Participating in science and technology education research

Overview 6.1

Educational research is a sound basis for achieving improvements to the educational system. Its practitioners - teacher educators and teachers are the most important resource in science and technology education. With them lies our best hope of finding solutions to the problems of science and technology education at the primary level. They are the agents of change. They know the problems, the subject matter and the demands of the relevant disciplines. They know their learners' changing needs, interests and aspirations. They are aware of the local community, they are conscious of what parents expect of schools. No one is better placed than teachers to recognise the first indications of success or failure in implementing curricula, and to effect the necessary improvements and changes in the classroom.

Science and technology education research is for improving the teaching/learning process in the classroom. Improvements to science and technology education at the primary level can be realised through teacher educators' and teachers' participation in research, both as researchers and as users of research findings. Areas of research in science and technology education at the basic level are vast, and more importantly interesting to conduct. The research process in itself is an interesting and challenging experience, while the research finding provides satisfaction to the researcher. The returns from conducting research are therefore beneficial not only to education but also to those who conducted the research.

It is therefore vital that teacher educators participate in research and are able to guide and steer teacher trainees towards developing a positive attitude to research in their classrooms.

Objectives 6.2

The monograph aims to:

- stimulate the interest of teacher educators in science and technology education research by outlining the advantages of participation in research;
- encourage teacher educators to participate in research activities and develop their research skills;
- assist teacher educators in developing the action research skills of teacher trainees.

6.3 What is science and technology education research?

Science and technology education research can be broadly characterised as activities that:

- encourage teacher educators to participate in research activities and develop their research skills;
- assist teacher educators in developing the action research skills of teacher trainees.
- through problem identification, information-gathering and analysis of data, lead to a better understanding of problems in science and technology education;
- produce findings which lead to improved classroom practices, programme planning and implementation, and more informed policy decisions at the school or college level.

An example of research leading to improved practice

Rita is a teacher in a well-endowed urban primary school situated near a teacher training institution. She became anxious about her learner's difficulties in understanding the 'particulate nature of matter'. After consulting Abdul, a science teacher educator at the teacher training institution, they decided that Abdul should observe Rita's classroom as she taught the topic 'particles in nature' to her class the following year.

Abduls' study of Rita's class involved observation, audio-taping examination of the textbook, and interviews with Rita and some of the learners in the class.

Three issues became clear from the information Abdul Collected.

- Rita's teaching in class was text-bound;
- she worked on the assumption that the particulate ideas were simple enough for learners to understand;
- Learners were unable to apply the particulate ideas. They thought that particles expand, melt, reduce in sizes, break up on application of heat, and that in a solution of water sugar particles remain particulate while the water is continuous.

Rita with Abdul's help, then developed five lesson plans on the 'particulate nature of matter', which utilised the constructivist approach. The development of these plans took Rita out of her classroom once a week for six weeks. Part of this time was used in trying out the activities with Abdul's help. Rita taught the new lessons while Abdul observed and recorded. After each lesson, which required learners to carry out activities that challenged their prior ideas about particles, Abdul interviewed Rita on some of her actions. Learners also interviewed, using questions prepared jointly by Abdul and Rita.

The findings indicated a marked change in the initial ideas of almost all the learners in the class. Rita commented on the confidence she had gained in using the constructivist approach and was determined to use it in teaching other topics.

Research can be carried out using interview, observation and audio-video recording to collect in-depth information on a problem such as teachers' and learners' use of curricular materials, and teaching particular science and technology topics. When narrative information is collected and used to give a detailed account of the problem under investigation, the approach to research is described as qualitative. In this

approach to research, the emphasis is not on drawing generalisations but on describing a situation in details.

In the quantitative approach to research, a problem is analysed by collecting numerical data through the use of questionnaires, tests, attitude scales and observations. In the quantitative research the emphasis generally is on drawing generalisations. Qualitative research can support quantitative research and vice versa.

