CONCLUSION

This study follows from some of the curricular consequences of The Education Commission, the Report (1964-66) regarding school science education programmes such as introduction of the structure of science at an early stage and chemistry as a separate discipline even from Class VI, the need to go deeper into the content than before, the emphasis on unifying concepts rather than memorization of facts, formulae and process, greater demands on abstraction and conceptualization, and investigatory approaches from the beginning.

The Kerala State Department of Education and particularly the State Institute of Education was very sensitive to these new developments and was one of the earliest to upgrade its syllabi. It was perhaps over enthusiastic in this attempt and its ten-year curriculum and text-books prepared by the middle of
1970's were probably even heavier and more abstract than the then eleven year syllabi of NCERT, evoking protests side by side with the implementation. It is in this context that this investigation was felt necessary - particularly from the point of view of whether the auxiliary conditions such as knowledge of the modern cognitive psychology needed to process an abstract syllabus, the physical facilities, organizational climate etc. needed to introduce investigatory and other modern approaches were available.

Some Major Research Questions raised in this study are:

1. What are the perceptions of Modernization by the participants in Education in Kerala?

2. What is the quantum of curricular upgradation and what is the quality of the conceptual processing revealed in the text-books - in the first phase of upgradation in mid 70's and the second phase of modernization in mid 80's?

3. What are the major facilitations and hindrances - physical, administrative, attitudinal etc.?
Methodology

The two major methods of investigation used are Analysis and Survey. The tools and techniques included:

1. Text-book analysis covering three periods - 60's, 70's, 80's - using a multi-dimensional analytical frame (rather than a precise schedule).

2. A scale of attitude to the modernization of science in schools.

3. A schedule administered to experts (69), teachers (97), and post-graduate students (42) on certain conceptual dimensions regarding modernization of science, hindrances and facilities, regarding certain conceptual aspects of modernization of chemistry education facilitations and hindrances.

4. A questionnaire to teachers (N=240) eliciting factual information regarding facilitations and hindrances.

5. A curricular item rating scale - filled in by 123 experts which included 97 items rated over 9 dimensions.
Summary of Findings

Findings for Analysis of Texts

1. Till the early 1970s, chemistry components could be found in certain units of the General Science texts. They were not adequately integrated, but remained as chunks taken from college chemistry without any clear policy or plan, but skipping the symbolic language. It was largely descriptive, light-weight and even haphazard.

2. By the middle 1970s a major upgradation had been effected in one stroke. Symbolic chemistry was introduced in the middle school, to be taught by teachers who were then illiterate in the chemical language. The high school course opened with particulate chemistry (mole concept, subatomic particles etc.). It was as if CHEM study and CBA fragments had suddenly come down upon children four years younger than the American target group for whom they were originally intended and made more difficult by the experimental and initially inconsistent meta-language in Malayalam. Besides violating the elementary principles laid down by Dewey and Whitehead, it was difficult to defend
this presentation even by the psychology of Ausubel or Vygotsky. The concepts were too 'advanced' and crowded to 'organize'. There has also been a tendency towards over-loading, premature precision, display-oriented experiments which hide the principle.

3. But the revision of the 1970s had the following merits.

(a) It was the first concerted effort to give school chemistry a unity, dignity and independence. Instead of the school modelling itself on the college, it set up a trend which forced colleges to upgrade their syllabus in course of time.

(b) The writers of text-book seemed to have a theory somewhat akin to Ausubel's "advance organizer", or Vygotsky's concept of approaching 'scientific' or 'heavenly' concepts from above (though some essential aspects of Ausubel's or Vygotsky's theory do not seem to have been adequately understood).

(c) The format and the lay out represented an improvement over the earlier books.
(d) Some success was achieved in standardizing the language of chemistry in Malayalam (though there were several dissonances and inconsistencies at the experimental stage).

