice of constructivism in science education.* Washington, DC: AAAS Press.

Tobin, K., Kahle, J., & Fraser, B. (Eds.). (1990). *Windows into science classrooms: Problems associated with higher-level cognitive learning.* London, England: Falmer Press.

Trickett, E. J. (1978). Toward a social-ecological conception of adolescent socialization: Normative data on contrasting types of public school classrooms. *Child Development, 49,* 408-414.

Trickett, E. J., & Moos, R. H. (1974). Personal correlates of contrasting environments: Student satisfactions in high school classrooms. *American Journal of Community Psychology, 2,* 1-12.

Trickett, E. J., Trickett, P. K., Castro, J. J., & Schaffner, P. (1982). The independent school experience: Aspects of normative environments of single sex and coed secondary schools. *Journal of Educational Psychology, 74,* 374-381.

Tye, K. A. (1974). The culture of the school. In J. I. Goodlad, M. F. Klein, J. M. Novotney, & K. A. Tye (Eds.), *Towards a mankind school: An adventure in humanistic education.* New York: McGraw-Hill.

Viennot, L. (1979). Spontaneous reasoning in elementary dynamics. *European Journal of Science Education, 1,* 205-222.

von Glaserfeld, E. (1984). An introduction to radical constructivism. In

P. Watzlawick (Ed.), *The invented reality* (pp. 17-40). New York: Norton.

von Glaserfeld, E. (1988, July-August). *Environment and communication.* Paper presented at the meeting of the International Committee of Mathematics Education, Budapest, Hungary.

WAEC (West African Examinations Council). (1960-1985). *Annual reports.* Lagos, Nigeria: West African Examinations Council Press.

Walberg, H. J. (1969a). Predicting class learning: An approach to the class as a social system. *American Educational Research Journal, 6,* 529-542.

Walberg, H. J. (1969b). The social environment as mediator of classroom learning. *Journal of Educational Psychology, 60,* 443-448.

Walberg, H. J. (1972). Social environment and individual learning: A test of the Bloom model. *Journal of Educational Psychology, 63,* 69-73.

Walberg, H. J. (1975). Educational process evaluation. In M. W. Apple, M. J. Subkoviak, & H. S. Lufler (Eds.), *Educational evaluation: Analysis and responsibility.* Berkeley, CA: McCutchan.

Walberg, H. J. (Ed.). (1979). *Educational environments and effects: Evaluation, policy, and productivity.* Berkeley, CA: McCutchan.

Walberg, H. J., & Anderson, G. J. (1968). Classroom climate and individual learning. *Journal of Educational Psychology, 59,* 414-419.

Walberg, H. J., & Anderson, G. J. (1972). Properties of the achieving urban class. *Journal of Educational Psychology, 63,* 381-385.

Walberg, H. J., Singh, R., & Rasher, S. P. (1977). Predictive validity of student perceptions: A cross-cultural replication. *American Educational Research Journal, 14,* 45-49.

Welch, W. W. (1979). Curricular and longitudinal effects on learning environments. In H. J. Walberg (Ed.), *Educational environments and effects: Evaluation, policy, and productivity.* Berkeley, CA: McCutchan.

Welch, W. W., & Walberg, H. J. (1972). A national experiment in curriculum evaluation. *American Educational Research*

Journal, 9, 373-383.

Wierstra, R. (1984). A study on classroom environment and on cognitive and affective outcomes of the PLON-curriculum. *Studies in Educational Evaluation, 10,* 273-282.

Wierstra, R. F. A., Jorg, T. G. D., & Wubbels, T. (1987). Contextual and individually perceived learning environment in curriculum evaluation. In B. J. Fraser (Ed.), *The study of learning environments, volume 2.* Perth, Australia: Curtin University of Technology.

Wong, A., & Fraser, B. (1994, March). *Science laboratory classroom environments in Chemistry: A Singaporean perspective.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Anaheim, CA.

Wood, D. J. (1976). Developmental psychology. In W. E. G. Gillham (Ed.), *Psychology today.* London, England: Hazzell Watson & Viney Ltd.

Wubbels, T., Brekelmans, M., & Hermans, J. (1988). Teacher behavior: An important aspect of the learning environment? In B. J. Fraser (Ed.), *The study of learning environments, volume 3.* Perth, Australia: Curtin University of Technology.

Wubbels, Th., Brekelmans, M., & Hooymayers, H. (1991). Interpersonal teacher behavior in the classroom. In B. J. Fraser & H. J. Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences.* Oxford, England: Pergamon Press.

Wubbels, T., & Levy, J. (Eds.). (1993). *Do you know what you look like?: Interpersonal relationships in education.* London, England: Falmer Press.

Yoloye, E. A.(1989). *Survey of resources in science mathematics and technical education in schools in Nigeria: Technical report.* Lagos, Nigeria: Federal Ministry of Science and Technology.

Zoller, U., & Watson, F. G. (1974). Teacher training for the 'second generation' of science curricula: The curriculum proof teacher. *Science Education, 58,* 93-103.

APPENDIX I

LEARNING ENVIRONMENT SURVEY
Student Actual Form

Scale Allocation and Scoring for Refined Version

The table below shows the scale allocation and scoring direction for each of the 32 items (from the original pool of 48 items shown on the following pages) which survived the item analysis procedures. Only these 32 items were included in any statistical analysis reported in this thesis.

Scale	Number of Items	Item Numbers
Negotiation	5	13 19 25 31 37
Autonomy	7	3 9 15 21 27 33 39
Student Centredness	7	4 10 16 22 28 34 40
Investigation	8	11 17 29 35 41 43 45 47
Differentiation	5	12 18 44 46 48
	32	

Items without their item numbers underlined are scored 1, 2, 3, 4 and 5, respectively, for the responses 'almost never', 'seldom', 'sometimes', 'often' and 'very often'.

Items with their item numbers underlined are scored in the reverse manner.

Omitted or invalid responses are scored 3.

LEARNING ENVIRONMENT SURVEY
Student Actual Form

DIRECTIONS

1. This questionnaire describes teaching and learning practices which could take place in this classroom. You will be asked **how often** each practice **actually takes place.** There are no right or wrong answers. This is not a test. Your opinion is what is wanted.