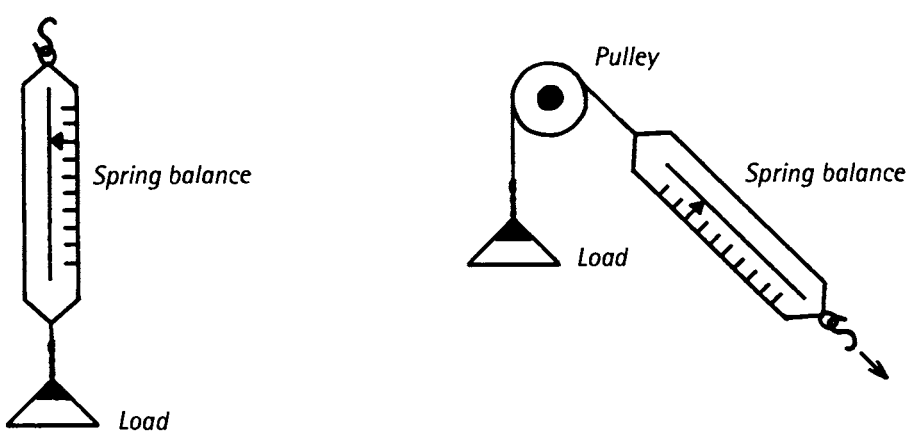
QUALITATIVE RESEARCH

A piece of qualitative research was done to find out the concept of a fixed pulley and its working. The sample consisted of 81 primary school learners of urban and rural areas. Learners were asked the following questions:

In which case the force required for drawing water from a well is less (a) using a pulley (b) directly without using a pulley.

The response sheets indicated that all learners responded that, "it takes less force to draw water by passing rope over a pulley". Analysis revealed that learners had misconception about the function of a fixed pulley. The pulley simply makes the work easier. The learners were not able to associate the change of direction of a force with actual effort done.

The same group of learners were directly involved in an activity to lift an object using a spring balance (a) Directly or (b) passing a string over a pulley as shown in the figure. The learners were able to associate that a single pulley is a simple machine which helps to change the direction of the force to make the work easier without changing the magnitude of the force.



Pulley makes the work easier with same effort

6.4 Relevance of Science and technology education research

Primary science, integrated and environmental science, and technology are some of the more recent innovations at the primary level of education. Teachers at this level are expected to put into practice the intentions of curriculum developers as specified in different curriculum documents. In reality, observations of learners' and teachers' activities in science and technology classrooms reveal that the intentions of curriculum developers are often reinterpreted by teachers to suit particular classroom contexts. Teachers face problems in putting curriculum specifications into action, and in making the far-reaching decisions expected of them in carrying out managerial responsibilities in the classroom. Teachers need opportunities to familiarise themselves with information on new curricula and on curriculum-related issues. This suggests the need for modifications in policy as well as in classroom practice, and of providing a focus of reflection to enable all parties to take appropriate decisions.

Activity

Identify some curriculum-related issues and suggest modified classroom practice for them.

This is where knowledge of research findings and action research become relevant. Very often research findings have not been widely applied in classrooms because teachers have limited access to them. This limited access may also be the result of a lack of awareness on the part of science and technology teacher educators about research findings, or difficulty in understanding the findings and interpreting them for classroom applications.

By taking advantage of relevant research findings, teacher educators can improve their own classroom practices and help teacher trainees to improve theirs. This could ultimately lead to informed and improved policy decisions and better classroom practices.

In sum, what research has to say to science and technology teacher educators may be defined in terms of **feedback** providing a focus for further **reflection** and **action**. The following case study, overleaf, illustrates this point.

6.5 The science and technology teacher educator as researcher

Science and technology teacher educators, as researchers, are mainly concerned with gaining a better understanding of their own classrooms, so as to enable them to make informed decisions before, during and after teaching/learning transactions. Such improved understanding will lead to improved quality in science and technology teacher education. It is not sufficient for teacher educators' work to be studied solely by outsiders. They need to study their work themselves. An insider, science and technology teacher educators has a more intimate knowledge of the setting, even though he/she sees it in his/her own way. An outsider, who may be a

An agriculture-related innovative teaching strategy for primary schools in Sri Lanka

The Ministry of Education of Sri Lanka was very much concerned about the growing incidence of malnutrition among primary school learners leading to poor health, erratic school attendance, school dropouts and low academic performance.

