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Research in Science Education

A TREND REPORT

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Science education occupies a very eminent place in curriculum both at school and university stages of education in India. Continuous advances in scientific and technological research has led to the growth and greater application of science in contemporary society. Accordingly science becomes a priority area in education, both at the compulsory education level as well as the level of specialization. Science education is supposed to perform a two-fold task. The prime objective, in individualistic perspective, is the cultivation of a scientific temper, which includes a spirit of enquiry, a disposition to reason logically and dispassionately, a habit of judging beliefs and opinions on available evidence, readiness to reject unfounded theories and principles, the courage to admit facts, howsoever, unsettling or disagreeable they might be, and, finally, recognizing the limits of reasoning power itself. It is also expected of science education that it would give individuals a firm grasp of the concepts and processes of science and impart to them the ability to use the scientific method of problem solving and the techniques of observation and experimentation in handling problem of comprehension or life. At the societal level, one of the major objectives of science education is to equip individuals to participate in the creation of a society which is free from poverty, hunger, disease and evils such as violence, exploitation, oppression, etc.

Researches in science education have to be reviewed in the context of these aims and objectives. In the world of today where knowledge is being multiplied exponentially, science education will not be able to justify itself by remaining merely contented with the objective of imparting a certain quantum of scientific knowledge, however large be the quantum. Since the rate at which knowledge in science today gets obsolete is very high compared to that in the forties or fifties, it is essential that the emphasis of science education should be on the development of abilities and dispositions of mind rather than merely the transfer of dead subject matter. This analysis might find acceptance among educationists and researchers in education but it is not enough, perhaps. Research in science education should be urgently addressed to the problem of developing a scientific attitude in the educand. Intensive studies will have to be directed towards this fundamental aspect of science education. What does the scientific attitude consist of, precisely? How can it be assessed accurately? Which strategies are most appropriate to inculcate the spirit of science in students? What steps should be taken to ensure that the attitude of scientific enquiry is applied also to extra-scientific domains, including questions having socio-psychological import? Research in science education awaits answers to these questions.

Thus science education, if properly conceived, should primarily be concerned with the education of the mind rather than acquisition of isolated pieces of scientific knowledge. Consequently, the vital aspects that should engage the attention of researches in science education consist in identification of these abilities and the ways and means to develop them among the younger generation.

Turning now from what is required to what has been and is currently being done, Table 15.1 gives the quantitative distribution of studies—surveywise and themewise.

Table 15.1

SURVEYWISE AND THEMATIC DISTRIBUTION OF RESEARCH IN SCIENCE EDUCATION

Sl. No.	Area of Science Education	Survey I	Survey II	Survey III	Survey IV	Others	Total
1.	Science Education	1	-	1	3	2	7
2.	Environmental Education	-	-	5	3	-	8
3.	Science Curriculum & Textbook Evaluation	1	4	4	18	2	29
4.	Scientific Attitude and Aptitude	-	1	4	6	3	14
5.	Creativity in Science	-	-	5	-	2	7
6.	Construction of Tests in Science	-	1	4	3	1	9
7.	Correlates of Achievement in Science	2	-	6	13	5	26
8.	Science Teaching	1	2	20	16	11	50
	Total	5	8	49	62	26	150

The figures include researches in science education based on a multiple-classifications system. If unilateral classification is followed, there will be only 101 studies.

SCIENCE EDUCATION

Pioneering researches have been conducted in science education to give a synoptic view of the trends. Veerappa (1958), for the first time, conducted a study to examine the position of science education in India and assessed the developing trends on the basis of observations in the USA, UK, etc. The feasibility of introducing these trends in Indian institutions was also investigated. He found that teaching science through Herbartian plans, the lecture demonstration method, and essay type questions in the examinations were the then trends. Barman (1983) studied the origin and development of modern science in pre-independent India while Sharma (1984) studied school science from 1947 to 1977. The journey has been from teaching science through the integrated or concept approach, shifting from general science to separate subjects and inclusion of environmental study programmes. These studies have highlighted the various shifts in the development of modern science curricula. The development of science education in the states has been studied only by Bhattacharya (1979) in Assam and Meghalaya and Sharma (1982) in Bihar. The former study is quite comprehensive and includes school teaching, teachers, scientists and educationists, colleges and their science teachers and even examination results in arts and science, while the latter study is confined to school-level students, teachers and teacher educators. Science education in secondary schools in Bangladesh and Nepal is studied by Aziz (1984) and Bajracharya (1986) respectively.

