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IMPLEMENTATION OF A SCHOOL-BASED SCIENCE PROGRAMME : A CASE STUDY

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Introduction

This paper tells the story of the first two years of a science programme which was planned and implemented by the staff of a local primary school. The programme formed the core of a submission for government funding* as a school-based innovation. The study describes the degree to which the submission's aims were achieved and attempts to analyse the factors contributing to the project's outcomes.

The aims of the project submitted for funding were as follows :

(i) to introduce materials-based inquiry programmes in four conceptual areas, with integration of these areas across grade levels;

(ii) to provide the school with the materials and specialist-assistance needed to implement the programmes;

(iii) to develop confidence in and expertise of teachers implementing their science programmes.

As such, the project aims were teacher-oriented, with the emphasis on providing each teacher with the expertise, resources and confidence to conduct inquiry-centered science lessons. However, the planners also anticipated consequences for the children such as "a deeper awareness, understanding and appreciation of life" and an "observable environment that is practical as distinct from theoretical" (Griffith, 1977, p. 1). It is useful at this point to present the teachers' rationale for the project since it expresses clearly the focus which the project had.

The teachers felt that assistance was needed for two main reasons :

(i) To establish all four syllabus concepts, namely, Plants, Animals, Matter, and Energy. The policy of flexibility and open inquiry is our "ideal", however, due to lack of experience and confidence, this very flexibility has tended to evolve a programme within which the biological science has become predominant. No matter how vitally a teacher feels convinced of the need for effective coverage of all facets of Science, it is acknowledged that choosing areas of study is largely determined by familiarity and confidence in that area, rather than searching and scrounging for materials

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* Schools Commission Grant.

to cover an area in which he/she is fearful of ineffectiveness or inadequacy.

(ii) To provide the school with basic equipment geared to all of the concepts, to provide the staff with the confidence and expertise to use this equipment and to extend their ability to improve teaching aids.

It has been our experience that enthusiasm and common sense are insufficient to achieve these aims; the need remains for stimulation of avenues within science, in particular the physical sciences, by an external source of advice and guidance. This need for sound, practical expertise could be satisfied from a community resource. The specialist's skills, knowledge, contact and stimulation vital to implementing the desired programme could become available through the services of a consultant. (Griffith, 1977, p. 1)

The project had some distinctive characteristics.

1. It was initiated and the programme planned and implemented by the teachers within the school, with one particular teacher acting as the motivator and co-ordinator.

2. The programme emphasises a "spiral concept" idea which allowed for selected topics to be treated sequentially through the seven grade levels. In the words of the planners, this approach should "ensure a total coverage of the (topic) rather than a series of sectionalised repetitions within the (topic)" (Griffith, 1977, p. 2).

3. A consultant (the author of this paper) was to be utilised on a contractual basis to assist teachers with implementing their programmes.

It is important to emphasise, at the outset, that the research presented here is not the result of a well-planned and controlled foray into the area of hypothesis-testing. Rather, it represents the opportunistic response of a science-educator who found herself in a position to document the reactions of an education system (a school and its staff) to an internally-initiated change (a child-centered, materials-based science programme). This paper, then, exemplifies what has come to be termed the "case-study" approach to research. It comes during a period when the dominance and effectiveness of the psychometric approach to education research is being seriously questioned (Power, 1976). At the same time, the descriptive tell-it-as-it-is approach is being encouraged as a valid and potentially useful alternative (Smith, 1978). The paucity of case studies of this type in specific research areas of education makes it difficult to demonstrate their effectiveness in generating useful data. Many more

studies are required to enable comparison and identification of generalisations for theory-development. However, one clear point is emerging from the discussions of alternative research paradigms: if the descriptive approach to classroom research is to be most useful, much care needs to be taken with data analysis and communication. In this paper, every effort has been made to separate descriptions of the system within which the data was collected, the data itself and any judgements or inferences based thereon. However, the study had some limitations, in particular those of the degree of the author's exposure to the situation and the observer's stance.

One of the problems associated with descriptive field studies of this type is the degree to which the researcher may become involved with the system or processes being observed. Ideally, the researcher should have free and intensive access into the system, while having no commitment to the outcomes of the particular project. The observer stance in the present study was far from ideal in the above sense and it is, therefore, important to describe the roles and consequent commitment this researcher had, the degree of access to the school under study and what Smith (1978) terms the level of "intensity of the observation".

This researcher filled the dual (and, at times, conflicting) roles of consultant for, and monitor of the science programme being implemented. The consultant involvement posed obvious problems from a research point of view:

(a) a more conscious effort was required to maintain an appropriate degree of objectivity with regard to data collection and evaluation;

(b) the consequent development of close professional ties between consultant and teachers may have influenced the teachers' responses to questionnaires. These questionnaires were the formal instruments monitoring the progress of the programme;

(c) access to individual classrooms for teacher observation was limited and occurred only as a result of requests by the teachers concerned. These teachers were relatively inexperienced with regard to science and lacked confidence. From the consultant's viewpoint to place them in a situation of being judged by an outside observer appeared counteractive to promoting teacher confidence and enthusiasm, and hence counteractive to the general aims of the project.

However, there was an advantage to the development of professional consultant/teacher relationships. It provided opportunities to gain insights into problem areas within the school (in particular between teaching and administrative staff) which, due to the limited access of the researcher, might not have been identified and which, in retrospect, had some impact on the programme implementation.

All visits made to the school were in the dual capacities of consultant and observer. These visits were made on a regular basis (weekly or fortnightly) and, initially, were always in response to specific requests by teachers for consultant assistance. Later in the study visits were also made for questionnaire distribution and collection and informal lunch-hour discussions with staff on the progress of the project. The longest visits made at any one time were generally 2–3 hours in length (e.g., class assistance with lessons, workshops, etc.). Time constraints on the researcher prevented longer on-site observing periods, a further constraint on the intensity of observation.

Describing the Scene

1. *The School:* The school in which the science project was planned and initiated catered for approximately two hundred students across the seven primary grade levels. The school (non-government) was in the process of phasing male students into the upper primary grades. Formerly, male students could attend the school for only the first three years. There were eight teachers, one for each of the grades, and a specialist teacher for drama, religious and intercultural activities. There was also a non-teaching principal and two to four support staff (aides, librarian, secretary) at any one time.

   At the time the programme was initiated, the school had seven self-contained classrooms, with no special facilities. There was a small storage room for resources adjacent to the principal's office. A building programme in progress during the study provided:

   (a) larger areas for administrative and staff rooms;

   (b) two new classrooms with wet areas and adjacent outdoor work areas, and

   (c) a library centre.

   The school is situated amongst a population of generally low socio-economic status as described by a high proportion of blue-collar workers, particularly production process workers and labourers. The area exhibits a relatively high Catholic migrant fraction of Southern-European origin (Houghton, 1979). The project submission described the school as "not classified as a disadvantaged" school, although pupils have very restrictive experiential backgrounds. As

an indication of the identified needs of this specific group, the following example is offered:

> Last year 45 pupils in years 4 and 5 were taken for a train/bus/ferry excursion. *Most* had never travelled by ferry, a *third* never by train, and *four* had never been on a bus. (Griffith, 1977, p. 11)

2. *The Teachers:* Over the three years relevant to this study (including the year in which the project was planned and submitted for funding) staff movements necessitated some teacher change and not all of these teachers provided data on their backgrounds. The data that were obtained are summarised in Table 1 and indicate that the staff were reasonably experienced as teachers though their experiences with science in particular were patchy and showed an orientation towards biological topics. All these teachers had recognised teaching qualifications and, with the exception of the teacher-motivator, they had received no inservice or other type of specialist training in primary science education.