(e) For the first time, an attempt was made in an Indian state system to introduce the structure of the discipline of chemistry rather than mere descriptive chemistry (but it is largely a verbalized structures, and this structured discipline is attempted in the ordinary school by the ordinary teacher for the ordinary pupil (but the language is extraordinary!).

4. The revision of the 1980s seems to follow the present world trend of adopting up to about Standard 8 integrated and environmental approaches providing a good general foundation. A fairly fast rate of presentation, adopted from Standard 9 onwards, does not appear unduly hurried particularly because of the good foundation, profuse illustration and clear and consistent discourse. If the 70s introduced modern content
into school chemistry the textbooks of the 80s introduce, perhaps for the first time, modern pedagogical approaches, including the curricular rhythms which could gladden a Whitehead or Bruner. However in Standard 10, particularly in organic chemistry, hurried and one-shot approaches are adopted and even some typographical errors were found in the first edition.

**Attitudinal Facilitations and Hindrances**

The mean attitude score of the total sample on a scale intended to measure modernity of outlook in terms of science education is 130.04. The standard error of mean is 0.97. The overall item mean is 3.6, close to the 'Agree' position to positive statements.

The median of the total score is 179.50 and the true mode 178.42. The distribution shows slight positive skew (0.118), which also indicates a favourable attitude.

The mean of men teachers is 183.63 (S.D. = 12.94); women teachers' mean score is 177.05 (S.D. = 14.99). Men have a significantly more favourable attitude to modernization of science education than women (C.R. = 3.34; p 0.1).
Among the sub groups, Experts display the most favourable attitude (Mean=183.52; S.D.=14.85); students come next (Mean=180.69; S.D.=14.76); Teachers show the least favourable attitudes. All the subgroups differences are significant at one per cent level:

- Expert student (C.R.=6.87)
- Student teacher (C.R.=4.65)
- Expert teacher (C.R.=21.24)

Correlation of total attitude score with age was done separately for the teacher group and expert group. For the teacher group (N=97) a positive correlation of 0.182 was obtained. For the expert group (N=69) the correlation was -0.223. Both the figures did not satisfy the test of significance on account of low sample size. But the trend indicated by the direction is interesting.

The advantage offered by the Likert type scale in permitting analysis of individual items was taken and some comparison of the groups of items were made. For this purpose the percentage of agreement and disagreement with each item were noted. (ignoring degree of affect). Among three items relating to curricular
upgradation two general items obtained agreement percentages of 85 and 74. But the specific item "school curriculum should emphasize theoretical concepts" scores 44% agreement and an equal proportion of disagreement.

Among the items classified under Brunerian creed, two relate to curricular upgradation with universalistic. Both the items were presented in the reverse form and got majority agreement. "It is not possible to make upgraded science understood by children from every strata of society even if it is presented well" (Agree 53%; Disagree 36%) "Intricate concepts in science can be understood only by very few pupils" (Agree 53%; Disagree 35%). Other Brunerian items presented in reverse form also elicit responses. "A modernized syllabus cannot be taught by an ordinary teacher" (Agree 56%, Disagree 36%).

But there are two reversed Brunerian items which elicit majority Disagreement responses: "The up-to-date concepts in science can be taught effectively only at post-graduate level" (Agree 27% Disagree 73%) "A modernized science syllabus is unsuitable for the ordinary pupil even if well taught" (Agree 24%, Disagree 66%).
Brunerian items presented positively tend to get majority agreement score. "It is impossible to present fairly advanced concepts in science in a simple manner so that anybody can understand it" (Agree 77%; Disagree 17%) "The fundamental structure of a discipline must be presented in such a way as to preserve some sequence to lead pupils to make discoveries themselves." (Agree 72%; Disagree 8%).

In tradition versus change, the trend seems to be equally balanced. But a 21st century oriented item gets 70% agree and 18% disagree responses.