2. On the next few pages you will find 48 sentences. For each sentence, circle one number corresponding to your answer. Draw a circle around

   1 If the practice actually takes place **almost never**
   2 If the practice actually takes place **seldom**
   3 If the practice actually takes place **sometimes**
   4 If the practice actually takes place **often**
   5 If the practice actually takes place **very often.**

3. If you want to change your answer, cross it out, and circle a new number.

4. Please provide details in the box below.

a. Name:_____
b. School:_____ c. Teacher's Name:_____
d. Subject:_____ e. Year/Class:_____
f. Your Sex (please circle): Male or Female

5. Now turn the page and please give an answer for every question.

LEARNING ENVIRONMENT SURVEY
Actual Form

In this class ....

1. I ask other students about their ideas.
2. the teacher helps me to think about what I learned in past lessons.
3. I think hard about my own ideas.
4. the teacher gives me problems to investigate.
5. students find out the answers to questions from textbooks.
6. students work at their own speed.

7. I do not ask other students about their ideas.
8. I see if what I learned in the past still makes sense to me.
9. I do investigations in my own way.
10. the teacher expects me to remember important ideas that I learned in the past.
11. students draw conclusions from information.
12. all students in the class use the same textbooks.

13. I am not aware of other students' ideas.
14. there is not enough time to really think.
15. I find my own way of doing investigations.
16. the teacher sets my learning activities.
17. students to carry out investigations to test ideas.
18. all students in the class to do the same work at the same time.

19. I talk with other students about the most sensible way of solving a problem.
20. I think about interesting, real-life problems.
21. I decide how much time to spend on an activity.
22. the teacher expects me to remember things that I learned in past lessons.
23. students to find out the answers to questions and problems from the teacher rather than from investigations.
24. different students do different work.

In this class ....

25. I try to make sense of other students' ideas.
26. I learn about things that interest me.
27. I decide if my solutions make sense.
28. I learn the teacher's method for doing investigations.
29. students are asked to think about the evidence behind statements.
30. different students to use different tests.

31. I pay close attention to other students' ideas.
32. what I learn has nothing to do with real life.
33. I can decide if my ideas are sensible.
34. the teacher insists that my activities be completed on time.
35. students carry out investigations to answer questions coming from class discussions.
36. students who have finished their work wait for the others to catch up.

37. I do not pay attention to other students' ideas.
38. I learn about things that are not really interesting.
39. I can decide how much time I spend on an activity.
40. the teacher shows the correct method for solving problems.
41. students explain the meaning of statements, diagrams and graphs.
42. different students to use different books, equipment and materials.

43. students carry out investigations to answer questions which puzzle them.
44. students who work faster than others move on to the next topic.
45. investigations are used to answer the teacher's questions.
46. the same teaching aid (e.g., blackboard or overhead projector) is used for all students in the class.
47. students solve problems by obtaining information from the library.
48. all students are expected to do the same amount of work in the lesson.

APPENDIX II

LEARNING ENVIRONMENT SURVEY
Student Actual Form

ANSWER SHEET

Name _____

School _____

	ALMOST NEVER	SELDOM	SOMETIMES	OFTEN	VERY OFTEN		ALMOST NEVER	SELDOM	SOMETIMES	OFTEN	VERY OFTEN
1.	1	2	3	4	5	**25.**	1	2	3	4	5
2.	1	2	3	4	5	**26.**	1	2	3	4	5
3.	1	2	3	4	5	**27.**	1	2	3	4	5
4.	1	2	3	4	5	**28.**	1	2	3	4	5
5.	1	2	3	4	5	**29.**	1	2	3	4	5
6.	1	2	3	4	5	**30.**	1	2	3	4	5
7.	1	2	3	4	5	**31.**	1	2	3	4	5
8.	1	2	3	4	5	**32.**	1	2	3	4	5
9.	1	2	3	4	5	**33.**	1	2	3	4	5
10.	1	2	3	4	5	**34.**	1	2	3	4	5
11.	1	2	3	4	5	**35.**	1	2	3	4	5
12.	1	2	3	4	5	**36.**	1	2	3	4	5
13.	1	2	3	4	5	**37.**	1	2	3	4	5
14.	1	2	3	4	5	**38.**	1	2	3	4	5
15.	1	2	3	4	5	**39.**	1	2	3	4	5
16.	1	2	3	4	5	**40.**	1	2	3	4	5
17.	1	2	3	4	5	**41.**	1	2	3	4	5
18.	1	2	3	4	5	**42.**	1	2	3	4	5
19.	1	2	3	4	5	**43.**	1	2	3	4	5
20.	1	2	3	4	5	**44.**	1	2	3	4	5
21.	1	2	3	4	5	**45.**	1	2	3	4	5
22.	1	2	3	4	5	**46.**	1	2	3	4	5
23.	1	2	3	4	5	**47.**	1	2	3	4	5
24.	1	2	3	4	5	**48.**	1	2	3	4	5

APPENDIX III

LEARNING ENVIRONMENT SURVEY
Student Preferred Form

DIRECTIONS

1. This questionnaire describes teaching and learning practices which could take place in this classroom. You will be asked **how often** you would **prefer** each practice to take place. There are no right or wrong answers. This is not a test. Your opinion is what is wanted.

2. On the next few pages you will find 48 sentences. For each sentence, circle one number corresponding to your answer. Draw a circle around

   1 If you would prefer the practice to take place **almost never**
   2 If you would prefer the practice to take place **seldom**
   3 If you would prefer the practice to take place **sometimes**
   4 If you would prefer the practice to take place **often**
   5 If you would prefer the practice to take place **very often.**

3. If you want to change your answer, cross it out, and circle a new number.

4. Please provide details in the box below.

a. Name:_____
b. School:_____ c. Teacher's Name:_____
d. Subject:_____ e. Year/Class:_____
f. Your Sex (please circle): Male or Female

5. Now turn the page and please give an answer for every question

---

Scale allocation and method of scoring for the preferred form of the LES are identical to that for the actual form (see Appendix I).

LEARNING ENVIRONMENT SURVEY
Preferred Form

In this class, I would prefer.....

1. to ask other students about their ideas.
2. the teacher to help me to think about what I learned in past lessons.
3. to think hard about my own ideas.
4. the teacher to give me problems to investigate.
5. students to find out the answers to questions from textbooks.
6. students to work at their own speed.

7. not to ask other students about their ideas.
8. to see if what I learned in the past still makes sense to me.
9. to do investigations in my own way.
10. the teacher to expect me to remember important ideas that I learned in the past.
11. students to draw conclusions from information.
12. all students in the class to use the same textbooks.

13. not to be aware of other students' ideas.
14. there not to be enough time to really think.
15. to find my own way of doing investigations.
16. the teacher to set my learning activities.
17. students to carry out investigations to test ideas.
18. all students in the class to do the same work at the same time.