The project was initiated and co-ordinated by one teacher in the school (Teacher E). She first became aware of a need for a balanced science programme in the school after attending an inservice workshop. Teacher E had no special science-teaching experience and, prior to this project, she professed to teaching science on an opportunistic basis and only within biological areas. She had attended several science workshops and it was these which heightened her awareness of a science need in her school.

When the opportunity to apply for funds arose, Teacher E introduced her ideas informally to the other teachers. Following discussion and agreement with her ideas, a submission was made for funding.

3. *The Programme:* This consisted of three parts:

   (i) a flexible framework (a topic/skills matrix) within which each teacher could stipulate areas of study to be covered by his/her class during a school year. An example of one such matrix drawn up by a teacher is shown in Figure 1;

   (ii) a planned sequence of topics across the grade levels within each of the themes of Weather, Animals and Plants (the "spiral concept" mentioned earlier). Areas of study for each year level were selected such that a graded sequence of topics was possible as a child moved through the different grades. An example of such a sequence is shown in Figure 2. In particular, the weather

TABLE 1

Background Characteristics of Teachers at the School During the Planning and Implementation Stages

	Teacher Identification									
	A	B	C	D	E	F	G	J	K	H
Years of teaching experience	20	12	11	16	8	8	No Data	No Data	4	No Data
No. years at present school at time of planning	1	4	0	8	4	2			0	
Regularity of science lessons	Wkly	Wkly	Irreg.	Wkly	Irreg.	Irreg.			Irreg.	
Areas of science treated	Biol.	All	All	Biol.	Biol.	Biol.			Biol.	
	*									
Present in planning phase	▨	▨		▨	▨	▨	▨			▨
Present in 1st year	▨	▨	▨	▨	▨	▨	▨			
Present in 2nd year	▨		▨	▨	▨	▨		▨	▨	

* Shading indicates teacher present at school at the time indicated.

Topic	Observing	Communicating	Classifying	Measuring	Predicting	Space/Time
MAGNETS	Different types. Effect on materials.	Reports from groups. Discussion of uses to man, dangers. Discussion of lode-stone discovery.	Attracted or not.	Distance of effect. Strength of magnets.	Which objects will be affected.	
FUNGI	Wide variety of fungi.	Uses to man, food, medicine. Pest aspect.	Ground, tree, food, crop.	Time to grow.	Results of tests.	Relationship between growth conditions and time taken.
ECOLOGY ANIMALS	Interdependence of plants and animals.	Theorizing absence of one or other—substitutes. Discuss extinction and preservation. Are zoos necessary?	Uses, abuses. What plants, animals supply—to other plants, animals.		Result if all life destroyed—if only plants/animals removed.	Inter-relationship—aquarium.

FIGURE 1: An example of a Topic/Skills matrix designed for a year 7 class.

activities were planned to culminate in a 'Weather Bulletin' chart made up of daily recordings from each classroom, while the plant activities were to be centred around the establishment of a vegetable garden within the school grounds;

CO-ORDINATED PROGRAMME FOR VEGETABLES

Year 1	Pod plants, e.g., beans, peas, sweet peas.
Year 2	Germination — seeds.
Year 3	Leaf vegetables.
Year 4	Root vegetables.
Year 5	Propagation — bulbs, suckers, cuttings, etc.
Year 6	Fruit, vines and berries.
Year 7	Reproduction, growth rates, etc. (interdependence on insects).

FIGURE 2: An example of a "spiral topic" (in this case from the 'Plants' theme).

(iii) activities which met "a need for actual visits and experience with practical science within the community" (Griffith, 1977, p. 11). They proposed activities such as:

(a) visits to museums, zoos and nature areas;

(b) observing activities at observatories, research organisations and media centres;

(c) observing industrial and chemical processes such as power production, flour manufacture, sugar refining, etc.

(d) 'live-in' experiences in selected natural areas.

The project allowed for the use of a consultant as required by the teacher for the implementation of the programme. Figure 3 lists the ways in which the planners visualised that a consultant may be required.

The programme was accompanied by an itemised equipment list and budget statement outlining the anticipated expenses. Categories of anticipated expenditures are displayed in Figure 4.

1. Inservice training, workshops, demonstrations
2. Advising on books and reference material
3. Advising on programmes, lesson sequence
4. Class or group demonstration of skills, equipment use
5. Advising on quality and quantity of resources, storage
6. Advising on excursions, visits
7. Addressing parents and friends re planned programme
8. Be available for sequences, advice, stimulation, assurance and building confidence

FIGURE 3: Anticipated areas of consultant use during the implementation of programmes.

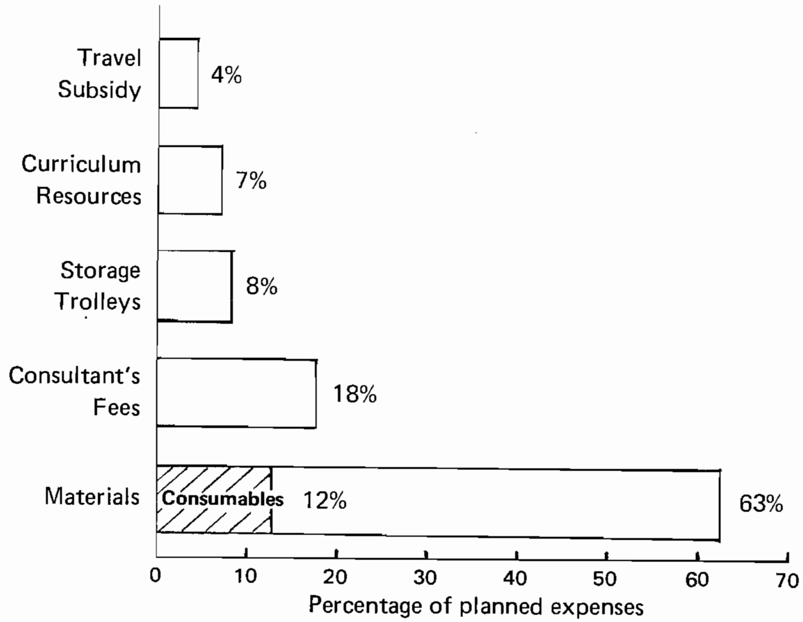

FIGURE 4: Expenditure categories of the planned budget.

Data-Gathering Instruments

The progress of implementation was monitored formally with questionnaires and informally by a diary of week-to-week observations and other anecdotal information.

1. *Questionnaires:* Over the two years of the study four questionnaires were distributed to each of the seven teachers involved with implementation (Table 2). (Completion of the questionnaires was voluntary and, hence, not all the teachers always returned completed forms.)