ENVIRONMENTAL EDUCATION

The study of environment by researchers in science education is quite a late phenomenon in the history of Indian education. Studies related to environment fall in two categories. For some, the environment has relevance as the approach to learning while for others it is important for its content as a subject of study in itself. The first study in this line was done by Exemmal (1980) when teaching through different models, the environmental approach was tested for its efficacy. In this study, six topics from the botany syllabus of standard IX were selected for construction of teaching models and tested for their efficacy through a parallel group design. The results were very encouraging. The environmental approach was found to be superior to the formal approach; besides this, a unique finding was that students of rural and low SES groups were significantly better in profiting from such instruction than their counterparts in urban areas and coming from high SES. Also, the environmental approach stimulated cognitive growth in pupils. Deopuria (1984) also compared the traditional and environmental approach and had very similar results. He found that primary students did better through the environmental approach than did middle and secondary level students. Also, both male and female teachers showed a positive attitude towards the environmental approach to learning. Joshi (1981) found that environment outside the class is potent enough to initiate learning, and hence environmental education should be considered essential at least at primary level. Unfortunately, teachers and syllabus are responsible for limiting the growth of this approach.

While preparing a curriculum in environmental studies at college level, Pai (1981) also found that the experimental group gained more than the control group in environmental activities. Also the students perceived clearly and vividly their environment and environmental problems.

Gupta *et al.* (1981) studied the awareness of environment among rural and urban schools and non-formal education centres with the help of 20 rural, 35 urban and 60 non-formal centre students of class IV. It was found that school-going rural children did better than the urban sample. Also, non-formal centre students were more aware than urban students. In this study, the components of environment in which students of these three groups were lacking or were well acquainted were also identified. Mishra (1982) studied the effect and relationship of home and school environment on scientific creativity. The home environment (permissiveness, nurturance, reward, punishment, conformity, control rejection, projectiveness, deprivation of privileges and social isolation) and school environment (creative stimulation, congnitive encouragement, acceptance, permissiveness, rejection and control) were found to have a significant effect on and relationship with the scientific creativity of 197 students of class XII (medical group) of U.P. studied for the purpose. The Central Regional Centre (1981) not only ascertained the local environment and developed study material for students and teachers relevant to local environment but also trained teachers, implemented the programme in selected schools, evaluted it and got encouraging results. The SCERT of Andhra Pradesh (1980) compared the old and new science curricula in environmental studies of classes III and V and found that the new curriculum relevant to the environment was more effective.

SCIENCE CURRICULUM AND TEXTBOOK EVALUATION

There have been quite a number of studies in the area of curriculum and textbook evaluation in India. However, research on foundational aspects of curriculum, the determinants and motives of curriculum, are almost wholly lacking. Most of the work is on either the development of science curriculum or evaluation and analysis of curriculum, particularly textbooks. Only Vashishtha (1986) analysed biology's position as a discipline from a philosophical standpoint. Mechanistic and organismic viewpoints in biology were studied for their origin, development and the present stand besides their 'trace' or application in education. Kelkar (1950) developed a curriculum for general science for secondary students, Bhartendu (1976) on a discovery-oriented approach, Uppal (1977) on science for secondary schools, Pai (1981) on environmental studies for college students, Joshi (1981) on an environmental approach for primary classes, Muttaqui (1981) on biology for secondary schools of Bangladesh, Mian (1983) on science and agriculture science for teacher training colleges of Bangladesh and Ramesh (1984) developed an objective-based curriculum in science for high school students.

Regarding evaluation of curriculum, Singh (1985) evaluated the courses, objectives and methods of teaching, i.e. the overall curriculum of biology through a survey in UP; Krishnan (1981) studied Kerala and Tamil Nadu science curricula through logical analysis and ratings from specialists; Goyal (1982) compared the curricula of the Rajasthan Board of Secondary Education and the Central Board of Secondary Education; Arora (1986) validated the science education curriculum for developing instructional competence at B.Ed. level; Brahadeeswaran (1986) analysed the effectiveness of chemistry curriculum of polytechnics; and Khalwania (1986) tested the effectiveness of a concept-based science curriculum in developing some skills for high-school goers. The MSBTPCR (1974) conducted a survey to get the opinion of primary teachers on science and mathematics syllabi. Uchat (1982) collected the reactions of students and teachers to science syllabi of class XII.