A project was developed by the Primary Education Department of National Institute of Education, and launched in 1993 with the school as the converging point of all nutrition-related activities in rural areas.

Objectives of the project:

- To upgrade the health and nutritional levels of primary school learners.
- To reduce the related incidence of poor health, low school attendance, school drop-out, low academic achievement, etc.

Implementation Strategy

As a first step of implementation of this project, a baseline survey was conducted among the families of learners of the small schools in rural areas. As the parents were mainly farmers and the knowledge of their modern farming methods, use of improved varieties of seeds, fertilizers were also noted down.

Findings of baseline survey

The baseline survey revealed many short comings related to the socio-economic status, education, health, hygiene etc., which need immediate attention.

Some activities were suggested for early implementation. One such activity that was implemented proved to be successful. It was the maintenance of agricultural plots in schools.

Agricultural plots were designed and carried out in some schools with the help of the agriculture instructor of the area and the teachers. These plots were used to teach not only agriculture but also concepts in science, mathematics, nutrition, social studies, etc. These plots also served as demonstration plots for the community. In addition these were used at nurseries to provide seeds and plants of improved varieties to the farmers.

Outcomes and follow-up

Teachers & parents (farmers) were given a training programme, where they learnt how to develop agricultural plots, nurseries, and techniques of seed culture and how to collect and retain rain water etc;

Back in the schools, teachers guided the learners in agricultural plots with the active participation of some parents.

The parents and learners started their home plots and transmitted all the knowledge and techniques they had acquired to others in the community.

Simultaneously a nutrition programme was launched with the assistance of the home economics unit of the NIE. The objective of that programme was to demonstrate the preparation of a nutritious meal using the agricultural produce of the areas. It was expected to prepare and supplement the mid-day meal using the given recipes.

Pedagogical outcomes

Lessons in language, mathematics, environmental studies are now being taught based on the theme of agriculture. Much enthusiasm has been shown by both learners and teachers in this novel approach.

Learning has become experimental and more purposeful, with reduced malnutrition, improve health and hygiene practices and also better academic performance.

colleague or research expert, is best used in a collaborative pact with the teacher educator, bringing specialist skills of 'seeing' and thinking about events.

The science and technology teacher educator as a researcher can collaborate with science and technology teacher at the primary level in order to understand and clarify aspects of the classroom situation at that level. The aim is to use the findings to improve science and technology teaching as well as teacher education. In such a research partnership, the roles and responsibilities of each partner could be as shown below. The teacher's role as researcher is rooted in their everyday practice in the classroom.

Relationships and responsibilities in a teacher-development research partnership

	Phases of research			
Key factors	Planning and preparation for research	Data-collection techniques	Analysis and interpretation	Report writing and use
Science and technology teacher educator	Primary responsibility for articulation of purpose, co-ordination of research and negotiation of activities	Identification and negotiation of possible strategies; primary responsibility for gathering mutually agreed information	Preparation and presentation of preliminary analysis; mutual interpretation of preliminary analysis leading to final analysis	Primary responsibility for writing account; responsive to teacher's editorial comments; perceived mutual benefit
Teacher	Negotiated participation in terms of perceived benefit, commitment and procedure	Identification of information sources and negotiation of appropriate strategies;	Responsive to preliminary analysis; mutual interpretation leading to final analysis	Negotiated representation in report writing and editing of personal accounts; perceived mutual benefit

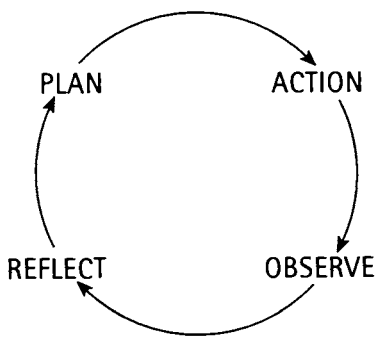
Source: Adapted from Cole, A.L. & Knowles, J.G. (1993) Teacher development partnership research: a focus on methods and issues. Americal Educational Research Journal, 30(3), 473-495

When teacher educators are researchers, they are co-learners too. As co-learners, in their daily classroom activities, science and technology teacher educators have a responsibility to listen to their learners' ideas and language, to assess their own teaching approach, to observe their learners and to reflect on classroom transactions in an attempt to make changes that will improve learning.