TABLE 2

Characteristics of Questionnaires Distributed to Classroom Teachers Involved with Implementing the Science Programme

Time of Distribution	Information Sought
Term II, Year I	(a) Teacher characteristics/background. (b) Role in planning stages. (c) Attitudes and anticipations towards the project at the time of planning.
Term III, Year I (At close of school year)	(a) Description of programme 'implemented' in 1st year. (b) Problems encountered. (c) Attitudes towards programme success for 1st year. (d) Attitudes towards plans for 1979.
Term II, Year II	(a) Description of programme 'implemented' in Term I of second year.
Term III, Year II (At close of school year)	(a) Description of the year's programme. (b) Problems encountered. (c) Consequences for teacher/students. (d) Attitudes and feelings regarding the two-year project.

2. *Diary-keeping:* A less formal but nevertheless valuable method of data-collection was the recording of all visits made to the school, the assistance provided during these visits, discussions with staff and any anecdotal information arising out of these visits. Smith (1978) describes vividly this manner of 'diary-keeping' by the observer in the field. Any information which appeared potentially useful in describing the project's progress or in identifying potential variables affecting such progress was recorded. The data in the diary enabled the researcher:

   (a) to determine the frequency and types of requests made by teachers or the consultant;

   (b) to record any problems and successes teachers voiced in the course of informal discussion;

   (c) to maintain a series of anecdotal data which, in retrospect (and with (b) above), conveyed much of the more subtle and undercurrent feelings which surfaced briefly from time to time and which may not have become apparent from the questionnaire data.

The Planning Phase

There were some important features characterising this phase. Firstly, a teacher within the school (E) was the co-ordinator and adviser for her teaching colleagues and carried much of the responsibility for the planning of the project and its submission for funding. In particular, this teacher provided:

(a) a rationale for the submission;

(b) a uniform (but flexible) framework within which teachers could plan their own programmes (the skills/topics matrix referred to earlier);

(c) a list of potential resources together with quotation prices;

(d) the written submission to the funding body.

Secondly, individual teachers prepared programmes for their own classes. As a result, the project was wholly school-based in philosophy, design and content. Teachers were encouraged by the co-ordinator to plan their own programmes within the framework she provided and using the curriculum resources which were available. They also provided lists of resources which they anticipated needing to run their programmes.

Thirdly, at the time of planning, teacher reaction to the project varied widely. These initial feelings ranged from very negative to very positive

(Table 3). The majority anticipated implementation problems which were:

(a) planning and organisation of students and materials;
(b) using some of the equipment;
(c) organising resources for large classes;
(d) may not be able to answer children's questions;
(e) problems with "mess";
(f) courage to start;
(g) not knowing the appropriate strategies to use in the classroom;

The teacher co-ordinator identified and anticipated problems peculiar to her role:

(a) staff may not use the ideas;
(b) appropriate use may not be made of funds;
(c) transport funds may not be sufficient.

TABLE 3

Attitudes of Teachers to the Project at the Time of its Submission for Funding

Teacher Identification :	A	B	C	D	E	F	G
How would you describe your initial reaction?*	--	++	0	-	+	No Data	No Data
How would you rate your commitment?	--	++	0	0	++		
Did you feel there was a need in the school for this innovation?	No	Yes	NR	Yes	Yes		
Did you feel the innovation would work?	No	Yes	Yes	Unsure	Yes		
Were you clear on your role?	No	Yes	Yes	Unsure	Yes		
Were you confident you could carry out your part?	No	Yes	Yes	Unsure	Yes		
Do you anticipate implementation problems?	Yes	No	Yes	Yes	Yes		

* Very positive ++   Negative -
Positive +   Very negative --
Ambivalent 0   No response NR

Teachers' viewpoints with regard to aspects of the project varied so widely. Tables 3 and 4 portray the variation of feelings which existed after the planning phase. All teachers identified potential positive consequences for teachers and/or children should the project be implemented. The negative consequences were fewer and stemmed from personal feelings of inadequacy (teachers A and D), potential problems with administrative personnel (teacher A), and concern with the role of co-ordinator and initiator (teacher E).

TABLE 4

Anticipated Consequences of the Project, at the Time of Submission for Funding, as Listed by the Teachers in the School

Positive Consequences	Negative Consequences
Teacher:	*Teacher:*
Increased awareness and experience (B) *	Untidiness or "mess" in classroom to which principal objects (A)
Improve my teaching of science (C)	"Ego-blow" if I failed (D)
Increased awareness of other science areas (D)	Consuming time and energy in maintaining interest of teachers, keeping accounts and purchasing equipment (E)
Improved confidence (E)	
Better balance of physical science (E)	
Children:	*Children:*
Enjoyment, interest and self-discovery (A)	Reprimanded for making a "mess" (A)
Development of inquiry skills (B)	May ask questions I can't answer (A)
Greater rapport with children (B)	Time consumed in preparation means decisions as to "priorities" (E)
Benefits with equipment use and self-discovery (C)	
Benefit from teacher's improved awareness of needs (D)	May feel disappointed with formal science "of high school" (E)
Spiral science through school (E)	
Broadens their experience (E)	
Benefit from teachers' enthusiasm (E)	

* Letters identify the individual teachers.

The Implementation Phase

For purposes of comparison and discussion, it is appropriate to identify stages which might occur during the process of implementing a science programme of this type. Three stages might be expected to occur:

- Stage I — an initiating phase during which teachers make the first attempt to implement their science programmes.
- Stage II — regular science lessons begin, on a selected topic (provided sufficient success is achieved at Stage I).
- Stage III — regular science lessons are maintained over a range of subject areas.

This three-stage framework will be used to describe the sequences of events and outcomes during the two years of the project.

The First Year

Just as there were varying attitudes and degrees of commitment to the project during the planning phases, so there were a variety of outcomes with the completion of the first year. These outcomes are summarised in Figure 5. Figure 6 outlines the degree of coverage of planned topics for this first year, while Table 5 summarises teachers' responses to questionnaire items concerning the year's efforts.

All teachers had initiated science lessons by the conclusion of the first half of the school year, though some began much later than others (Table 5). Teachers A, B and F sought consultant advice and classroom assistance to begin. While B and F met with success initially, A identified a serious problem which she described as being inhibited by a principal who felt that science had to be clean and tidy. As a result, teacher A did not continue with a formal science programme. Other problems were encountered by teachers during this initiating stage. Teacher E sought consultant advice regarding objectives and appropriate depth of coverage of topics. Teacher C (new to the school) cited a lack of preparation and confidence, though time and experience brought solutions. For all but one teacher, initiating problems were solved sufficiently for science lessons to begin on a regular basis.

All the teachers encountered problems once regular science lessons had begun and these are listed in Table 6. In many cases, experience and/or consultant advice provided solutions, though some remained unsolved at the end of this year. By the end of the first year, five of the seven teachers had reached Stage III, that of maintaining regular science lessons (though of varying frequencies). No data on lesson frequency were obtained from Teacher G.