The SCERT of Andhra Pradesh has done work at the institutional level in the area of science curriculum evaluation. The SCERT (1980 and 1982) evaluated the in-service training of secondary schoolteachers in science-teaching courses of colleges of education with respect to its content, method and improvization of techniques. The same institution (1981) evaluated the UNICEF-aided science and mathematics pilot project scheme for classes VI and VII. The SCERT (1980) and Natarajan (1983) evaluated the district-level science fairs and educational exhibitions. In all these studies the reactions, practices and the understanding of the students, teachers or parents were quantified.

Joshi (1979) developed an edit code for evaluation of school science textbooks, particularly with the help of content analysis data. After that only a few textbooks of science have been evaluated. The SIE of Orissa (1979) evaluated an NCERT science textbook for class III and the SIE (AP, 1980) evaluated textbooks of environmen-

mental studies of classes III and V. Mukhopadhyay (1983) evaluated the comprehensibility of language used in science textbooks at primary level in Rajasthan. Roy (1988) also evaluated general science textbooks for high schools of Bangladesh.

Two studies were different from the above studies area-wise. Patel (1976) developed chapters suited to different levels of readability while Menon (1986) studied the Gujarat Science Education system from the angle of the process of science enquiry. He fixed the norms of development of the process skill of scientific enquiry among students through a multi-cross-sectional survey, studied the overall impact of the curricular system on the development of process skills of scientific enquiry and examined textbooks of classes VIII to XII from the point of view of evaluation and instructional practices.

Discussion about researches in science curriculum will remain incomplete if some recently published, thought-provoking curriculum development work of NCERT and its programmes are not mentioned, even though they may not be research studies. The special character of science in the first ten years of school, i.e. in general education, was discussed in detail by Bhargava (1979). Efforts were made to partially reflect such thinking in the NCERT-produced Upper Primary Science Curriculum which was developed between 1975 and 1978. But, in general, the science curriculum remained loaded with facts, figures and data and was oriented only towards the examination. The development and transaction of curriculum at national and state levels continued to remain divorced from the objectives spelt out for science education. In the years 1981–83, the Department of Education in Science and Mathematics undertook in-depth studies and the actual state of the art science education was identified in detail. On the basis of these findings, in the year 1985, the Department of Education in Science and Mathematics of the NCERT presented an approach paper in a National Seminar which was organized to discuss the New National Policy on Education. The new policy was finalized in 1986. Immediately after the coming of the New Education Policy, the NCERT set up a Working Group. This working group discussed the findings of the Department of Education in Science and Mathematics of the NCERT. In its report, the working group spelt out the dimensions of scientific literacy, which need to be attained through the study of science in general education. On the basis of the report of this working group, a national-level meeting of voluntary agencies was held in 1986 to spell out the steps to be taken for improving science education. In the light of recommendations of this meeting, the Department of Education, Ministry of Human Resource Development, introduced two projects: (1) a Scheme for Improvement of Science Education in Schools, and (2) a Scheme of Environmental Orientation to School Education. In addition, to improve the textbooks on science and mathematics, an advisory committee was set up and a writing team for each class was set up which included subject experts, teacher educators, voluntary agencies, teachers associations and NCERT faculty members.

Bhargava, between 1981 and 1987 gave thought-provoking views on the existing state of science teaching, the requirements for higher studies in science, the objectives of science in general education and the constraints on effective implementation, Ganguly (1986) gave a detailed account of integrated science development in India; Hijam (1986), through a district-based survey, showed how carelessly science curriculum was implemented. The findings of Hijam were probably true for the whole country. The study by Ghosh (1985) on the teaching of biology is undoubtedly interesting. The latest developments in environment education were mentioned by Ganguly in 1986 and the linkage of science with daily life situations was discussed in Ganguly (1987).