Thus science and technology teacher educators are, at least informally, carrying out action research - using classroom data to clarify curriculum and learning problems. As researchers, teacher educators develop problem-solving skills and questioning attitude. This questioning attitude can further refine their data-gathering methods and analysis techniques and so improve the quality of teaching and learning.

Action research has been defined as 'research carried out by practitioners with a view to improving their professional practice and understanding it better'. It is a form of inquiry centred on relevance and context to bring about change in practice. Action research involves trying out ideas in practice as a means of increasing knowledge about and/or improving curriculum teaching and learning. Collaborative action research with science and technology teachers helps to eliminate the isolation that has long characterised teaching, as it promotes professional dialogue leading to the creation of a professional culture in schools. Collaborative action research can also assist teachers doing research for the first time.

There are a number of models for action research. Problem-solving projects are common forms of this type of research. Action research models usually involve a cycle of reflecting, planning, collecting data, trying out strategies, obtaining and analysing feedback, modifying plans in the light of feedback, and continuing on the cycle as summarised in below.



Characteristics of action research 6.6.1

Action research, like other types of research, seeks to increase knowledge and understanding of a phenomenon or event. However it differs from more formal research methods in a number of ways:

- Action research does not require extensive training in research methods. Teacher educators can carry it out on their own, in collaboration with another teacher educator, a research specialist or a teacher.
- The goal of action research is to obtain knowledge that can be applied directly to the situation being studied. It also helps to improve the teacher educators' performance.
- Problems investigated in action research are ones that teacher educators view as interfering with their efficiency or that of their colleagues.
- Action research does not require the rigorous literature review expected in more formal research. A literature review using secondary sources is usually adequate to begin with.

- Action research can use the learners, with whom the teacher educators work, as subjects.
- Action research is flexible: immediate changes can be made to plans in response to the particular conditions of a situation.
- The tools used do not need to be tested in separate trials and reliability and validity established.
- Analysis of most action research data involves use of simple descriptive statistics instead of inferential procedures. The subjective opinion of the researcher is given prominence. The focus is on practical significance of the results rather than statistical significance.
- In contrast to formal research, where research findings are reported in terms of their theoretical importance, action research findings are reported to portray the impact of the findings on the science and technology teacher educator's work. They are also reported to inform other science and technology teacher educators about the implications of the research for professional development.

6.6.2 Focus areas for action research in science and technology education

Since action research is geared towards helping practitioners to study their own practice in order to solve their problems, the content of the research should be relevant to the teaching activities of the teacher educators and teachers.

Research based on the activities carried out by science and technology educators and teachers can be classified into the following broad areas:

- **Pupils' learning:** This may involve using strategies to explore learners' ideas about science and technology or identifying the problem-solving strategies of learners. Areas such as learners' misconceptions; questioning; designing and making; scientific vocabulary and 'second-language-science learning' could be investigated.
- **Teaching strategies:** This may include trying out different approaches to teaching science and technology topics. For example, the teacher may be interested in finding out how he or she can help learners to have a better understanding of the 'scientific concepts and processes. The teacher educator may also be interested in finding out how a teacher trainee uses a teaching technique to which he or she has been introduced.

Example

Does an alternative strategy to traditional practical work in schools, which is more cost-effective, achieve similar objectives?

Will participation in 'hands-on' activities help learners to develop:

- a more positive attitude towards science practical work?
- an increased understanding of certain basic scientific concepts?
- designing and making skills?