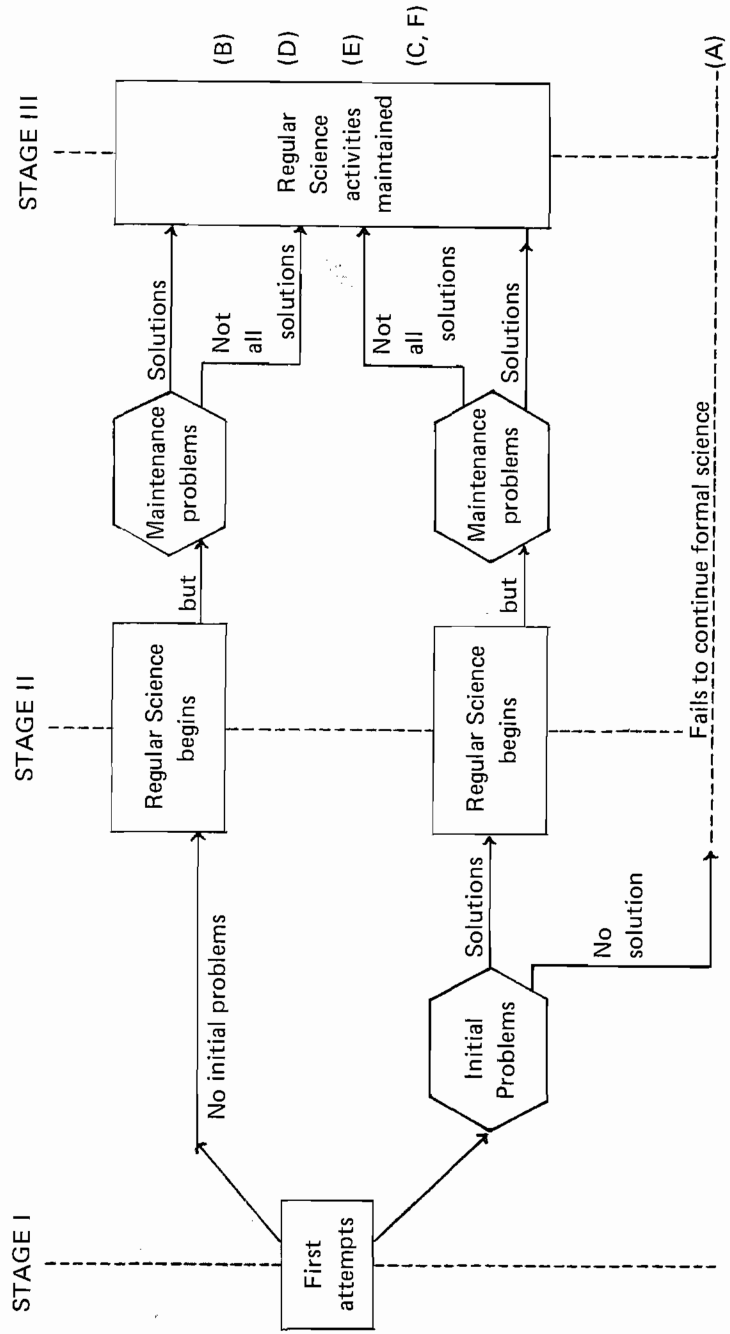

FIGURE 5: Flow chart summarising the sequence of events and outcomes for each of the teachers during the first year of the project.

TABLE 5

Teachers' Responses to Questions Relating to Programme Implementation and Maintenance During the First Year of the Project

Teacher Identification :	A	B	C	D	E	F	G
Phase I							
When were first attempts made to implement programme?	Wk8/T1	Wk2/T1	Wk2/T1	Wk1/T1	Term 1	Term 2	Wk4/T2
Was programme begun as planned?	No	Yes	Yes	Yes	No	No	Yes
Did you have implementation problems?	Yes	No	Yes	No	Yes	No	Yes
Phase II – III							
How frequent are your science lessons (end of 1st year)?	None	Wkly	Wkly/ F'nightly	Daily/ Wkly	Wkly	Mthly	
Did you have problems maintaining your programme?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were these problems overcome?	No	Yes	Yes	Yes	No	Yes	
Has your confidence in teaching your programme changed?	No	No	Yes/Inc.	No	Yes/Inc.	Yes/Inc.	
How do you feel about the project (end of 1st year)?*	--	++	+	0	+/++	++	
How do you feel about beginning a programme next year?	-	++	+/++	0	+/++	+	

* Very positive ++ ; Positive + ; Ambivalent 0 ; Negative - ; Very negative --

TABLE 6

Problems Encountered by Teachers During the First Year of Implementation of the Project

Problem	Solution ?
1. Children manipulating equipment (B)	Yes
2. Children recording and inferring (B)	Yes
3. Providing time and freedom for discovery (F)	Yes
4. Dealing with large classes (B)	Yes – by developing small groups
5. Obtaining materials for large groups (D)	Yes – with consultant help
6. Maintaining tidiness (D)	Yes
7. Organising materials (C)	Yes – with experience
8. Maintaining regular science lessons (E)	Partially – with consultant help
9. Integration with other subjects (F)	Yes
10. Developing a more positive attitude (C)	Yes – with experience
11. Lack of confidence and experience (B)	Yes – with experience
12. Lack of knowledge and organisation (D)	Partially
13. Problems with principal (D)	

Not all teachers began with their programmes as planned and those who did begin with their original programmes did not necessarily stay with planned topics throughout the year. Figure 6 indicates the degree of coverage of planned programmes as well as indicating those teachers who incorporated unplanned topics into their programmes.

Teachers identified the following reasons for deviating from their planned programmes:

(a) a lack of confidence with unfamiliar topics led to more familiar "proven" ones being used. For example, in term 2, teacher E did much effective child-centred activity in the biological areas in