SCIENTIFIC ATTITUDE, APTITUDE AND INTEREST

Unfortunately, so far there has not been a single study on the nature and concept of the scientific attitude. Maybe this is because educational researchers have left this area to scientists. Sood (1974) studied the attitude towards science and scientists among students and teachers and found the understanding of science positively related to it. Srivastava (1980) also measured scientific attitude and found that the amount of scientific knowledge or general exposure to science courses made an impact on scientific attitude.

Saxena (1985) found that science students have a favourable attitude towards physics and this attitude to physics is correlated with a cognitive preference style of recalling while it is negatively correlated with application style. Shinde (1982) found that the scientific attitude of secondary school children is not related to involvement in non-formal activities. In this study the scientific attitude of boys and girls did not differ whi-

that of different regions differed. Bandopadhyay (1984) found that parent education and SES led to favourable attitudes towards science, besides other contributory factors like teacher's influence, peers' influence, vocational value of science and the future aim in life. Ghosh (1986) also found that, while boys and girls did not differ on scientific attitude and aptitude, there was a positive relationship between scientific aptitude, attitude and academic motivation. Sarah (1983), Srivastava (1983) and Yadav (1987) also studied attitude and achievement.

Giri (1976) measured the aptitude for physics in the high school seniors of Bihar through a battery of tests. Ganguli *et al.* (1972) validated a Scientific Knowledge and Aptitude Test. Chatterjee *et al.* (1972) found that there was a high degree of correlation between biographical factors and achievement in and aptitude for the technical stream. Mitra *et al.* (1978) found that scientific interest was highly related with probabilities of success in the higher secondary course. Raveendranathan (1983) found that Engligh-medium schools had higher interest in science than Malayalam medium students.

CREATIVITY IN SCIENCE

Creative students and particularly, creative science students have always been a subject of curiosity for researchers. However, only a few studies have been done, those too quite lately, only after 1979. There should by now have been a good quanta of work on creative children's thinking, learning and working patterns, but only Rai (1982) has studied the process of problem-solving in creative science and non-creative science students. Two groups of creative and non-creative students identified by the Creativity Test of Mehdi, totalling 200, of Patna were tested on problem solving in the same conditions. It was found that creative children needed more tasks as assignments in their curriculum. Jhag (1979) studied the personality correlates of creative children on 700 students of Bhopal Division and found that scientific creativity was normally distributed and urban students were better in it. Creative children were found to be better in abstract thinking, emotional stability, independence, self-sufficiency, self-concept and intelligence, and were more venturesome relaxed, controlled and doubting. Mishra (1982) found that home and school environment had a significant positive relationship with scientific creativity. Bhadauria (1980) found that the gifted students had better creative potential (on verbal and literary problems), creative production, originality, adjustment and spontaneous flexibility, and positive self-concept than non-gifted students. Gupta (1980) standardized a test of creativity in the physical sciences for secondary students. Sharma (1986) studied low, average and high creative physics students on certain instructional media and learning tasks, while Talegaonkar (1984) developed the teaching strategies to encourage students to solve problems in science creativity. Singh (1987, 1988) discussed measurement of scientific creativity in the Indian context. The process-based teaching of science was an important concern to all who were connected with the teaching of science at primary level. Several aspects of process-based science teaching were discussed by Goel (1987, 1988).

CONSTRUCTION OF TESTS IN SCIENCE

Construction and standardization of achievement or diagnostic tests started quite late in the field of science education. It was first attempted by the SCERT (1971) of Andhra Pradesh, followed by Rawat (1976), Sali (1977), Khandewale (1981), Gadkari (1982), Ansari (1984), Verma (1986) and Banmalidas (1987). Of these, Rawat (1976) and Verma (1986) constructed diagnostic tests while the rest constructed and standardized achievement tests. All these tests were constructed in physics, chemistry or general science, but not in biology. The sample of these studies varied from 250 to as many as 6130 (Sali, 1977). For performance, researchers measured it through percentages, stanines, Z scores, T scores and reliability was measured by different reliability coefficients. In the separate study, Sethia (1972) also diagnosed a few low SES students and conducted remedial teaching.