Essentialist items where the conservative slant is quite transparent get majority Disagreement, but an essentialist item clothed in the respectable garb of disciplinary value elicits agreement. "It is good to teach certain time old ideas, even if they are out-of-date, for their disciplinary value". (Agree 72%; Disagree 22%).

Items representing Intelligent adaptation of ideas from abroad get majority agreement responses.
When life-oriented items are presented in transparent and noncontroversial forms, they elicit high agreement. But the typically pragmatic (reversed) items: "Experience-centred curriculum tends to unsystematic and therefore unscientific" gets 72% Agree and 18% Disagree responses.

The three transparent talent development items obtained very high agreement responses (74%, 83% and 89%). Two items where avoidance of premature selection for talent and compartmentalization got only marginal majority agreement (53% and 54%).

The five positively worded methodology items got majority Agree responses: Learning to learn and independent scientific thinking skills (55%), helping students pursue science studies for themselves (76%), ability to recognize and tackle problem in any situation (78%), Learning scientific laws and concepts from teachers and books and slowly understanding their significance later (positive in the modified advance organizer sense) (59%). This can also be interpreted as a disguised conservative item). The negatively
worded methodology item "Allowing children to do experimental investigations by themselves instead of learning properly from the teachers has been the cause of much indiscipline" gets only 22% Agree and 68% Disagree responses.

In appliances, the progressive stance of non-identification of science with display of materials and costly equipment, generally gets high agreement responses. But an item which strong progressivists and Rousseau would regard as negative, viz., "It is impossible to teach science unless the government supplies to us all the materials, accessories and procedures" gets low agreement response (37%) as against 47% Disagreement.

The idea of consulting different participants in education in the preparation of the curriculum has high agreement response: Practising teachers to be consulted (89%); Panel of really competent experts (67%); Industrialists and applied scientists (63%). Pupil participant was presented in a negative form. "Pupils' reactions need not be taken into consideration in framing the syllabus because curriculum is matter for elders to decide." This item elicited 20% Agree and
66% Disagree responses. Thus the respondents favour consultation with a wide panel of participants in education, including pupils.

**Conceptual Facilitations and Hindrances**

In the exploration of the concept of modernization of school science, "making science more experience-centred" gets the first rank followed by 'developing independent learning skills by pupils' 'using effective methods of presenting scientific ideas to children' and 'developing scientific creativity' share the 3rd and 4th rank.

Among the modernization concepts ranked low by the sample, "frequent change of syllabus" and "adding more content" get the last two ranks. But one or two items with a Brunerian slant, e.g., "giving more importance to the structure rather than the content of the discipline", "bridging the gap between high-level research and the school curriculum" get very low ranks, probably because teachers and even many 'experts' are not familiar with these ideas. Barring this, on the whole, items which a progressive science educator would judge as a modern concept in science education is identified as high by the sample, and those which could be called
reactionary or pseudo-modern get low rank on modernity scaling by the respondents.

The index scores (Max 3, Min 0) of the pooled sample of teachers, experts and students on the rating of certain hindrance factors presented in the schedule reveal interesting findings: on the ranks based on the scores, overcrowded class rooms top the list of hindrance factors, followed by lack of facilities for academic growth and non-specialists in chemistry teaching the subject, lack of scientific knowledge on the part of teachers, lack of instructional materials and out-dated examination system. The administration and social factors have not been perceived very sharply as hindrances. On the whole student group display a higher sensitivity to the hindrance as seen from the mean index scores (Students 1.99, teachers 1.66 and experts 1.69).

Among the facilitating factors, presented for rating, the highest overall rating is obtained by 'The Education Department Organises useful workshops and in-service courses for teachers' followed by 'Agencies like Sastra Sahitya Parishad, Science Society etc. are taking interest in science (Rank 2). 'Teachers are taking the initiative
in upgrading their own knowledge of the content' (Rank 3) 'Teachers co-ordinate with school administrators to improve the school science teaching' (Rank 4) 'A good portion of the teachers have started taking the initiation in upgrading the chemistry syllabus' (Rank 5) and 'Examination system is being improved' (Rank 6).