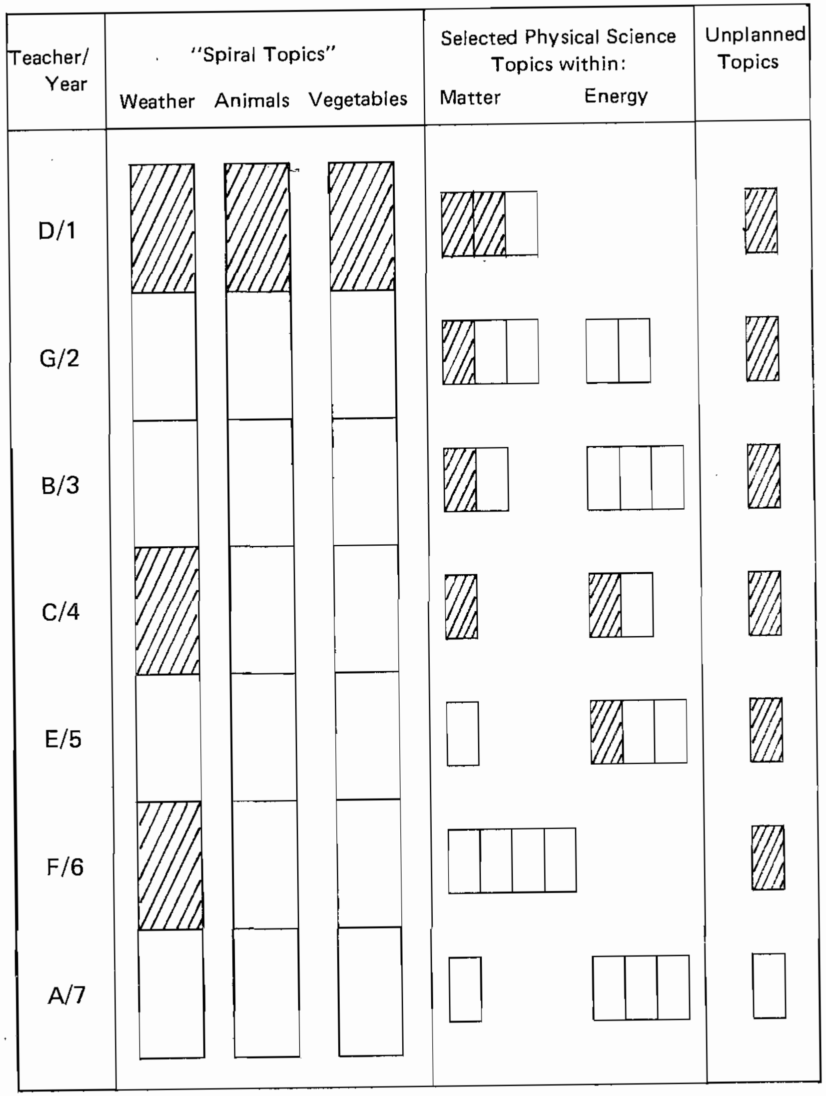

FIGURE 6: Topics planned and topics actually covered during the first year of the project.

(Shading indicates those areas treated in the classroom; unshaded areas indicate those topics planned but not covered.)

which she felt most confident. It was not until term 3 that, with consultant support, she tackled the first of her planned physical science topics;

(b) topics arose incidentally or developed with the children's interests (teacher F);

(c) use was made of more structured, sequenced curricula. The original programmes were planned as simple matrices identifying topics. As such, they did not identify activities, teaching strategies, sequences, or organisational practices for material distribution and use.

Following attempts to implement her programme with a large class of year 2 children, teacher G expressed a need for a more structured, sequenced science programme and, with consultant help, began incorporating ideas from the SCIS* programme into her classroom science. Teacher D (who taught next door and shared teaching ideas with G) also found the SCIS organisation of materials useful and used the material resources in her classroom. SCIS materials remained on loan to the school for the use of these two teachers for the remainder of the project.

Those teachers who considered their problems solved had very positive attitudes towards the project at the end of the school year (Table 5). Of the two who considered their problems only partially solved, teacher E maintained her positive attitude while teacher D's feelings were still ambivalent. When asked to identify the two main obstacles to implementation during this first year, teachers cited a lack of confidence (expressed as a perceived lack of knowledge or experience) and the storage and organisation of materials.

Author's comments: At the outset, the very nature of the school—its small size, the professional and co-operative nature of the staff and the apparent free interchange of ideas and experiences which occurred—seemed to provide an ideal climate for success of the project. With the exception of teacher A, the teachers expressed a commitment to the project and there was a general consensus that the children's education was lacking in the science area. The ambivalence which was present arose from a lack of confidence with the subject which, in turn, stemmed from a perceived lack of science knowledge and teaching experience with using materials. This lack of confidence was perhaps a major reason for the relatively late start made by some of the teachers to implementing their science programme.

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* *Science Curriculum Improvement Study — Material Objects, Organisms.* New York: Rand McNally & Co., 1970.

In the first term of this school year, it became apparent that some problems might develop with regard to relationships between some teaching staff and the principal. Teacher A had attempted to initiate her science programme with floating and sinking activities. This, and subsequent attempts, raised issues of 'noise' and 'untidiness' between A and the principal. Teacher A identified this as a major reason for her not continuing formal science with her class. She was also most negative towards the project and her resultant lowered commitment may have contributed to her lack of persistence in the face of administrative problems.

A measure of success was achieved in the first year of the project in that five classes of children now experienced some science on a regular basis. However, it is evident from Figure 6 that large parts of planned programmes were not dealt with in this first year. There appeared to be a number of reasons for this:

(a) the planned programmes were very ambitious in the number of topics teachers expected to cover. This is perhaps a natural outcome when teachers are inexperienced with materials-centred inquiry strategies. Teachers themselves remarked that, "topics, once begun, lasted longer than anticipated";

(b) teachers were slow to implement a science programme. Again, this was probably due to their lack of confidence in the subject matter and inexperience with the use of materials. The relatively extensive treatment of topics by teacher D is an exception and is worthy of some comment. Teacher D is an experienced year 1 teacher who, initially, appeared to be the least confident with science as a discreet subject. Her view of science as a body of content with which she was not familiar caused her much concern. However, as the year progressed, her awareness of "what is science" broadened considerably to include the basic skills—skills which she had always taught, but not within the context of "science". She was later to make the comment that (the consultant) "had made me more aware of the science content of my own programme . . . a lot of science is being done almost daily in short lessons of observation, hearing, seeing, smelling, tasting";

(c) the vegetable garden (around which the spiral topic of "vegetables" was to evolve) failed to eventuate in the first year as had been planned. A need to fence the area and to provide water immediately adjacent to it were unforeseen complications. (Both fence and tap were provided by the winter of the second year and were sufficient impetus for teachers to cover the topic as planned.)

The very few requests made by teachers of the consultant during the first two terms of this first year was a worrying feature. It will be remembered that a feature of the project was that the consultant was to be available at the request of individual teachers to assist with any problems related to implementing and maintaining science programmes. Apart from a workshop organised for parents by the teacher co-ordinator and consultant, and which teachers also attended, only one or two approaches were made to the consultant during the first 8 to 10 weeks of the school year. However, teachers began to make more use of the consultant in the second half of the first year. It now seems there were two factors which helped to overcome the initial reluctance to seek advice. Firstly, teachers needed time to develop an awareness of their own needs and how best to meet these needs via a third person. Secondly, it was important for the consultant to become a regular visitor to the school.

In the second half of the year, the consultant made weekly visits to the classroom of teacher E (at her request) to assist with the planning and running of her science programme. These formal visits (which were often prefaced with lunch in the staffroom) encouraged other teachers to make indirect requests of the consultant via teacher E. It wasn't long before these indirect approaches developed into direct and specific requests for assistance in areas of perceived need. The majority of requests made during this period were for classroom assistance with science lessons and for ideas for science activities. Requests for materials were very few; the purchasing and organizing of resource materials prior to the start of the year meant materials were readily available for most activities. At the end of the year, the only resource identified as lacking was the vegetable garden.

Teachers were becoming more aware of the use to which common household materials could be put for science activities. However, this raised the problem of storage space and, during lunchtime discussions with staff, it was obvious that the principal's attitude towards classroom "tidiness" was also causing some problems. One teacher commented "she doesn't come into my classroom anymore," with the implication that it was too untidy. The principal's insistence on neatness, both with regard to storage cupboards and classrooms, was obviously causing some friction among staff.

However, despite what seemed to be minor problems at the end of this first year, the majority of teachers were coping with regular science in limited areas and attitudes remained positive regarding the second year.

The Second Year

Implementation was more successful in this second year for the following reasons:

(a) teachers familiar with the project moved quickly into stage II, with the majority maintaining science lessons throughout the year (Figure 7);

(b) a greater number of topics were covered in physical science areas, with less emphasis on tried and tested topics; and

(c) one "spiral" topic was treated at all year levels.

The overall result (diagrammed in Figure 8) was that more science was done along the lines originally planned in the submission.