19. to talk with other students about the most sensible way of solving a problem.
20. to think about interesting, real-life problems.
21. that I decide how much time to spend on an activity.
22. the teacher to expect me to remember things that I learned in past lessons.
23. students to find out the answers to questions and problems from the teacher rather than from investigations.
24. different students to do different work.

In this class, I would prefer.....

25. to try to make sense of other students' ideas.
26. to learn about things that interest me.
27. that I could decide if my solutions made sense.
28. to learn the teacher's method for doing investigations.
29. students be asked to think about the evidence behind statements.
30. different students to use different tests.

31. to pay close attention to other students' ideas.
32. that what I learn has nothing to do with real life.
33. that I could decide if my ideas are sensible.
34. the teacher to insist that my activities be completed on time.
35. students to carry out investigations to answer questions coming from class discussions.
36. students who have finished their work to wait for the others to catch up.

37. not to pay attention to other students' ideas.
38. to learn about things that are not really interesting.
39. that I could decide how much time I spend on an activity.
40. the teacher to show the correct method for solving problems.
41. students to explain the meaning of statements, diagrams and graphs.
42. different students to use different books, equipment and materials.

43. students to carry out investigations to answer questions which puzzle them.
44. students who work faster than others to move on to the next topic.
45. investigations to be used to answer the teacher's questions.
46. the same teaching aid (e.g., blackboard or overhead projector) to be used for all students in the class.
47. students to solve problems by obtaining information from the library.
48. all students to be expected to do the same amount of work in the lesson.

APPENDIX IV

LEARNING ENVIRONMENT SURVEY
Student Preferred Form

ANSWER SHEET

Name _____

School _____

	ALMOST NEVER	SELDOM	SOMETIMES	OFTEN	VERY OFTEN		ALMOST NEVER	SELDOM	SOMETIMES	OFTEN	VERY OFTEN
1.	1	2	3	4	5	**25.**	1	2	3	4	5
2.	1	2	3	4	5	**26.**	1	2	3	4	5
3.	1	2	3	4	5	**27.**	1	2	3	4	5
4.	1	2	3	4	5	**28.**	1	2	3	4	5
5.	1	2	3	4	5	**29.**	1	2	3	4	5
6.	1	2	3	4	5	**30.**	1	2	3	4	5
7.	1	2	3	4	5	**31.**	1	2	3	4	5
8.	1	2	3	4	5	**32.**	1	2	3	4	5
9.	1	2	3	4	5	**33.**	1	2	3	4	5
10.	1	2	3	4	5	**34.**	1	2	3	4	5
11.	1	2	3	4	5	**35.**	1	2	3	4	5
12.	1	2	3	4	5	**36.**	1	2	3	4	5
13.	1	2	3	4	5	**37.**	1	2	3	4	5
14.	1	2	3	4	5	**38.**	1	2	3	4	5
15.	1	2	3	4	5	**39.**	1	2	3	4	5
16.	1	2	3	4	5	**40.**	1	2	3	4	5
17.	1	2	3	4	5	**41.**	1	2	3	4	5
18.	1	2	3	4	5	**42.**	1	2	3	4	5
19.	1	2	3	4	5	**43.**	1	2	3	4	5
20.	1	2	3	4	5	**44.**	1	2	3	4	5
21.	1	2	3	4	5	**45.**	1	2	3	4	5
22.	1	2	3	4	5	**46.**	1	2	3	4	5
23.	1	2	3	4	5	**47.**	1	2	3	4	5
24.	1	2	3	4	5	**48.**	1	2	3	4	5

APPENDIX V

SCHOOL LEVEL ENVIRONMENT QUESTIONNAIRE (SLEQ)
Actual Form

Scale Allocation and Scoring for Refined Version

The table below shows the scale allocation and scoring direction for each of the 35 items (from the original list of 48 items contained in the following pages) which survived the item analyses. Only these 35 items were included in any statistical analysis reported in this thesis.

Scale	Number of Items	Item Number								
Affiliation	6		7	13	19	25	31	37		
Professional Interest	7	2	8	14	20	26	32	38		
Participatory Decision-Making	7	3	9	15	21	27	33	39		
Innovativeness	9	4	10	16	22	28	34	40	43	44
Resource Adequacy	6	5	11	17	23		35	41		
	35									

Items without their item numbers underlined are scored 1, 2, 3, 4 and 5, respectively, for the responses SD, D, N, A and SA. Items with their item numbers underlined are scored in the reverse manner. Omitted or invalid responses are scored 3.

SCHOOL LEVEL ENVIRONMENT QUESTIONNAIRE (SLEQ)
Actual Form

DIRECTIONS

There are 44 items (questions) in this questionnaire. They are statements to be considered in the context of the school in which you work at present.

Think about how well the statements describe the school environment in which you actually work. Indicate your answer on the Answer Sheet by circling:

SD if you **strongly disagree** with the statement.

D if you **disagree** with the statement.

N if you **neither agree nor disagree** with the statement.

A if you **agree** with the statement.

SA if you **strongly agree** with the statement.

If you change your mind about a response, cross out the old answer and circle the new choice.

In this school ....

1. I seldom receive encouragement from colleagues.
2. Teachers frequently discuss teaching methods and strategies with each other.
3. Decisions about the running of the school usually are made by the principal or a small group of teachers.
4. It is very difficult to change anything in this school.
5. The school or department library includes an adequate selection of books and periodicals.
6. There is constant pressure to keep working.
7. I feel accepted by other teachers.
8. Teachers avoid talking with each other about teaching and learning.
9. I have to refer even small matters to a senior member of staff for a final answer.
10. I am not expected to conform to a particular teaching style.
11. The supply of equipment and resources is inadequate.
12. Teachers have to work long hours to complete all their work.
13. I am ignored by other teachers.
14. Professional matters seldom are discussed during staff meetings.
15. Action usually can be taken without gaining the approval of the subject department head or a senior member of staff.
16. Teachers are encouraged to be innovative in this school.
17. Video equipment, tapes and films are readily available and accessible.
18. Teachers do not have to work very hard in this school.
19. I feel that I could rely on my colleagues for assistance if I needed it.
20. Many teachers attend inservice and other professional development courses.
21. Teachers frequently are asked to participate in decisions concerning administrative policies and procedures.
22. It is considered very important that I closely follow syllabuses and lesson plans.
23. Adequate duplicating facilities and services are available to teachers.
24. There is no time for teachers to relax.