CORRELATES OF ACHIEVEMENT IN SCIENCE

In the area of correlates of achievement in science, the rate of research is steady but diverse. So there are studies on the psychological structure of the learners, different SES groups, teaching methods and styles, medium of instruction, urban and rural settings and their relationship or effect on the achievement of the students. No doubt, many of the researches clarify and verify common myths and beliefs about factors related to achievement, through systematic and scientific studi-

but still, many a time just commonsense facts are 'verified'. It is a commonsense observation and philosophical and sociological analysis as well help us to arrive at the facts that, in the context of modern curricula, by and large, an urban student ought to achieve better than his rural counterpart; an intelligent, psychologically able student with a favourable attitude to science, learning through the English medium and activity-oriented methods will perform better than a less intelligent, mentally less able, Indian-language-medium student, learning through teacher-centred methods. This is the gist of studies conducted by Banerjee (1972), Das (1975), Chatterjee *et al.* (1978), Joseph (1979), Pal (1982), Bhargava (1983), Sarah (1983), Singh (1983), Chhikara (1985), Raj Rani (1986), Sontakey (1986), Mehna (1986) and Singh (1983) on psychological aspects; Pathak (1972), Sharma (1975), Yadav (1984), and Ghosh (1985) on socio-economic aspects; Pandey (1981), Mishra (1982), Tripathi (1982), Shinde (1982) and Agnihotri (1987) on curricular aspects; and the SIE, Maharashtra (1971) and Raveendranathan (1983) on the language aspect of achievement. Raju (1982), however, adopted a different approach and found that cognitive and effective outcomes of students were not only overlapping but also interdependent. Khanam (1983) related students' performance with personality types and instructional design for concept and rule learning. As expected, the tools in these studies ranged from psychological testing of abilities to survey through questionnaire and interviews and parallel group design experimental studies, besides achievement tests and scores.

SCIENCE TEACHING

In the area of science teaching there are basically two types of studies. One type, which can be termed as status studies, pertains to the survey of the present state of teaching of science subjects at different levels, while the other type is related to the experimental verification of the effectiveness of different methods or strategies of teaching. Except for Adinarayan (1984) who judged the status of science teaching in primary schools of Tamil Nadu through a parallel group design of experimental method, the rest of the studies in this sub-area relied on questionnaires and interview schedule or, in one case an achievement test (Swarnamma, 1978) besides the opinionnaire. Patole (1967) studied the teaching of science in rural primary schools through an extensive survey of 100 schools, 550 teachers, 550 elementary teacher trainees, 2000 pupils and 200 rural family heads and found that primary science teaching was in a miserable condition. Science was taught as a part of social science; the teachers were not qualified; in standard I, the teacher handled as many as 73 students; only 10 per cent of the schools possessed complete science equipment and none of the schools had a separate science room. Then Swarnamma (1978) and Sachdeva (1986) found almost similar conditions for the teaching of biology and physics respectively. Muddu (1978) conducted a survey of 120 high schools and then Desai (1986) surveyed 460 higher primary (middle) schools of Karnataka and found that, though the textbooks were attractive and suitable, and experiments were conducted by teachers, the climate for motivation for teaching and learning of science was not there. Radha (1984) also studied the personality characteristics of science teachers.

The problems faced by teachers or students while teaching or conducting science practicals seem to be a matter of interest for the NCERT or UGC but not Ph.D.-level researchers since all the three studies conducted in this area, Rajput *et al.* (1978), Muddu (1978) and Singhal (1983) were financed projects. Needless to say, the findings were highly disappointing. Teaching science without practicals or laboratories, teachers teaching subjects other than the one they are qualified and appointed for, weak expression and strictly confining themselves to the syllabus were some of the problems exposed through these studies. Mishra (1977) identified a sizable number (23.38 per cent of his sample) as educationally backward in science and mathematics and diagnosed inferior intellectual potential as the cause of their backwardness.

Chand (1984) found the effects of the personalized system of instruction and Bloom's Mastery Learning Strategy on the retention of high school children in the science stream while Bhadwal (1984) studied the effect of an interim test on the performance and test anxiety of high school children following programmed instruction material in general science. Vaidya (1974 and 1979) studied the problem-solving behaviour of students through psychological tests, SES scale and a few problems and extracted ten factors related to students' problem-solving behaviour. Arya (1981), Jain (1982) and Srivastava (1987) conducted studies on problem-solving behaviour through Piagetian tasks and found the level of students' progress in different concepts and stages of development.