There was teacher movement into and out of the school at the beginning of the second year, with three new teachers arriving. Teachers J and K remained throughout the year, while teacher L was a 12-week replacement for teacher G. Both J and L sought consultant advice to begin their science programmes. Subsequent outcomes for these and other teachers are flowcharted in Figure 7. By the end of term 1 (week 12), regular science lessons were established in five of the seven classrooms. In two rooms, science was less regular and frequent. Teacher J taught only 2 or 3 initial lessons. (This teacher departed later in the year due to illness and no further data were available.) Teacher A taught science when and as often as topics arose and "when opportunity presented itself—incidental teacher —a lot was observation through classroom windows, e.g., weather, shadows, etc."

The close of the school year signified the official end of the project from the point of view of the funding body. At this time teacher responses indicated increased confidence with regard to teaching science, with science being taught more frequently in five classrooms (Table 7). However, there were problems in maintaining regular science, many of which were not solved by the completion of the second year. Of these problems (listed in Table 8), that of sequencing ideas was a recurring one.

Author's comments: At the start of the second year, the majority of teachers were eager to begin science. Compared with the previous year, teachers seemed more confident and consultant visits with staff brought comments and/or requests regarding individual science programmes. The SCIS programme was still the choice of teachers D and G. Teacher D liked its association with her reading readiness programme. Teacher A was still loath to teach science and her attitude remained negative. She felt her class was so lacking in basic skills that she couldn't afford time for

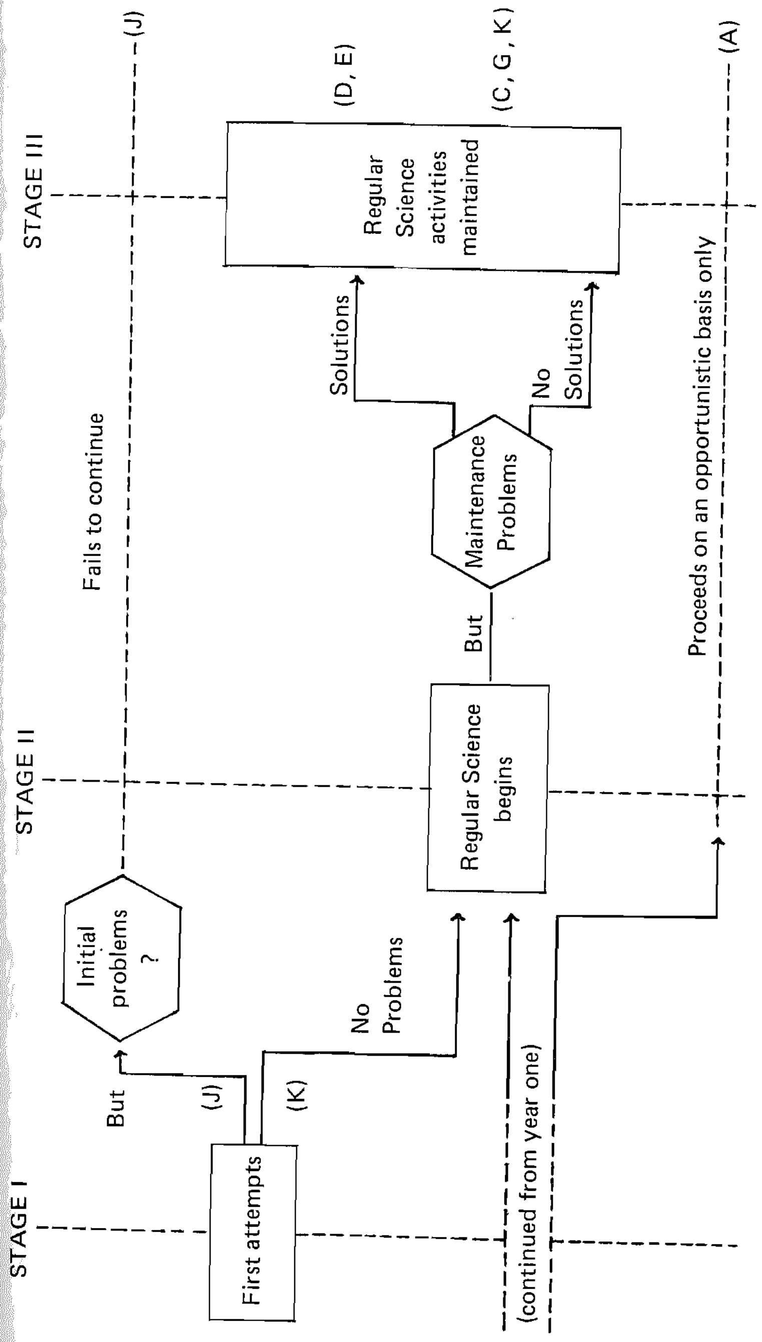

FIGURE 7: Flow chart summarising the sequence of events and outcomes for each of the teachers during the second year of the project.

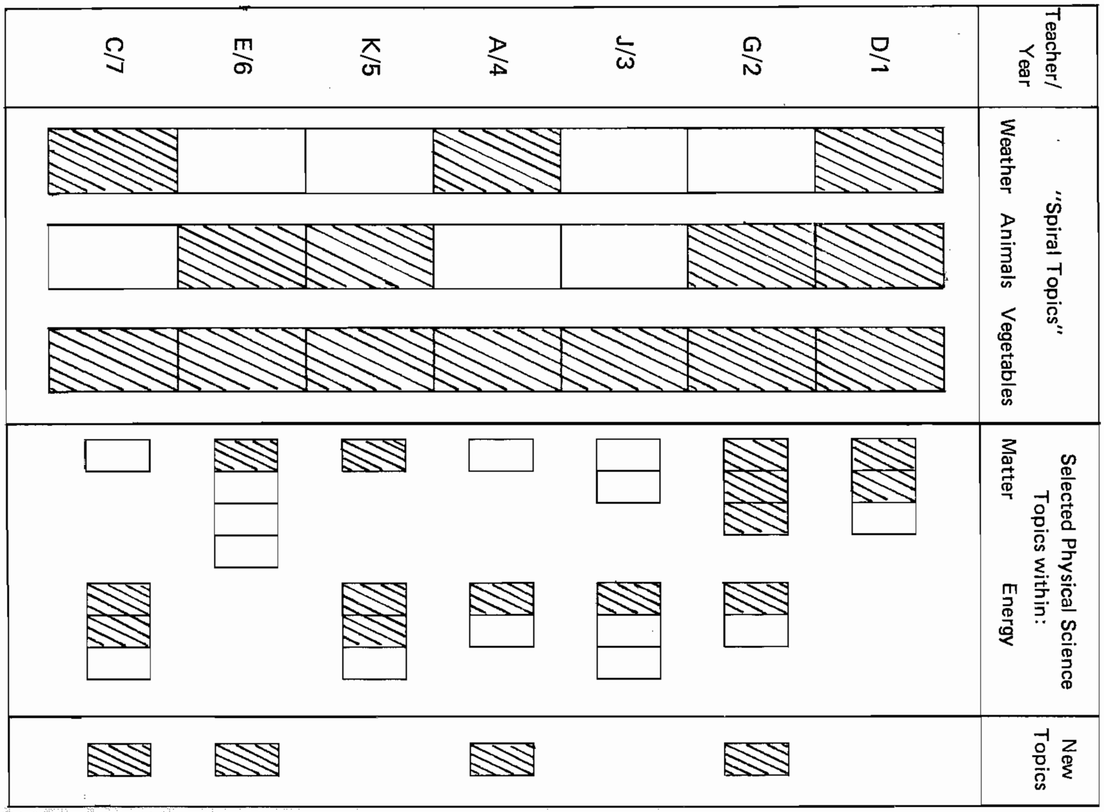

FIGURE 8: Proportion of planned science topics dealt with by teachers during the second year of the project.