Exemplar Case Study

1 An innovative experiment in science teaching in rural areas in India – discovery approach

For improving the quality of science teaching in formal system and to overcome the problem of dropout in rural schools and to help the learners in developing self confidence, self reliance, initiative and skills of innovation, a science teaching programme, popularly known as Hoshangabad Science Teaching Programme (HSPT) was started. It laid emphasis on learning through the use of local specific materials and was environment-based. Its emphasis was on discovery approach to science teaching. The objectives of the project were to investigate the feasibility of science teaching through discovery-approach through environment, develop scientific attitude among the learners, to apply scientific method in different situations. The curriculum was based on 'process-approach' rather than 'product-approach' with a view to give opportunities to the learners to explore scientific phenomena of their local environment. Thus the emphasis of the programme was to shift from 'textbook oriented' teaching and learning to 'learning by doing'. In this case study more than 206 government middle (upper primary)school, 500 school teachers, 120 school officials, 50 trainees/co-ordinators and 40,000 learners were involved.

The teachers were trained for teaching science through discovery approach. Excursions and field trips were organised during the training programme for teaching the topic related to the environment.

The case study focused on to nurture and develop the inherent analytical power, ability to formulate and observe problems, make logical analysis and to impart training to tap resources in their own areas. In HSTP all the basic components of science education, that is, curriculum, textbooks, teaching methods, time table, teacher's training and examination system were innovative. A desirable change that took place in teacher's attitude was to encourage learners to find out answers to problems by themselves. HSTP succeeded in bringing the concept of learning through environment based on discovery approach.

- **Attitude:** This will include developing ways of increasing learners' interest in science and technology and counteracting negative attitudes. It may also involve developing ways of increasing the involvement of girls in science and technology. For example: Is there a gender difference in learners' enjoyment of practical work? What kinds of 'hand-on' activities increase the motivation of girls to study science and technology?
- **Assessment and evaluation:** Assessment and evaluation are integral parts of the educational process because they provide vital feedback about the extent to which the objectives of science and technology education are being achieved. The information obtained through assessment and evaluation can be used to take corrective measures. Teacher educators and teachers can conduct research on issues and problems related to assessment and evaluation, such as:

  good assessment practices for the measurement and evaluation of learners' behaviour, ethics and values;

  techniques for assessing the skills of acquiring, organising and using information.

6.7 Promoting science and technology education research

As stated earlier, science and technology teacher educators are expected to conduct research for their own professional development, on their own, in collaboration with colleagues, teachers and with other researchers. Relevant research findings can have beneficial effects on their competence, on the content of the curriculum, and on the learning environment. They need to know how to initiate, execute and use research.

2 Improved Science Education in Primary and Middle Schools in Madhya Pradesh and Uttar Pradesh, India

To improve the quality of science and technology education taught as environmental studies at the elementary level in the states of Madhya Pradesh (MP) and Uttar Pradesh (UP) an Indo-German Project was started in 1986 it provide technical and logistic support to the schemes formulated by these states under the National Policy on Education (NPE), 1986. The main work plans of the project were the improvement and development of teaching materials, a versatile portable laboratory in the form of a kit. Three workshops were established for production of Primary Science Kits one each at the National Council of Educational Research and Training (NCERT), New Delhi, Allahabad (UP) and Bhopal (MP). Training programmes were conducted for pedagogical and technical staff of the project. Training was also provided to the primary school teachers of Madhya Pradesh and Uttar Pradesh. The Primary Science Kit (PSK) package consisting of teacher's handbooks on environmental studies – science, a set of 70 chart cards, PSK and the manual of PSK were developed under the project.

The main emphasis in the handbook has been on motivating the learners to formulate questions and how to guide, help and supervise them in their investigations. The learner-centred, activity-oriented, problem-solving activities given in these teacher's handbooks have been possible with the help of the PSK package and other locally available materials from the environment. The Teacher's handbooks and other items of PSK were finalised after proper trial. During the trial, teachers with or without a science background who were teaching environmental studies to both urban and rural schools participated in the development of PSK package.

In order to train a large number of teachers in MP and UP a 'Cascade system' of training was chosen which operated from State Council of Educational Research and Training (SCERTs).It operated at three levels. Firstly, the experienced science teacher educators from SCERTs of MP and UP and NCERT who were involved in the different developmental stages of the PSK package were selected and trained to act as Key Resource Person. Then the experienced science teacher educators from District Institute of Education and Training (DIET) and other teacher training institutions of MP and UP were selected and trained by the Key Resource Persons to act as Resource Persons. Finally the primary school teachers of various schools, were trained by the Resource Persons. The cycle of training was to be repeated to induct more new teachers at regular intervals at the selected training centres/DIETs of the two states.