In this school ....

25. My colleagues seldom take notice of my professional views and opinions.
26. Teachers show little interest in what is happening in other schools.
27. I am encouraged to make decisions without reference to a senior member of staff.
28. There is a great deal of resistance to proposals for curriculum change.
29. Tape recorders and cassettes seldom are available when needed.
30. You can take it easy and still get the work done.

31. I feel that I have many friends among my colleagues at this school.
32. Teachers are keen to learn from their colleagues.
33. I have to ask my subject department head or senior member of staff before I do most things.
34. Most teachers like the idea of change.
35. Facilities are not adequate for catering for a variety of classroom activities and learning groups of different sizes.
36. Seldom are there deadlines to be met.

37. I often feel lonely and left out of things in the staffroom.
38. Teachers show considerable interest in the professional activities of their colleagues.
39. I have very little say in the running of the school.
40. New courses or curriculum materials seldom are implemented in the school.
41. Projectors and filmstrips, transparencies and films usually are available when needed.
42. It is hard to keep up with your workload.

43. There is much experimentation with different teaching approaches.
44. New and different ideas are always being tried in this school.

APPENDIX VI

SCHOOL LEVEL ENVIRONMENT QUESTIONNAIRE (SLEQ)

Actual Form

ANSWER SHEET

Name _____

School _____

	STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE		STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE		STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE
1.	SA	A	N	D	SD	**16.**	SA	A	N	D	SD	**31.**	SA	A	N	D	SD
2.	SA	A	N	D	SD	**17.**	SA	A	N	D	SD	**32.**	SA	A	N	D	SD
3.	SA	A	N	D	SD	**18.**	SA	A	N	D	SD	**33.**	SA	A	N	D	SD
4.	SA	A	N	D	SD	**19.**	SA	A	N	D	SD	**34.**	SA	A	N	D	SD
5.	SA	A	N	D	SD	**20.**	SA	A	N	D	SD	**35.**	SA	A	N	D	SD
6.	SA	A	N	D	SD	**21.**	SA	A	N	D	SD	**36.**	SA	A	N	D	SD
7.	SA	A	N	D	SD	**22.**	SA	A	N	D	SD	**37.**	SA	A	N	D	SD
8.	SA	A	N	D	SD	**23.**	SA	A	N	D	SD	**38.**	SA	A	N	D	SD
9.	SA	A	N	D	SD	**24.**	SA	A	N	D	SD	**39.**	SA	A	N	D	SD
10.	SA	A	N	D	SD	**25.**	SA	A	N	D	SD	**40.**	SA	A	N	D	SD
11.	SA	A	N	D	SD	**26**	SA	A	N	D	SD	**41.**	SA	A	N	D	SD
12.	SA	A	N	D	SD	**27.**	SA	A	N	D	SD	**42.**	SA	A	N	D	SD
13.	SA	A	N	D	SD	**28.**	SA	A	N	D	SD	**43.**	SA	A	N	D	SD
14.	SA	A	N	D	SD	**29.**	SA	A	N	D	SD	**44.**	SA	A	N	D	SD
15.	SA	A	N	D	SD	**30.**	SA	A	N	D	SD						

APPENDIX VII

SCHOOL LEVEL ENVIRONMENT QUESTIONNAIRE (SLEQ)
Preferred Form

DIRECTIONS

There are 44 items (questions) in this questionnaire. They are statements to be considered in the context of your preferred or ideal school working environment.

Think about how well the statements describe the school environment in which you would prefer to work. Indicate your answer on the Answer Sheet by circling:

SD if you **strongly disagree** with the statement.

D if you **disagree** with the statement.

N if you **neither agree nor disagree** with the statement.

A if you **agree** with the statement.

SA if you **strongly agree** with the statement.

If you change your mind about a response, cross out the old answer and circle the new choice.

Scale allocation and method of scoring for the preferred form of the SLEQ are identical to that for the actual form (see Appendix V).

In this school ....

1. I would seldom receive encouragement from colleagues.
2. Teachers would frequently discuss teaching methods and strategies with each other.
3. Decisions about the running of the school usually would be made by the principal or a small group of teachers.
4. It would be very difficult to change anything in this school.
5. The school or department library would include an adequate selection of books and periodicals.
6. There would be constant pressure to keep working.

7. I would feel accepted by other teachers.
8. Teachers would avoid talking with each other about teaching and learning.
9. I would have to refer even small matters to a senior member of staff for a final answer.
10. I would not be expected to conform to a particular teaching style.
11. The supply of equipment and resources would be inadequate.
12. Teachers would have to work long hours to complete all their work.

13. I would be ignored by other teachers.
14. Professional matters seldom would be discussed during staff meetings.
15. Action usually could be taken without gaining the approval of the subject department head or a senior member of staff.
16. Teachers would be encouraged to be innovative in this school.
17. Video equipment, tapes and films would be readily available and accessible.
18. Teachers would not have to work very hard in this school.

19. I would feel that I could rely on my colleagues for assistance if I needed it.
20. Many teachers would attend inservice and other professional development courses.
21. Teachers frequently would be asked to participate in decisions concerning administrative policies and procedures.
22. It would be considered very important that I closely follow syllabuses and lesson plans.
23. Adequate duplicating facilities and services would be available to teachers.
24. There would be no time for teachers to relax.

In this school ....

25. My colleagues seldom would take notice of my professional views and opinions.
26. Teachers would show little interest in what is happening in other schools.
27. I would be encouraged to make decisions without reference to a senior member of staff.
28. There would be a great deal of resistance to proposals for curriculum change.
29. Tape recorders and cassettes seldom would be available when needed.
30. You could take it easy and still get the work done.

31. I would feel that I have many friends among my colleagues at this school.
32. Teachers would be keen to learn from their colleagues.
33. I would have to ask my subject department head or senior member of staff before I do most things.
34. Most teachers would like the idea of change.
35. Facilities would not be adequate for catering for a variety of classroom activities and learning groups of different sizes.
36. Seldom would there be deadlines to be met.

37. I would often feel lonely and left out of things in the staffroom.
38. Teachers would show considerable interest in the professional activities of their colleagues.
39. I would have very little say in the running of the school.
40. New courses or curriculum materials seldom would be implemented in the school.
41. Projectors and filmstrips, transparencies and films usually would be available when needed.
42. It would be hard to keep up with your workload.

43. There would be much experimentation with different teaching approaches.
44. New and different ideas would always be tried in this school.