(Shading indicates those topics actually treated.)

TABLE 7

Teacher Responses to Questions Relating to Running of Science Programme in 2nd Year of Implementation of Project

Teacher Identification :	A	C	D	E	G	K	J
Frequency of science in 1979.	'Incidental'	Weekly	Daily	Weekly	F'nightly	Weekly	No Data
Approximate lesson length (minutes).	30–60	60	15	60	30	45–50	
Were there 'running' problems?	Yes	Yes	Yes	Yes	Yes	Yes	
Were all 'running' problems overcome?	No	No	Yes	With experience	No	No	
Were the resources adequate?	No	Yes	Yes	Yes	No	Yes	
Confidence changed with regard to teaching science since beginning of 1979?	↑	↑	↑	↑	↑	↑	

* Increased ↑

TABLE 8

Problems Listed by Teachers as Occurring During the Second Year of the Programme

Problems Running Programme in 2nd Year	Solution?
The sequencing of 'formal' science lessons	No
Lack of confidence and organisation of materials	Being overcome gradually.
Inability to use storeroom freely	Yes — storeroom key supplied.
Ideas for teaching topics	No
(a) Inability to sequence lesson steps	No
(b) Difficulty determining appropriate experiences/knowledge children should be guided to discover	No
Lack of some special items of equipment, e.g., aquaria	No
Sequencing ideas and organising lesson plans	No

other subjects such as "science and social science" which she regarded as "not so important in primary school." Teacher A's class did, however, join in the vegetable topic in term 2. In fact, the establishment of a school garden area proved to be an effective strategy for promoting enthusiastic support at all class levels. The children's enthusiasm was evident from the lunch hours they spent caring for their plots. There seemed to be no doubt of the topic's success and it occupied the science hours of all classes from term 2.

Neither of the other "spiral" topics were implemented as successfully (Figure 8). Some out-of-class time was used to develop the weather topic when a staff meeting was held to revise areas within the topic and change them where teachers felt change was required. A weather workshop held one afternoon, organised by the consultant, provided activities to develop related concepts and ideas for child-constructed measuring apparatus. Despite this, the weather topic was never initiated on a whole-school basis. There are reasons which explain, at least partially, why this was so. Firstly, the vegetable topic occupied the science time of some classes in

term 3 as well as term 2. Secondly, teachers continued to develop other science activities in the classroom. Thus it may have been over-ambitious to expect another "spiral" topic to be developed during this time.

Throughout this second year, there was a subtle but noticeable change in teachers' perceptions of their needs with regard to science. Whereas material organisation and distribution were common problems in the first year, the problems of selection of content and activities and the sequencing of these were more common in the second year. In a final discussion with teachers, selection of content *within* a topic and sequencing were identified as the major areas of concern.

The Innovation in Retrospect

Six of the seven teachers provided written comments describing their views on the project at the completion of the two years. The following points emerged:

(a) the majority did not run their programme as it was originally planned;

(b) they identified several major problem areas which they encountered;

(c) they identified positive outcomes of the project within their school; and

(d) they all considered the project to be "partially" successful.

Only two teachers (K and D) considered that their programme ran as planned. The remaining teachers listed the following reasons for change:

(a) the original programme contained "too much" and not all topics could be dealt with in the time available (2 teachers);

(b) topics were introduced which were not previously considered; and

(c) other topics "arose" out of planned topics.

When the teachers rated the project as "partially" successful (as distinct from "completely" successful or "unsuccessful"), they gave as reasons a list of the *most serious* problem areas which they had encountered when implementing and maintaining their programmes. These areas are listed in Table 9. Four of the teachers considered that these problems remained unsolved at the conclusion of the project. On the other hand, the teachers also identified outcomes which they considered to be the major successes of the project. These are listed in Table 10.

TABLE 9

Major Problems Identified by Teachers as Arising when Implementing and Maintaining their Science Programmes

Lack of teacher confidence (4)*
Effective sequencing of ideas within a topic (3)
Overcoming noise and untidiness (2)
Adequate preparation time (2)
Organising classroom for effective teaching (1)
Insufficient classroom demonstrations (1)
Large class sizes (1)
Lack of expertise in physical science area (1)

* Numbers in brackets indicate the number of teacher-responses.

TABLE 10

Major Successes Identified by Teachers as Arising Out of the Two-year Programme

* Resource Area	Socialisation Area
Now have enough equipment on hand (2) Availability of consultant help	Communication and exchange of ideas (2) Development of a school-science-feeling
Teacher-competence Area	**Child Area**
Improved confidence (3) Broadened awareness of what is science (2)	Child enjoyment. Knowledge retention. Improved vocabulary. Familiarity with materials.

* The classification is the author's.
Numbers in brackets indicate more than one teacher-response for that item.

Consultant-use by teachers varied greatly over the two years of the programme. Major areas of use (excluding informal assistance given in the course of discussion) are shown in Figure 9. Most frequent use was made in the areas of in-class assistance and providing activities for lessons on particular topics. The consultant was not used equally by all teachers. Teacher E sought advice for ideas and in-class assistance continually throughout the project. Teachers A, J and K made little or no use of the consultant. The remaining teachers sought advice at regular but less frequent intervals than E, often simply seeking reassurance and confidence-boosting. The 'formal meetings' category included three staff meetings and three meetings with education advisers and project administrators.

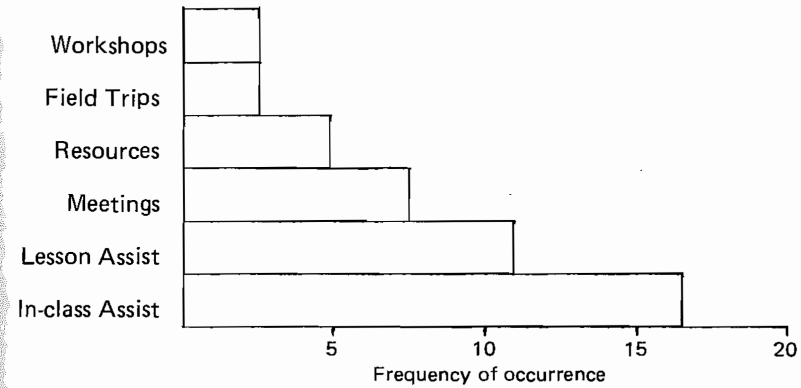

FIGURE 9: Frequency of consultant use by teachers during the project.

Conclusions

Two questions will be discussed here:

(a) to what extent were the aims of the project fulfilled (i.e., the degree of success), and

(b) what factors were relevant in determining the success (or otherwise) of the project.