The training of teachers added a new dimension to the teaching-learning of environmental studies at the primary level by allowing teachers to have hands-on-experience and exposing them to learner-centred, activity-based, environment-oriented and problem-solving-based approach. Follow-up courses were also conducted for teachers to obtain feedback for the improvements of teaching-learning and to find solutions to the difficulties and pitfalls, encountered while using the PSK package.

Science and technology teacher educators may obtain problems or ideas for research by:

- observing and listening to learners and teachers in the classroom;
- obtaining feedback from research findings which may motivate them to initiate action research;
- reflecting on their own teaching procedure;
- observing and examining classroom teaching practice of teacher trainees;
- developing a habit of questioning and testing the ideas of other practitioners in the field;
- critically examining assessment results and assignments;
- critically reviewing research studies conducted by others.

This list is by no means exhaustive. However, for science and technology teacher educators to take a research approach to their teaching, they should be able to identify discrepancies between the reality (in their classrooms) and what is considered 'good practice'. Such an approach requires open-mindedness on the part of teacher educators.

Some problems for Action Research

1 To study the effectiveness of teacher's demonstration and learners' activity method for science teaching.

2 To find out causes of disinterest among learners towards activities in a science class.

3 To identify difficulties faced by teachers to teach concept of 'nature of matter'.

4 To study the factors responsible for lack of interest among science teachers for activity-based science teaching.

5 To compare achievement in science of girls and boys among the learners at the primary level.

Why a research proposal? 6.7.1

Once a research idea has been conceived, or a problem identified for research, it is good practice to write it up as a research proposal.

Apart from possibly being needed for an application for funding or a proposal for studying a higher degree, writing a formal research proposal can also serve to focus attention on:

- clarifying and stating the problem;
- clarifying the objectives of the research';
- identifying the population, sample and procedure for collecting and analysing data;
- specifying the individual activities in the study and when to perform them;

- identifying the materials required for the study;
- estimating the cost of various aspects of the study.
- estimating the time/duration.

A written research proposal also allows the researcher to receive feedback from colleagues on the clarity with which the problem is presented, the procedures to be used in the study, and on the relevant literature available.

6.7.2 Writing a research proposal

Science and technology teacher educators need to develop the skill of writing research proposals, as part of their professional responsibilities and development. A research proposal is a systematic description of the researcher's whole plan of action designed to collect the data intended, resolve the problem, provide and answer or demonstrate a need for further research.

The basic elements of a research proposal are:

- The title
- An introduction and background to the study.
- Identification of the problem to be investigated - a precise statement of the problem or purpose is needed.
- Identification of research questions or objectives arising from the problem statement, and the hypothesis, if any, to be tested.
- **Details of the research design and procedure:** Describing the activities that would lead to the attainment of the objectives - answering the research questions or testing the hypothesis. These should include: identification of target population and sample, and instruments/materials to be used; phases of the activities, their components, methods or procedures for collecting data and techniques for data analysis.
- **The time schedule:** This should give an indication of the starting date for the research, when it will end and the timetable for the different phases.
- **A budget:** this gives an indication of how much the research will cost. It should be detailed and comprehensive and should include all items of expenditure and the total amount required.

Activity

Identify the problems of action research in science and technology and prepare a research proposal for your research problem.

One of the most important aspects of a research study is communicating the results to others. Research reports are means of documenting and disseminating research information. Science and technology teacher educators and their learners need to be conversant with the skills of writing research reports.

There are many formats for writing reports but there is general agreement on the format detailed below.