APPENDIX VIII

SCHOOL LEVEL ENVIRONMENT QUESTIONNAIRE (SLEQ)

Preferred Form

ANSWER SHEET

Name _____

School _____

	STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE		STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE		STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE
1.	SA	A	N	D	SD	**16.**	SA	A	N	D	SD	**31.**	SA	A	N	D	SD
2.	SA	A	N	D	SD	**17.**	SA	A	N	D	SD	**32.**	SA	A	N	D	SD
3.	SA	A	N	D	SD	**18.**	SA	A	N	D	SD	**33.**	SA	A	N	D	SD
4.	SA	A	N	D	SD	**19.**	SA	A	N	D	SD	**34.**	SA	A	N	D	SD
5.	SA	A	N	D	SD	**20.**	SA	A	N	D	SD	**35.**	SA	A	N	D	SD
6.	SA	A	N	D	SD	**21.**	SA	A	N	D	SD	**36.**	SA	A	N	D	SD
7.	SA	A	N	D	SD	**22.**	SA	A	N	D	SD	**37.**	SA	A	N	D	SD
8.	SA	A	N	D	SD	**23.**	SA	A	N	D	SD	**38.**	SA	A	N	D	SD
9.	SA	A	N	D	SD	**24.**	SA	A	N	D	SD	**39.**	SA	A	N	D	SD
10.	SA	A	N	D	SD	**25.**	SA	A	N	D	SD	**40.**	SA	A	N	D	SD
11.	SA	A	N	D	SD	**26**	SA	A	N	D	SD	**41.**	SA	A	N	D	SD
12.	SA	A	N	D	SD	**27.**	SA	A	N	D	SD	**42.**	SA	A	N	D	SD
13.	SA	A	N	D	SD	**28.**	SA	A	N	D	SD	**43.**	SA	A	N	D	SD
14.	SA	A	N	D	SD	**29.**	SA	A	N	D	SD	**44.**	SA	A	N	D	SD
15.	SA	A	N	D	SD	**30.**	SA	A	N	D	SD						

APPENDIX IX

TEST OF SCIENCE-RELATED ATTITUDES

Scoring Procedures for Refined Version

Following item analysis, Items 3, 4, 5, 10 and 16 from the following pages were omitted. Items 1, 6, 7, 13, 14 and 17 are scored 1, 2, 3, 4 and 5, respectively, for the responses SA, A, N, D and SD. The remaining items (Items 2, 8, 9, 11, 12, 15, 18, 19 and 20) are scored in the reverse manner. Omitted or invalid responses are scored 3.

TEST OF SCIENCE-RELATED ATTITUDES

DIRECTIONS

1. This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2. For each statement, draw a circle around

   SA if you STRONGLY AGREE with the statement;
   A if you AGREE with the statement;
   N if you are NOT SURE;
   D if you DISAGREE with the statement;
   SD if you STRONGLY DISAGREE with the statement.

Practice item

0 It would be interesting to learn about boats.

Suppose that you AGREE with this statement, then you would circle A like this:

0 SA (A) N D SD

3. If you change your mind about an answer, cross it out and circle another one.

4. Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

Name: _____

School: _____ Year/Class: _____

1.	I would prefer to find out why something happens by doing an experiment than by being told by the teacher.	SA	A	N	D	SD
2.	I would dislike being an agricultural scientist after I leave school.	SA	A	N	D	SD
3.	I enjoy reading about things which disagree with my previous ideas.	SA	A	N	D	SD
4.	Agriculture is a well-paid occupation.	SA	A	N	D	SD
5.	Agricultural science lessons are fun.	SA	A	N	D	SD
6.	Agriculture demands hard work.	SA	A	N	D	SD
7.	I would like to belong to an agricultural science club at school.	SA	A	N	D	SD
8.	Farming is only for the poor people.	SA	A	N	D	SD
9.	I dislike agricultural science lessons.	SA	A	N	D	SD
10.	Agriculture involves too many areas of knowledge.	SA	A	N	D	SD
11.	I get bored when watching agricultural science programs on TV at school.	SA	A	N	D	SD
12.	Agriculture does not require capital (money).	SA	A	N	D	SD
13.	I would like to be given an agricultural science book or a piece of scientific equipment as a present.	SA	A	N	D	SD
14.	Agriculture demands the use of many tools and equipment.	SA	A	N	D	SD
15.	Talking to friends about agricultural science after school would be boring.	SA	A	N	D	SD
16.	Computers are too sophisticated to use in farm programmes.	SA	A	N	D	SD
17.	In agricultural science experiments, I report unexpected results as well as expected ones.	SA	A	N	D	SD
18.	A job as a farmer would be risky.	SA	A	N	D	SD
19.	I would enjoy school more if there were no science lessons.	SA	A	N	D	SD
20.	Agricultural products are too cheap to enable farmers to make a good living.	SA	A	N	D	SD

APPENDIX X

TEST OF ENQUIRY SKILLS

Scoring of Refined Version

Following item analysis, four items (namely, Items 1, 6, 9 and 18) were omitted from the set of 18 items contained in the following pages prior to performing any of the statistical tests reported in this thesis.

Items were scored 1 for the correct response and zero otherwise. The correct responses to the various items are: 2E, 3A, 4C, 5B, 7C, 8C, 10C, 11B, 12E, 13E, 14E, 15D, 16B and 17A.

TEST OF ENQUIRY SKILLS

DIRECTIONS

1. The purpose of this test is to find out what things are known by students at school.

2. Try to answer all questions.

3. Do not write on this test booklet. All answers should be written on your Answer Sheet. Any extra working may be done on other paper.

4. Each question has four or five alternative answers represented by the letters **A, B, C, D** and **E**. Choose one answer from the alternatives, and circle the letter you have chosen on the Answer Sheet.