"Local resources - material and human - are being adequately harnessed for teaching science" is rated last but one as a facilitating factor and 'Parent-Teacher Associations are taking an interest in the upgraded curriculum gets the last rank (20).

Findings from Questionnaire

The majority of teachers of chemistry at the time of survey were third class graduates, with only 37% having obtained second class and only 5% first class.

There was a significant tendency for more qualified teachers to be concentrated in the rural areas, probably contributed by the factor that better qualified teachers tend to get recruited in recent years and that senior teachers tend to gravitate towards the prized urban areas.
About one-fourth of the teachers of chemistry have not taken chemistry as the main subject in the degree course.

About two-thirds of the teachers of chemistry teach the subject as the major workload.

Only a minority of teachers have expressed involvement in science club activities or in other academic type of extra-teaching involvement.

The majority of teachers (51.5%) have stated that their science degree has not at all been effective in coping with the needs of the new syllabus. Only about one-sixth (16.5%) have responded that it has been helpful to cope with all the needs of the new syllabus.

About three-fourths (74.2%) have reported having attended inservice course of some sort, but only about one-third have attended courses of one month and more. The most popular courses are those of 5 days’ duration with 43.8% teachers having attended them. Ten-day courses have been attended by 14.1% and one-day seminar by 28.2% (It is obvious that some teachers represent a kind of seminar culture having attended more than one course).
Various benefits obtained by teachers from the inservice courses have been reported such as 'received up-to-date information' (33.0%), 'revised portions once studied and forgotten' (72.3%), 'received experience in practical work' (53.6%), 'obtained contact with specialists in the field' (44.1%), 'got opportunity to exchange ideas with teachers handling the same subject' (69.3%), 'received materials like books and reference materials' (51.6%), and 'got opportunity to clear the doubts' (58.5%).

The defects noted by the participants are even more significant: "too short" (60.9%), "too long" (6.0%), "too much time spent in supplying information available in the text-book" (36.7%), "much time spent to teach what they already knew" (47.6%), "really difficult concepts not given due emphasis" (56.0%), "difficult experiments not demonstrated" (60.9%), "not given sufficient practical work experience" (65.3%), "too much of unnecessary repetition" (37.5%), "uninteresting" (51.6%), "resource persons unable to clear doubts" (63.7%), "resource persons got angry when doubts were asked" (14.5%), "administrative routine required more time than teaching-learning process" (22.2%).
About one-third of the teachers indicated that they would change their job if they got an opportunity. This tendency of 'non-attachment' to teaching was significantly more among men than among women. Salary dissatisfaction was also more among men than among women.

The sensitivity to environmental potentiality is very low, and the proneness to exploit them for education even much less.

Though the presence of a laboratory in the school is reported by 89% of the sample, the 'laboratory' generally means nothing more than a demonstration table and some apparatus and chemicals kept in locked almirahs. It is evident from the fact that only 17.7% of the 'laboratories' have water supply, only 18.9% have a sink and none have gas supply. Only 2.8% have replied that they have equipment sufficient to demonstrate all the experiments required according to the new (1970s) syllabus. Even by the old 1960s standards less than half (43.5%) had the necessary equipment.

Nearly 90% of the respondents report the presence of a science club in their school. Most of the schools report a club strength of 40 to 60 pupils. The activities
reported include: exhibitions, field trips, debates, seminars, improvised aids, science projects, models etc. There is reason to believe that in many schools the activities are routine and sporadic (with a live period around the time of the District/State Science Fairs). But a minority of science clubs do have regular activities. The Sastra Sahitya Parishad also helps school in such activities. Men teachers are more sensitive to this kind of help than women teachers.

Useful reference material is scarce in schools. The Encyclopaedia is 'available' in about half the schools, but usually it is kept in glass case in the headmaster's room, more for exhibition than for use.