- **The title:** The report must start with a title. The title must clearly indicate the subject of the research to the reader/user.
- **The abstract:** After the title comes the abstract, which contains the important ideas and main steps of the study. It is a brief summary of the whole study and should include a statement of its purpose, the type of subjects used, brief statement of design, data and analysis techniques, results and findings. The whole matter should be no longer than three-quarters of a side of A4 paper.
- **Statement of the problem:** The statement introduces the reader to the problem which should be clearly described. If research hypotheses were formulated, these should also be included in this section of the report.
- **Design and procedure:** In this section, the researcher should clearly explain the following aspects:
  - The nature of the design including the sample: whether it is a descriptive survey, correctional or experimental design; the characteristics of the samples, including number, sex, age-range, class or form, and sampling procedure.
  - The instruments, such as questionnaires, rating scales, tests, etc., which served as the main tools for obtaining data, including the name of the instrument, complete details of its source, and psychometric characteristics such as reliability and validity information;
  - The procedure followed to conduct the study: a detailed step-by-step description of how it was carried out.
- **Results:** There are many ways of presenting results depending on what they are, how they were collected and what they are intended to show. Tables, graphs, lists or figures should be used wherever possible to help present results clearly, and referred to in the account of the results. All tables, charts, graphs and terminology used should be clearly explained so that they help the reader to understand the report. Where statistical tests of significance have been indicated, it is useful to include all formulations that led to the rejection or acceptance of the stated hypotheses. In qualitative research, a detailed description of observations made, including some of key atatements made by the source of data should be included.
- **Discussion of results:** In this section, the results should be carefully explained (of course within the limitations of the study), question by question or hypothesis by hypothesis. Part of the discussion should include explanations of the results within the context of existing knowledge of the problem. Do the results contradict or corroborate other findings? Or do the results stand out clearly on their own? Are there unexpected results? Why? Here the researcher should explain, argue and

possibly make predictions based on his or her findings. This is the section for the researcher to propound his or her views.

- **Suggestions and Recommendations:** Research results present some notions on the nature of a problem to the researcher. From such understanding it will be possible for the researcher to suggest solutions to the problem. It is in this section that conclusions, possible solutions and recommendations are discussed. Suggestions might also include scope of further research.
- **Bibliography and references:** The bibliography is a list of the publications studied by the researcher. Questions or particular references to other work in the report are listed under "References". If the report is intended for publication in a journal, the author should refer to that publications and follow their style for setting out the references or bibliography.

6.8 Recommendations in support of research in science and technology education

- **Research data banks:** To promote research in science and technology it would be immensely helpful if data banks were created where research data could be stored and made available to researchers to support action research. The data bank could also provide researchers' and teachers' research findings for use in their research/teaching.

  The Commonwealth Secretariat may like to support the establishment of such banks and their networks.
- **Workshops in action research:** Many science and technology teacher educators working at the primary level do not have enough experience of research. They do not lack knowledge of research problems and issues but they lack competence and experience in research methodology. It would be very useful if workshops could be organised for teachers and teacher educators to develop their skills of research methodology. This would help promote action research. The Commonwealth Secretariat may like to support such training programmes or conduct workshops in member countries.

Case study: The Toray Foundation Award in Malaysia

Some private sectors provide funding and awards to encourage and support research.

The Toray Foundation involved in textile manufacturing in Malaysia, for example, provides cash awards to practising teachers for any research conducted in the area of teaching and learning of science and mathematics at the school level.

The Foundation started giving the award in 1993 and managed to arouse research interest amongst teachers in schools. When it first started, the award attracted a total of nine proposals from schools throughout Malaysia. However, in 1994 as many as 11 proposals per state were received. The quality of proposals have also shown considerable improvement.

- **Private sector involvement:** Education authorities, industry, public and private sectors should be called upon to encourage and support research.

- **Regional clearing houses:** Science and technology research materials, such as research reports and evaluation instruments published in the local language, should be collected in regional centres. Many educational institutions cannot subscribe to journals. Ways should be found to make journals available to educational institutions doing research.

- **Networking:** Networks of researchers and institutions conducting research in science and technology should be established.

- **Dissemination:** Mechanisms should be set up for the dissemination of research information, particularly at the local level through newsletter, occasional monographs, seminars and discussions, conferences, teachers' meet, symposia, etc.

- **Support mechanisms for novice researchers:** Teacher educators of primary teachers generally lack research skills. To promote research, teacher educators need training in research methodology. They also need support at different stages of research through the establishment of suitable mechanisms. The establishment of local research advisory committees could be one way forward.