Which method of science teaching is the best? From the studies it seems to be a matter of taste rather than reason. What induces one to find the efficacy of a particular method or instructional strategy is not clear. The researches here are not very coordinated and organized. The researchers have picked up a method or strategy or a package and compared it with the traditional teaching through a parallel group design and have come out with the finding that their method was more effective than the traditional method, of course without strictly defining the traditional method. Kamalakanthan (1968), though, found that the problem-solving method was in no way more effective than the traditional method, he could not refrain from commenting in the end that the problem-solving method still had a favourable position and the spirit of the scientific method could not prevail. In other studies, Sharma (1978) found guided activity, Muddu (1978) found motion pictures, Exemmal (1980) found an environmental approach, Sivadasan (1981) found science kits and the tutorial system, Hopper (1982) found the modular approach, Sahajahan (1980) found modules, Sastry (1982) found educative toys, Anjaria (1984) found a systems approach, Deopuria (1984) found an environmental approach, Adinarayan (1984) found instructional packages, Ganguli (1985) found an open-ended approach of doing practicals, Dwivedi (1983), Desai (1986) and Kalacherry (1987) found programmed learning, Barve (1986) and Soner (1975) found filmstrips, Sushma (1987) found the concept attainment model in biology and Pillai (1987) found Gagne's conditions of learning more effective than the traditional methods of teaching science. Kumar (1981) and Sharma (1982), however, compared three methods not with traditional methods but among themselves and found the multi-media method the most effective; programmed learning as the second most effective; and the expository method as the least effective of the three; and also that a branching programme was more effective than a linear programme. Dighal (1985) discovered that two or three methods when combined gave better results than any one in isolation. Basu (1981), Ravindranath (1982), Vardhini (1983), Desai (1985), Joshi (1987) and Lambhate (1987) developed instructional strageties for science teaching and found them effective. In the evaluation of methods, Kumar (1982) observed 205 teachers twice, to gather the fact that though the level of science teachers' questioning was higher than that of the social science teachers, very small duration (6.09 per cent) was devoted to this aspect of questioning by teachers.

Sharma (1979) analysed 120 science teachers to get their classroom behaviour through the Flanders Interaction Analysis Category System, an adapted Guilford Zimmerman Temperament Survey and a self-developed Science Teacher Behaviour Inventory and found that science teaching was not satisfactory since the teachers dominated the class and the students got neither encouragement nor the opportunities to add their own ideas. Joglekar (1981) also studied the influence of 8th grade science teachers of Bombay and found that teachers' classroom behaviour was direct and sex, age, teaching experience or training programmes and type of the schools had no effect or relationship with the teachers' pattern of influence. Malik (1984) and Swamy (1987) studied the personality factors and basic understanding respectively of science teachers.

SOME CONSIDERATIONS FOR FUTURE SCIENCE EDUCATION RESEARCH

Our analysis on science education researches clearly indicates the need for identification of certain priority areas which can contribute significantly to the present-day society. There is a need to look closely at likely human concerns of the 1990s and beyond. These will have to be catered for through the development of various innovative curricula in science and allied disciplines. Our efforts must be directed to the generation of knowledge concerned with how people learn science and how to instruct them. We need to know what helps whom and under what conditions and which design/strategy leads to most effective instruction.

To what extent are our research agenda, our questions and answers, linked to the real world of the science teacher? Have we become so engrossed in our research that we find only what we are looking for? What is the congruence beween our reseach agenda and their questions? If the teachers influence what students learn by stimulating certain learning styles and study habits, then the link between teachers classroom behaviour and students learning needs greater attention and deeper probes.

There is a great need for research into the dimensions of the instructional and nurturant effects of various types of instructional practices in science education today. Competence in teaching stems from the capacity to reach out to differing children and to create a rich and multi-dimensional environment for them. This demands that we widen our experience with different models of instruction in various classroom settings

Also we must examine a diverse range of alternative patterns of instruction upon which teachers may model their behaviour. Each design of instruction prepared, with learning theory underlying its procedures, should be validated to see that each child becomes a productive and effective learner. Science education researchers will also be interested to know exactly what changes in knowledge occur as a result of instruction. Science education research, thus, should direct its attention, (i) to improving the existing procedures of science instruction, and (ii) to establishing new and verified procedures for teaching science.