The majority (60.9%) report getting text-books in time. About two-fifths have reported that kits and laboratory supplies are received in time.

Among various innovation-encouraging agents, about three-fourths have checked the headmasters, about two-fifths have checked their colleagues, about three-fourths have indicated pupils, about one-fourth have identified parents and administrators, checked by a little over 30 per cent. The Sastra Sahitya Parishad
is specifically mentioned as an innovation-promoting agent by a few men teachers. The science magazines brought out by the Parishad in Malayalam, viz., Sastra Keralam, Sastra Gathi and Ürika (Eureka) are useful reading materials for both pupils and teachers.

Ratings of Curricular items on certain Facilitation Hindrance Dimension

Ninetyseven items in the chemistry syllabus were rated carefully by experts on nine dimension (six alone analysed and presented).

On the aspect of Difficulty (for pupils) 13 items were rated as very easy. Most of these items (except chemical bonds) are of a descriptive nature. Seven items were rated as easy. Most of the items were of a conceptual nature, though not of an abstruse type. The mole concept, the gram atom and gram mole, and calculations involving the mole concept are rated as difficult. No item has been rated as very difficult.

In the dimension 'Teacher's Mastery' no item has been rated as difficult or very difficult. Most items have been rated as Easy or Very Easy. Six items are rated as of 'Average Mastery'. These include chemical
calculations, mole concept, radioactivity, passage of X-Ray and γ-Ray, electroplating and discharge of ions.

The pupils' Difficulty ratings and Teacher Mastery ratings were combined into a conceptual Dimension rating. Under this, none were difficult or very difficult; 46 were of average difficulty; 36 were easy and 15 were very easy.

Under the dimension, 'Applicability to Life Situations', 16 were rated as very much applicable. Many of them relate to solution. The others are electrolytic dissociation, electrolysis, acids, bases and salts, manufacture of metals/compounds, effect of temperature/pressure/catalyst on rate of reaction. Nine items were rated as 'Applicable'. These included some solution items, density (relative density), diffusion of gases, purification of metals and manufacture of non-metals. The vast majority of items were rated as moderately applicable. Twelve items were rated as having low applicability. Two of these relate to history of chemistry and the others pertain to theoretical chemistry. Those rated high on Application are of a practical or descriptive nature. Under Availability of Environmental Resources, 12 were rated as very much available. Most of the items were related to solutions. Two related to
rate of reaction. Fourteen were much available: Diffusion, many solution items, dissociation, electrolysis, energy charges, thermo chemistry, slow and fast reactions come under this category.

The above two ratings were combined into a single Environmental Dimension. In the combined category, 11 are very high in the environmental availability. Of these, except 'influence of catalysts on reaction rate', all are solution-related items. Eight items are rated as highly available in the environment. Of these, four are solution items, two are electrolytic items. The others are volume-temperature relation, diffusion, and Acids, bases and salts. The two items rated very low in this dimension relate to the past - History of chemistry. The twelve items rated low are either of a theoretical nature or those involving costly equipment, or natural process not directly visible.

Under procurability of instruments, two are rated as very difficult, six as difficult, 58 as moderate and 32 as easy. Nine items are rated as easily procurable. Of these eight are related to solutions and the other is influence of catalyst on reaction rate.
Under Feasibility to do Experiment, ten have been rated as Quite Feasible. Eight of these relate to solution. The others are Acids, bases and salts and effect of temperature and pressure on the rate of reaction. Eighteen items have been rated as feasible. Seventeen items have been rated as 'not feasible'. These include either highly theoretical matter, or those that involve costly equipment. Four items have been rated as 'not at all feasible'. Of these the two history of chemistry items have, understandably obtained a zero score. The chemistry of earth, the planets and the stars gets a rating of 0.25, and the effect of concentration of reactants on reacting rate (0.38) (Minimum score 0-Maximum -2).