Practice Question

0 Which one of the following is usually covered with feathers?

A	a fish	**C**	a dog
B	a bird	**D**	a snake

B is the best answer. Therefore you would circle **B** beside **0** on the Answer Sheet like this:

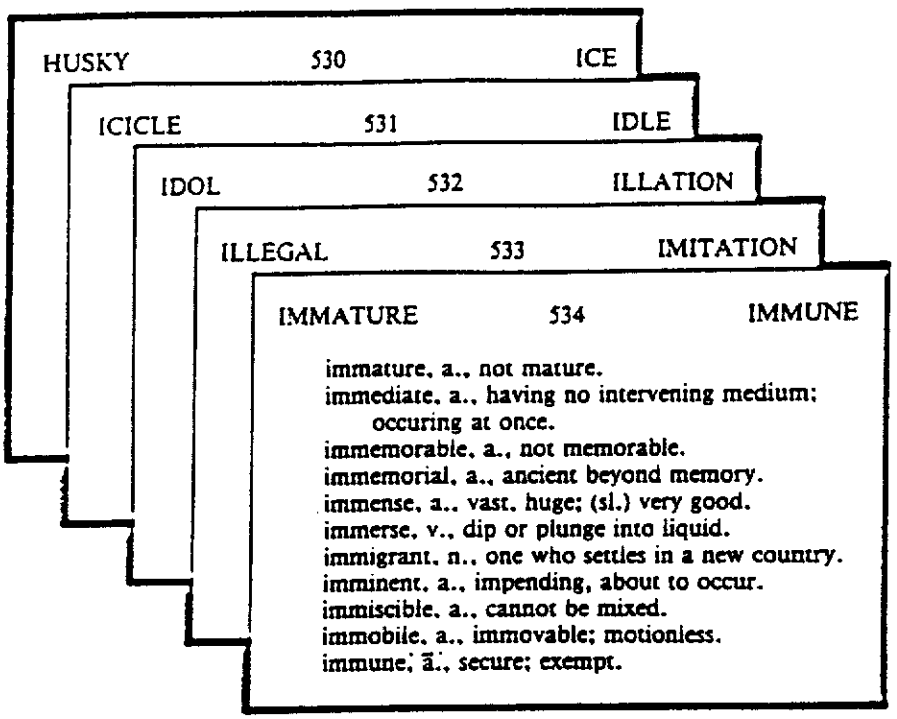
0 A (B) C D E

5. If you want to change an answer, cross out your first answer and circle the new one.

Skill 1: Library Usage

In the western region of Africa, there lives a well-known tribe called the Fulanis. To find information about Fulanis, a library is a useful place to look. Questions 1-2 will test how well you could use a library to find out about Fulanis.

To answer Questions 1-2, use the information in the diagram which shows several pages from a dictionary.



1. On which dictionary page in the diagram would the word 'iddo' be found?

   A Page 530. B Page 531. C Page 532.
   D Page 533. E Neither A, nor B, nor C, nor D.

2. Only one of the following ways of spelling a word is correct. According to the diagram, the correct spelling is

   A immence. B emmense. C imence.
   D imense. E immense.

3. Below is a list of five references found at the back of a book on Fulani. Use these references to answer question 3.

REFERENCES

A. Audu, John. Fulani History. Lagos: Heineman, 1969.
B. Robert, Malu. The Tribal Studies Journal, 15, 1970, 37-45.
C. Henry, Jauro. The Fulani of Senegal. Accra: Longman, 1966.
D. Wonigman, Musa. Fulani Townsmen. Cotonou: Macmillan, 1965.
E. Amana, Shekari. Fulani of the River Jalloun. Nairobi: Methuen, 1967.

In which one of the references would it be best to look first to find information about Fulanis in the eighteenth century?

A Reference A. B Reference B. C Reference C.
D Reference D. E Reference E.

4. The name of the author of *The Fulani of Senegal* is

A Audu, John. B Robert, Malu. C Henry, Jauro.
D Macmillan. E Methuen.

Skill 2: Index and Table of Contents

Not all tribal people live in as hot a climate as the Fulanis do. Two tribes living in a much warmer climate of Africa are the Kikuyus and the Creoles. Questions 5 and 6 will test how well you could use the Index and Table of Contents in books to find out about these two tribes.

To answer Questions 5 and 6, use the Table of Contents below which is taken from a book about the Kikuyu.

TABLE OF CONTENTS

5. On which one of the following pages would information about the arrival of the white man be found?

A Page 6. B Page 14. C Page 39.
D Page 80. E Page 85.

6. In chapter 5, information would be found about

A the magic of the medicine man.
B the language spoken by Kikuyus.
C bark paintings.
D places where Kikuyus live.
E animals hunted by the Kikuyus.

To answer Questions 7-9, use the Index below which has been taken from the back of a book about Creoles.

INDEX

7. For information about the Creole living in Liberia, you would look in the Index under

A Hunting people. B Craftsmanship. C Creole.
D Liberia. E Monrovia.

8. To find information about Creole children, you would first look in the Index under the heading

A Liberia. B Marriage. C Children.
D Creole of Liberia. E Busama people.

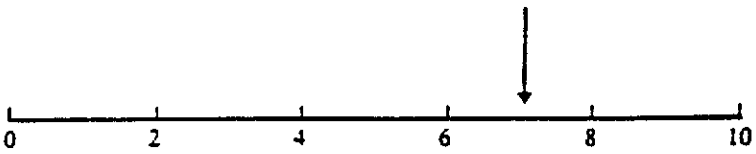
9. Where would you turn to find information about burial ceremonies?

A Page 14. B Page 22. C Page 37.
D Page 40. E Page 40.

INTERPRETING AND PROCESSING INFORMATION

Skill 3: Scales

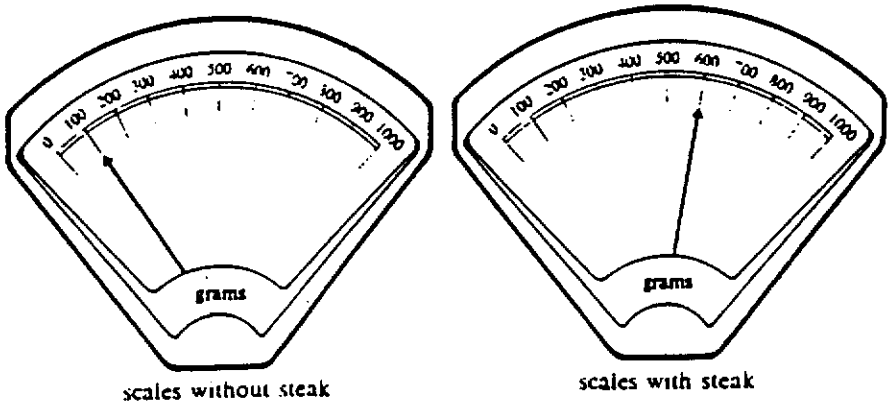
10. The diagram below represents some of the distance (kilometre) posts along the village road.



A tractor driver runs out of diesel fuel at the point marked by the arrow. If there was a distance post at this point, it would show a reading of

A 6. B 6.5. C 7.
D 7.5. E 8.