If we consider the aims outlined in the Introduction, there is no doubt that the project was partially successful. There was an increase in both the amount of material-centred science done and the proportion of physical science topics incorporated. However, only one of the three planned "spiral" topics was treated as planned and, with the exception of teachers D and G (years 1 and 2), there was little evidence of class-to-class collaboration on other topics. With regard to the areas of confidence and expertise, it was obvious that the teachers' lack of confidence was paramount. This confidence lack persisted as teachers identified problem areas which arose and either remained unsolved or were replaced with other perceived "inadequacies". For example, the initial problems of organising and distributing material appeared to be largely overcome with experience, while the later problems of content selection and sequencing remained unsolved. This may have contributed to continued feelings of inadequacy to work a programme independently of a consultant. It seems that the project's framework was deficient in providing avenues for the development of expertise in vital areas. What type of framework, then, would be most sympathetic to the aims of such a project as this? One such framework is outlined in Figure 10.

In order to implement a child-centred, material-based inquiry science programme, a teacher needs to develop competence in a number of crucial areas concerning curriculum judgements and classroom behaviours. These areas are detailed in the upper part of Figure 10. To be completely successful, a project should provide opportunities for education in any of these areas teachers feel inadequate. A second requirement for success is a school personnel which is sympathetic to the aims of the project and which produces a favourable climate for change within the school. There needs to be a committed and aware teaching staff which, in turn, receives administrative support for the project (Figure 10).

Figure 10 provides a basis for identifying which essential components were inherent in the framework of this particular project (asterisked in the figure) and, in turn, those components which were missing. The planning stage of the project provided time for teachers to utilise curriculum resources and select relevant science topics for their respective classes. However, the selection of activities within these topics and their sequencing were left to the discretion of individual teachers and were neither determined nor discussed during this planning period. Likewise, while sufficient materials were purchased for teacher-use, techniques of classroom storage, distribution and organisation were acquired largely on a trial-and-error basis. The important teacher development area of "strategies" was not identified as such in the project framework, though it was perceived by the co-ordinator as an area where consultant advice might be sought. In fact, much effective work in this area was done by the consultant with teacher E, by regular in-classroom interaction and assistance. Effective development with all teachers would have required much more frequent group interaction for identification of strategies,

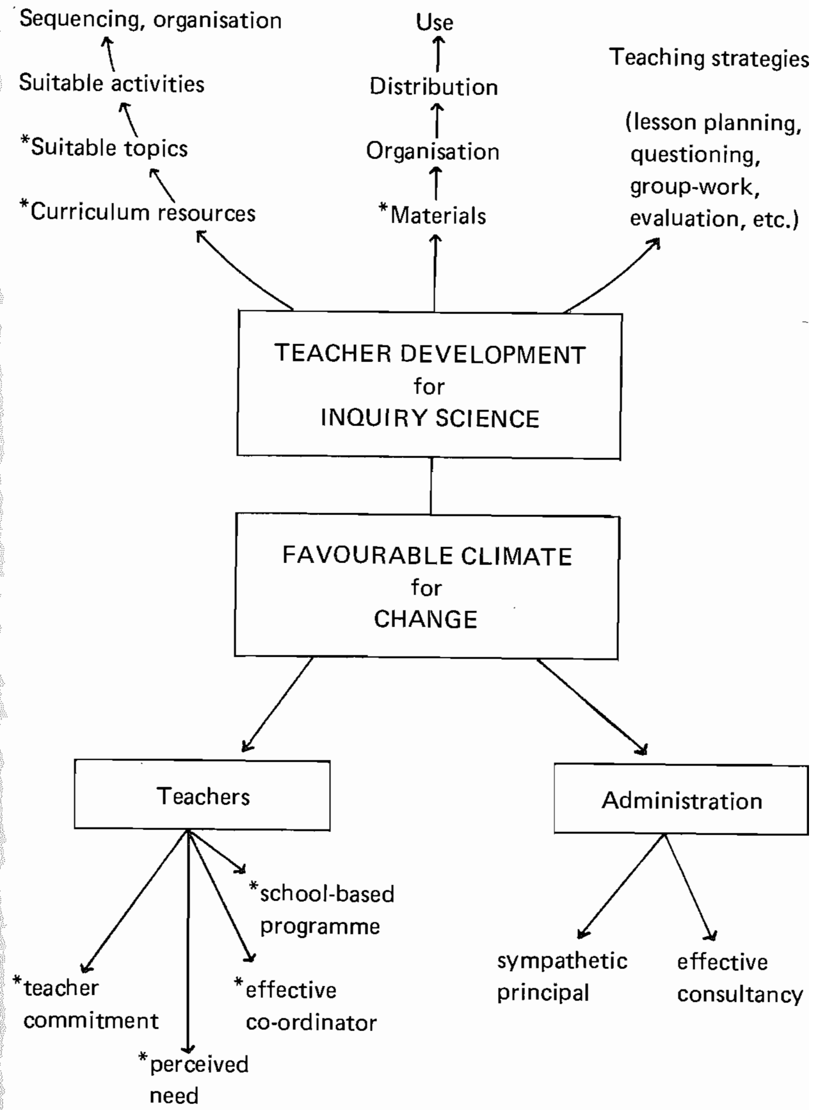

FIGURE 10: Components which might be considered necessary for the successful design and implementation of a school-based inquiry science programme.

* Denotes those areas which were effective in promoting success in this particular project.

feedback and discussion. This could not be achieved without more provision in the school timetable for out-of-class contact between consultant and teachers, hence the need for a sympathetic and aware administration.

The evidence suggests that, at the planning stage, a favourable climate for change existed in the school. Individual teachers felt responsible for their programmes, and there was an enthusiastic co-ordinator within the school to provide impetus and do much of the preparation and organisation needed to get the project "off the ground". Teacher-commitment to the project was implicit in the document submitted to the funding body. However, this proved to be not the case for at least two teachers and, where there was a lowered commitment, the programme was less successful.

The deterioration of relationships between teachers and principal worked against improving teacher commitment. The principal had taken up her position at the beginning of the first year of the project and seemed both unaware of and unsympathetic to the aims of the project. The problems which arose with access to resources and the need for tidiness and quiet in classrooms worsened over the two years of this study. Teachers made allusions to other problems also during this period (e.g., lack of consultation on teaching matters) which suggested a slow erosion of relationships between teachers and principal. As a result, there was a subtle but noticeable decline in teacher enthusiasm generally and hence in the climate for change.

To summarise, we can identify a number of factors which contributed to the degree of success of the project:

(i) The programme was school-based, written by the teachers and co-ordinated within the school.

(ii) The majority of teachers perceived a need for the programme and were committed to its implementation.

(iii) Resources were provided.

(iv) A consultant was available to use as the teachers saw fit.

(v) At least initially, a favourable climate for change existed in the school.

On the other hand, there were a number of factors which were either inherent within the project framework, or developed as a result of the local situation which prevented or hampered the complete success of the project:

(i) The programmes were somewhat over-ambitious.

(ii) Not all teachers were fully committed.

(iii) Teacher mobility meant that teachers new to the school were not familiar with the needs/aims of the programme.

(iv) The project framework did not allow sufficient opportunity for teacher-development in those areas vital to programme implementation and maintenance.

(v) The administration was unsympathetic to the aims and needs of the project.

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