The last two ratings were combined into a single Practical Work Dimension. In this combined category, 8 items were rated as 'very practicable', 16 as practicable, 7 as practicable, 2 (historical items as totally impracticable) and others as moderate.
Some Recommendations for Action

1. Some of the defects in the text-books of the 70s such as overloading premature precision, lack of curricular rhythm etc., seen in the text-books of the 70s have been corrected in the books of 80s so far as general chemistry is concerned. But the books of the 80s have committed in organic chemistry the same type of defects which were earlier found in general chemistry, though in a lesser extent, these need to be corrected.

2. So far a general chemistry is concerned there is an impression, that the chemistry sequence from classes six to eight seem to proceed at a very leisurely pace followed by a sudden transition to the disciplinary approach in Standard IX. Perhaps the introduction of a little more progression in chemistry in Standards VI to VIII would have been in order.

3. Though the chemistry of the basic science of Standard VIII appears as very light as compared to previous text of Standard VIII or the present book of Standard IX, the formal and verbal treatment of the topics by the teacher makes it less time consuming.
Many teachers read the text books or tell the content and complain that there is not enough work to do for the year. In fact the treatment of certain aspects like acids give plenty of scope for school-based and even home-based experiments and investigations. If these are approached in this way not only will administrators will be satisfied that enough time is spent on teaching science, but a firm experiential foundation would have been built on which the formal and conceptual treatment of acids and other things are taken up in the higher classes. Approached in this way children could appreciate the majesty of the spiral curriculum.

4. The complaint in Standard IX about the heaviness of the curriculum is largely because teachers have not been trained to process conceptual science. There is not much difference in the way teachers present descriptive chemistry and theoretical chemistry. Hence inservice courses for teachers should include the method concept processing and cognitive psychology.

5. There does not seem to be any one in State Institute of Education, NCERT who seems to be aware of this concept processing. None of the booklets published by SIE relate to these aspects. In the NCERT itself the number of
people who seem to be aware of these techniques are very few and probably there is none or at the most a handful in the Departments of Teacher Education and Science Education. Mass teacher orientation programmes started after the NPE was launched but in all effective systems a lot of silent and deep work and understanding dialogue precede the wider diffusion of the processing models. The number of people who understand Piaget, Bruner, Ausubel and Gagne are very few and the number who applied to curriculum are even fewer. There are however some very profound sensitive and relevant remarks in the National Policy of Education. A lot of quite scholarly dialogic and pragmatic work has been done instead of the display oriented and cock-sure approaches in mass orientation programmes.

6. There is reason to believe that teaching models have been diffused on a fairly wide scale particularly among teacher educators. But it would appear that many of these model are really organic grams transferred from American books to Indian Blackboards, occasionally modified by Indian experts. Such models would make sense only if backedly relevant episodes.
Though the overall attitude to modernization of science is favourable, such global affect is often of a spectorial nature and does not easily translate itself into practice. The analysis of individual items of the Likert type shows that the idea of consulting different participants in education in the preparation of the curriculum has high agreement response. But in practice such consultation is of a very limited nature. Hence effective steps must be taken to set a foot a dialogic process which alone can ensure progressive correction and improvement in the curriculum.

Another factor emerging from the analysis of individual item is that attitudes in relation to statements reflecting a very modern stance such as the Brunerian items evoke negative responses. This analysis of the attitude — understanding complex suggest that many teachers and even experts are not appreciative of the honest forms in which highly abstract subject matter has to be presented to children. They seem to be insensitive to the sufferings of the ordinary child in the ordinary school taught by the ordinary teacher
when highly abstract matter is taught in 'dishonest' verbal forms. Hence the really modern ideas regarding science education and sensitivity to progressive approaches should be developed not only in the teachers but also among the experts at the highest level both in State Institute of Education and in National Council of Educational Research and Training. This cannot be achieved by mass orientation programmes developed overnight by people who have themselves not seriously studied modern developments in science education in theory and practice. Experts should stop posing as omniscient and start with the stance that there are several things which they have to learn and continue to learn. So a concerted and collaborative programme of self education has to be initiated for the experts as well as the teachers.