11. Mrs Musa used her kitchen scales to find out the weight of some steak.



scales without steak scales with steak

According to the readings in the two diagrams, Mrs Musa's steak weighs

A 100 grams. B 500 grams.
C 600 grams. D 700 grams.

Skill 4: Averages, Percentages and Proportions

12. Suicide insect-spray takes different amounts of time to kill different types of insects. The figures below show the times taken to kill various insects which were sprayed with equal amounts of Suicide insect-spray.

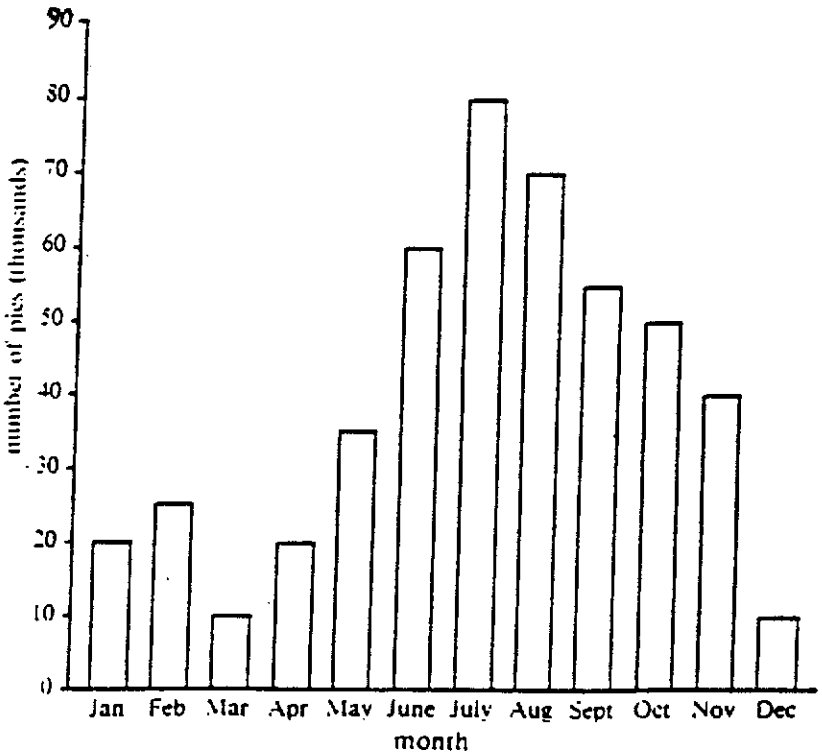
Type of insect	Time taken to kill insect
Fly	2.5 seconds
Beetle	3.6 seconds
Ant	3.6 seconds
Weevil	3.8 seconds
Cockroach	4.0 seconds
Moth	4.7 seconds

The average (mean) time in which Suicide insect-spray killed the above insects was

A 22.2 seconds. B 11.1 seconds. C 2.5 seconds.
D 3.6 seconds. E 3.7 seconds.

Skill 5: Charts and Tables

13. The diagram below shows the number of yam tubers sold in a local market during different months of last year.

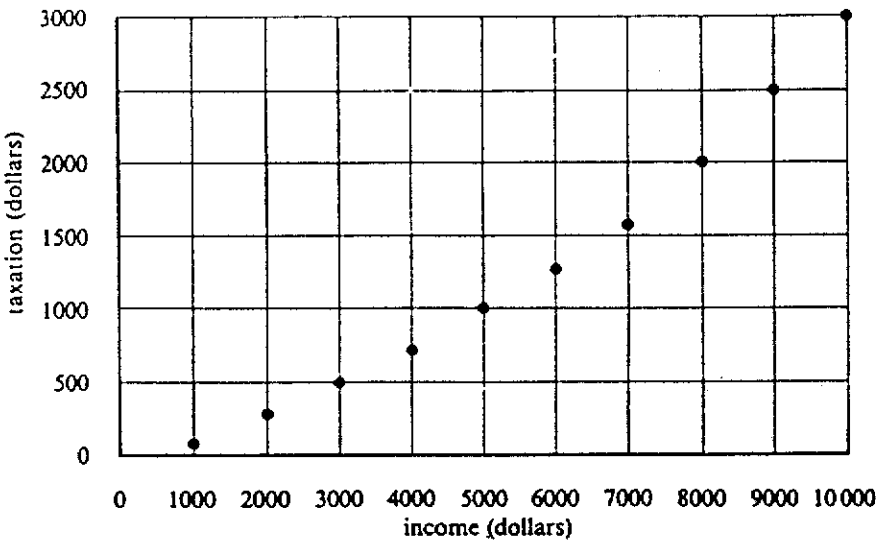


The yam tuber sales for February and August combined are equal to the combined sales in

A October and November. B July and December.
C June and November. D September and May.
E May and June.

Skill 6: Graphs

14. The graph below shows the relationship between income and taxation.



A person who pays a tax of $1000 has an income of

A $0. B $100. C $1000.
D $4000. E $5000.

CRITICAL THINKING IN SCIENCE

Skill 7: Comprehension of Science Reading

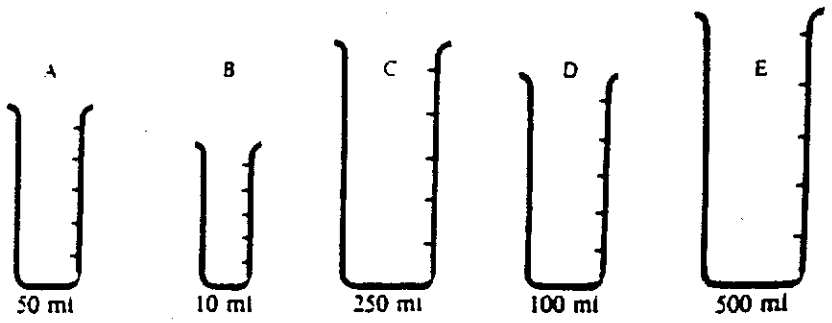
15. Banana farmers want to earn as much money as possible. To do this they have to sell more banana fruits. There are problems involved in the transport of bananas from Abeokuta to Kano. Sometimes the fruit becomes dried out during its journey North. Partly lining the boxes with wax paper prevents this happening. During the train trip they are shaken continuously and may become too soft and ripe to eat when they arrive in Kano. To prevent this happening they are picked from the tree when they are hard and green. However fruit shops in Kano cannot sell hard green bananas. To overcome this problem the bananas are stored in rooms filled with nitrous oxide (laughing gas). This is done for a day before they go to the shops. It ripens them. Therefore the customers can buy light yellow, firm, juicy fruit.