The effect and effectiveness of different media are determined by how students perceive them, which in turn determines the amount of mental effort they will invest in processing the information with which they are fed. Our investigations should also be directed towards how these perceptions can be improved.

Scientific and technological information in the context of the individual and society raises the question of values and ethics. The current debates on nuclear energy and application of biotechnology in human genetics, etc. exemplify the diversity of judgements people make and conflicts that arise, even when people work from a common knowledge base. Questions involving values should find a place in science education research. Development of value-based curricula could be of greater interest to the society at large than is generally realized.

An area of increasing interest in recent years has been the use of computers in science instruction. Computerized and computer-based learning systems are gaining ground all over our country. Researchers must attempt to assess the facilitative effect of these specialized learning strategies in terms of learning outcomes, learning time and attitudes.

The emerging vision of an education in science is that science and technology should be brought into the real life of the student. The science education programmes so developed should be in harmony with modern conditions of science, technology and society and our science education research should help achieve this. These are some of the priority areas for research in science education. A planned research programme in a programmatic framework should guide the future researcher so that it might contribute to making science education more effective and productive.

ABSTRACTS: 808—864

808. ADINARAYAN, K., *Science Teaching in Primary Schools—a Training Programme*, Laxmi College of Education, Gandhigram, Madurai, 1984 (NCERT financed)

The major objectives of the study were (i) to identify areas of competence in the teaching of elementary science, (ii) to evaluate the course in elementary science based on competency required in the teacher, (iii) to develop competence criteria for observational, investigatory and inquiry skills in pupils, (iv) to develop packages of instructional aids for teachers, and (v) to determine the advantages and effectiveness of packages in terms of development of skills in pupils.

Two units of the science syllabus of class IV and V, prescribed by the Tamil Nadu Government, were selected for teaching. Instructional packages were prepared for teaching through the experimental method as well as the customary method. A comparison of the effectiveness of the methods was made on the basis of criterion tests for knowledge, comprehension and observation, inquiry and investigatory skills. Some semi-urban and rural schools were selected from Athoor Panchayat Union of Madurai district using stratified random sampling. Forty-eight teachers were selected of whom 24 comprised the experimental group and were oriented to the objectives of the programme, analysis of content, methods, and evaluation techniques, organization of classes, administration of tests, and the role of teachers during teaching, discussion, group work and demonstrations. The sample of 760 pupils was divided into equated groups in each school on the basis of age, mental ability and science background test. A criterion test was developed for assessing knowledge and comprehension, observation, inquiry and investigatory skills. Reaction towards science activities was measured through a reaction scale prepared by the investigator.

The major findings were as follows: 1. There was a significant difference in the development of skills among students in the experimental group. 2. Class IV students in nine schools and class V students in seven schools of the experimental group indicated an increase in knowledge and comprehension in comparison to the control group of students. 3. As regards observational skills, class IV students in nine schools and class V students in 11 schools of the experimental group showed significant improvement. 4. Investigatory skills developed significantly in 11 schools in each of the classes of the experimental group. 5. Performance of the experimental group in inquiry skills of ten schools in class IV and seven schools in class V increased significantly. 6. The experimental group greatly favoured science activities.

809. AGNIHOTRI, S.K., *Study of Influence of some of the Methods of Teaching Physics on the Achievement in Physics of Class X Students in Delhi*, Ph.D. Edu., Del. U., 1987

The objective of the study was to test the following hypotheses: (i) There is no significant difference between the mean achievement in physics of different groups of students taught by different methods, viz. lecture-cum-demonstration method, laboratory method, programmed instruction and assignment-cum-discussion method. (2) The interaction between teaching methods and different schools is not significant. (3) The interaction between teaching methods and different levels of students is not significant.

The investigation followed the pretest/post-test experimental method of research where two units of physics were taught according to the design by different methods, viz., the method devised by the investigator, the traditional method, or the lecture-demonstration method, programmed instruction and assignment-cum-discussion method. For the experiment ten schools were selected from Delhi in which physics was taught. A sample of 520 grade X students was selected. They were divided into four groups of 130 each. The achievement of students in physics in each of the four groups in each of the schools was similar prior to the experimental teaching. The tools used were: (i) An achievement test, (ii) the programmed learning material and, (iii) instructural material for different teaching methods.