The concept of "bridging the gap between high level research and the school curriculum" and that of "giving more importance to structure rather than the content of the discipline are rated very low by the sample as indices of modernization. The only solution to this problem is for highly qualified scientist to directly work with young children and collaborate with school teachers to bridge this gap and to explore how the
structure of the subject would emerge in the lower classes. Since the latest chemistry books in Kerala schools have been written by a very highly qualified scientist, who has also presented the ideas very clearly, this ideal has been partially realised. But there is a tendency to stop the collaboration at this point, with the result that an excellent text book is misused by many teachers. Hence the scientist-school collaboration should extend further and be carried over into the preparation of detailed curriculum materials and even in teaching, on the models set by Seaborg, Pigmental and others.

'Overcrowded classrooms' has been ranked first among the hindrances. Overcrowded classes lead to 'indiscipline' or rather 'disorder', especially with inexperienced teachers. Even the more experienced teachers also tend to maintain 'discipline' by the use of passive methods. Scientific matter communicated through such methods does not constitute genuine science. The problem is how to activate and introduce investigatory processes in a large class. Plenty of foreign experiences are available for such adaptation to difficult situations. Some available studies on
multiple class teaching (like those of Goel, NCERT, 1985) and group techniques (like the Group Project by Headmasters in Coimbatore, 1964) are interesting indigenous efforts. Actually there is nothing highly technical or extraordinarily difficult in such approaches. What is required is concern for the pupils studying under difficult conditions, some degree of flexibility, ability to shift between different groups and give attention to the needy, permissiveness to allow pupils to work on their own, receptivity to new ideas emerging from pupils or from the situation, willingness to tolerate some amount of healthy 'confusion', and ability to quickly restore order when total group task is about to commence. Cases are not unknown where extremely sensitive teachers working with innovative group of children have landed in Brunerian or Schwabian modes of operations even without any explicit theory. If in such a situation an educational consultant with a clear understanding of modern science education theory, ability to recognize such theory in its practical operation and willingness to give credit to the innovating teacher could interact, a clear case of reconstruction in the Deweyan sense and cumulative self-corrective
progression can emerge. Only then could we be said to have begun the task of inservice teacher education in science, which on the co-researcher model would also be a case of inservice education of resource persons.

Among the facilitations rated by the sample the highest goes to 'The Education Department organizes useful workshop and inservice courses for teachers'. From the externally visible, quantitative point of view this could be quite true. The SIEs/SCERTs were founded for this purpose. If only the internal, continually self-correcting and dialogic dimensions could be built in it would be ideal. That the ideal situation has not been reached, or perhaps not even been approached, would be obvious from the replies received with reference to the teachers' questionnaire. While some benefits are recorded, serious shortcomings of the workshops are also recorded by a large percentage.

The interest taken by agencies like the Sastra Sahitya Parishad and Teachers' initiative in improving their own knowledge get the second and third rank among facilitations. These touch internal factors
which could be generative. If such self-initiated work is appreciated and quantitatively oriented programmes built on these we would have genuine models of inservice education.

"Local resources - material and human - are being adequately harnessed for teaching" is rated last - but one among the facilitating factors. From the teachers’ questionnaire also it is seen that environmental sensitivity and utilisation of the environment by the teachers for science education is very low. This calls for a genuine, interacting environment based environmental education - not the type of environmental education in which experts come armed with paper packets and modules rather than relying on investigating and mentally instructing the actual environment - according to certain disciplinary and interdisciplinary structures.