Banana boxes are partly lined with wax paper to

A help ripen the bananas quickly.
B keep the nitrous oxide gas inside the box.
C prevent fruit flies getting into the box.
D keep the moisture in the fruit.

Skill 8: Design of Experimental Procedures

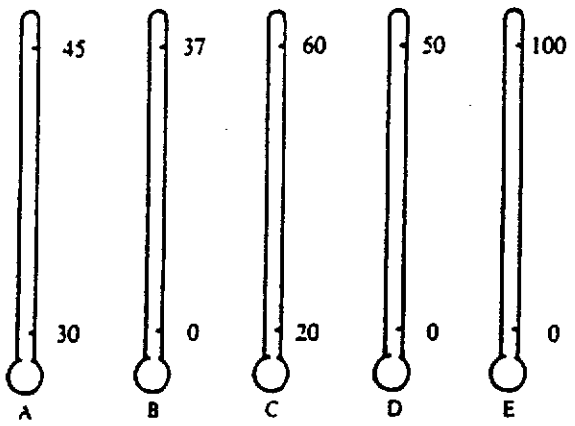
16. Below are five containers which can be used for measuring amounts of liquid.



Which of the above containers would be the most accurate to use to measure five millilitres of water?

A Container A. B Container B. C Container C.
D Container D. E Container E.

17. The diagram shows five different mercury-in-glass Celsius thermometers



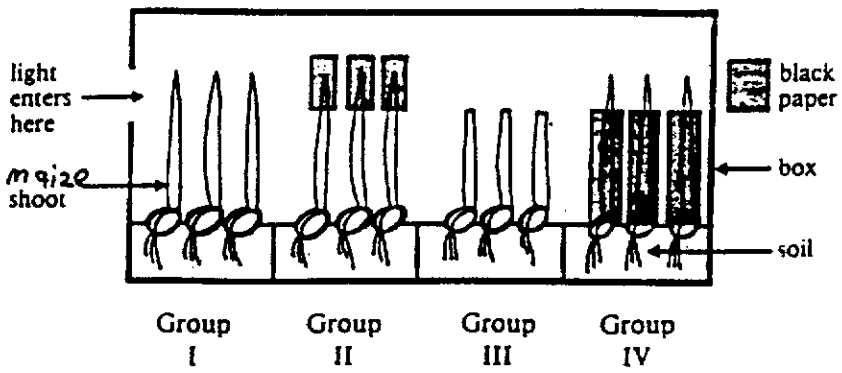
The normal farm animal body temperature is 37 degrees Celsius. The body temperature of sick animal ranges from about 36 to 42 degrees Celsius.

The thermometer most suited for accurately measuring the body temperature of farm animals would be

A thermometer A. B thermometer B. C thermometer C.
D thermometer D. E thermometer E.

Skill 9: Conclusions and Generalisations

18. The apparatus in the diagram is used to test whether a maize stem grow towards light when light falls on their tips. There are four different groups of maize stems.



Group I	ordinary maize stems.
Group II	maize stems with the tips covered with black paper.
Group III	maize stems with the tips cut off.
Group IV	maize stems with black paper covering all of the stem except the tip.

If it is true that maize stems grow towards light when light falls on their tips, which stems would grow towards the light?

A Group II only.
B Group IV only.
C both Group I and Group II.
D both Group III and Group IV.
E both Group I and Group IV.

APPENDIX XI

TEST OF ENQUIRY SKILLS

ANSWER SHEET

Name: _____

School: _____

Year/Class: _____

1.	A	B	C	D	E
2.	A	B	C	D	E
3.	A	B	C	D	E
4.	A	B	C	D	E
5.	A	B	C	D	E
6.	A	B	C	D	E
7.	A	B	C	D	E
8.	A	B	C	D	E
9.	A	B	C	D	E
10.	A	B	C	D	E
11.	A	B	C	D	
12.	A	B	C	D	E
13.	A	B	C	D	E
14.	A	B	C	D	E
15.	A	B	C	D	
16.	A	B	C	D	E
17.	A	B	C	D	E
18.	A	B	C	D	E

APPENDIX XII

PERFORMANCE SKILLS TEST

Scoring of Refined Version

Following item analysis, four items (namely, Items 4, 6, 16 and 18) were omitted from the set of 27 items found in the following pages prior to performing any of the statistical analyses reported in this thesis. Each item is scored 1 for yes and 0 for no.

PERFORMANCE SKILLS TEST

Name _____

School _____

Class/School _____

DIRECTIONS

On the space in front of each item, tick Yes if the performance was satisfactory. Tick No if it was unsatisfactory.

USES LABORATORY EQUIPMENT PROPERLY

1.	Selects equipment that is appropriate for a given experiment.	Yes	No
2.	Assembles equipment correctly for the experiment.	Yes	No
3.	Manipulates equipment as needed during the experiment.	Yes	No
4.	Measures accurately with proper measuring device.	Yes	No
5.	Follows safety rules in conducting experiments.	Yes	No
6.	Uses materials without wasting any.	Yes	No
7.	Completes experiment on time.	Yes	No
8.	Cleans equipment and returns to proper place.	Yes	No

SOIL CONTENT

Soil Air

9.	Takes soil from the field with minimum disturbance.	Yes	No
10.	Puts appropriate soil in the labelled glass jar.	Yes	No
11.	Pours optimum volume of water.	Yes	No
12.	Records actual events (observations).	Yes	No

Soil Water

13.	Notes the colour of the soil.	Yes	No
14.	Weighs the soil.	Yes	No
15.	Keeps in dry place for one week and weigh again.	Yes	No
16.	Records appropriate result in the practical notebook.	Yes	No

Soil Organic Matter

17.	Weighs the soil.	Yes	No
18.	Heats the soil for half hour.	Yes	No
19.	Observes smoke and odour.	Yes	No
20.	Heats for another half hour.	Yes	No
21.	Observes soil colour changes.	Yes	No
22.	Weighs the soil again.	Yes	No
23.	Records the new weight in the practical notebook.	Yes	No

Soil Organisms

24.	Pours saltwater on a garden soil spot.	Yes	No
25.	Observes some soil animals crawling out.	Yes	No
26.	Takes appropriate quantity of soil on a piece of white paper.	Yes	No
27.	Uses hand lens to discover other small animals/plants in the soil sample.	Yes	No