The science club seems to provide a set of scientific activities and even investigation for a limited number of pupils. This base should be widened. During science fairs, apart from the few prize-winning entries, a large number of students do make science exhibits of some sort. Even if these are fed back into the teaching situation, instead of relying only on their display value - there can be some improvement in science teaching.
Suggestions for Further Research

1. This study has a survey aspect. Though some of the tools prepared for the survey are of an unconventional nature, breaking new ground, they have been administered to a limited sample. A follow-up study conducted with more refined tools on a larger sample could be useful.

2. Many of the tools were constructed with the textbooks of the 70s as the reference point. The texts of the 80s are a vast improvement over the earlier texts. But they also seem to have some defects, especially with reference to distribution of curricular load between the classes, treatment of organic chemistry etc. Hence it would be necessary to prepare tools with reference to this new framework and conduct a new study.

3. The new concept of curricular research, especially with reference to conceptual processing, dialogues in the classroom etc., as popularised by Fenshaw, Lyback, White and others need to be conducted afresh in India. The time has not yet come when such studies can be considered as 'safe' at Ph.D. level. At the first
instance such studies should be undertaken as group projects by very competent scholars.

4. With reference to the concept processing studies, the major role has been played by cognitive psychology, as represented by Piaget, Bruner, Ausubel, Gagne and others. More recently applied linguistics is also playing an increasing role in analysing pathways in classroom transactions. Such studies need to be popularised in India. The problem is more complex here since the Indian languages are very different in lexical, morphemic and syntactical structures as compared to English and other European languages. A pioneering study has been conducted by Radhamany with reference to the linguistic analysis of the Textbooks in chemistry (Malayalam) version. But then she has touched the most recent books only incidentally. And studies like pathanalysis are totally lacking.

5. This study reveals very high environmental insensitivity on the part of teachers. In botany Examenal’s study on “Construction of certain models for teaching botany using ethnic and environmental resources and testing the efficacy of such models”
has broken new ground by developing sophisticated models of restructuring environmental and culture based knowing long lines that can be preparatory to or even part of the discipline of botany. It would be worthwhile in attempting similar models in chemistry also.

6. The practice of diffusing innovation 'from above' with NCERT and SIE/SCERTs as wisdom-emitting agencies has now become a standardised practice. But apart from the fact that very little research on the lines of Fensham, Kornhauser, Gardner and other chemistry educators have been done by these agencies, their documentation of relevant research studies abroad, especially with reference to the science concept processing side with young children, and the diffusion of what documentation exists among those involved in decision-making in science education does not seem to be extraordinarily strong. Hence

(a) Effective documentation of such relevant studies in science education should be systematically undertaken by NCERT, SIE/SCERT's, Universities and others concerned, and a networking system of relevant information must be developed.
(b) Fresh studies should be conducted in our setting on aspects like 'task-analysis', 'exploring the honest forms in which abstruse concepts can be taught to young children' etc. Such students call for co-researcher and participatory research models, and the contributions of the participating teachers should be acknowledged.

(c) The innovations already being conducted by agencies like the Sastra Sahitya Parishad should be documented, pooled and acknowledged and networking systems developed.

7. The type innovation-diffusion systems adopted in the country are such as to give rise to several distortions. These should be analysed on the lines adopted by Miles (ed.), so that effective steps can be taken for inducing health into the whole system.

8. The final draft of the New Policy on Education has several profound concepts such as refining sensitivities and perceptions, developing a scientific temper and independence of mind, network arrangements between different institutions in the areas of
research and development and education in science and technology, environmental conservation, energisation of the cultural creativity of the people science education reflecting the spirit of inquiry, creativity, objectivity, the courage to question, and an aesthetic sensibility. These cannot be achieved by gullible, uninformed, quickly baked models of mass orientation of teachers. An equally profound model of research encompassing interdisciplinary science transaction, in-depth analysis, cognitive psychology, applied linguistics and even philosophy of science education should be undertaken to match the lofty sentiments expressed in the New Policy on Education.