The findings of the study were: 1. The traditional method or the lecture-cum-demonstration method followed by the verification type of laboratory work was more effective than the assignment-cum-discussion method but this mehtod was less effective than the programmed instruction method for the teaching of physics. 2. With respect to achievement in physics, programmed instruction for the teaching of physics was less effective than the method of teaching physics systematically designed by the investigator, but this method was found to be more effective than the assignment-cum-discussion method and the traditional method or the lecture-demonstration method followed by the verification type

of laboratory work. 3. Out of all the four methods, the method of teaching physics systematically designed by the investigator was found to be most effective with respect to achievement in physics and the assignment-cum-discussion method was found to be the least effective with respect to achievement in physics. 5. The relative effectiveness of all the four methods with respect to achievement in physics was the same, not only for all the schools but also for all the levels of students. 6. If all the four methods selected for this investigation were ranked with respect to achievement in physics, it was found that the method of teaching physics systematically designed by the investigator was the first, the programmed instruction modified by the investigator for the teaching of physics was the second, the traditional method or the lecture-demonstration method followed by the verification type of laboratory work was the third and the assignment-cum-discussion method was the fourth.

810. ANJARIA, R., *Systems Approach in the Teaching of Science: An Exploration*, Ph.D. Edu., SGU, 1984

The major objectives of the study were (i) to prepare an instructional model with the help of resources for the unit on 'Light' in Std. X, on the basis of the systems approach, (ii) to measure the effectiveness of the systems approach in the teaching-learning process, and (iii) to evaluate the effectiveness of the systems approach in planning the design of the experiment.

Students of Class X of three different schools of Surat formed the sample of the experiment. In all, there were 248 students selected for the conduct of the experiment. The students in each school were divided into two groups, an experimental group and a control group. The two groups in each of the three schools were matched, with respect to their mean age, previous achievement, and sex. The investigator prepared programmed learning materials, a tape slide visual programme on the unit of 'light', and a criterion test. She also utilized the available resources like charts, models and film-strips. For measuring intelligence, Patel's Non-Verbal Group Intelligence Test was used. Pretest/post-test with control group experimental design was used. Both formative and summative techniques of evaluation were employed. In group matching, intelligence was controlled statistically by using analysis of covariance.

The major findings of the study were as follows: 1. The experimental group scored higher than the control group and the t-test was found to be significant. It could thus be claimed that the systems approach to instruction was more effective than the traditional approach to instruction. 2. With reference to retention of the subject matter, it could be claimed that the systems approach to instruction was more effective than the traditional approach to instruction. 3. Replication of this experiment could considerably confirm the results and could raise the level of generalizability. 4. The systems approach was found effective in planning the design of the experiment. It was found effective in maximum utilization of available resources.

In the school situation, the systems approach should be used for designing and managing classroom instruction for planning the curriculum, for scheduling classroom activities, and for evaluation procedures.

811. ANSARI, A.M., *Construction and Standardization of Achievement Tests in General Science for Standards V, VI and VII for Children Studying through Hindi as the Medium of Instruction in Greater Bombay*, Ph.D. Edu., Bom. U., 1984

The objectives of the study were (i) to construct and standardize a battery of achievement tests in general science for pupils of classes V, VI and VII studying through Hindi as the medium of instruction in Greater Bombay, (ii) to compare the achievement in science of children studying in municipal and non-municipal schools in the city of Greater Bombay, and (iii) to compare the achievement of boys and girls in science.

For standardization of achievement tests, the test items were tried out on different samples. The try-out sample was 1200 students. Item statistics were calculated. The final sample for fixing the norms included 1702 students of class V, 1462 students of class VI and 1391 students of class VII. The norms were expressed in stanines, percentiles and standard scores.

The major findings were as follows: 1. The performance of boys was better than that of girls. 2. The students of non-municipal schools had a better performance in general science than those of municipal schools. 3. These findings held good for all the classes, viz. class V, class VI and class VII.

812. ARORA, S.K., *Validation of a Science Education Curriculum to Develop Instructional Competence at the B.Ed. Level*, Ph.D. Edu., Kur. U., 1986

The objectives of the study were (i) to verify if the cur-

riculum of teaching science in B.Ed. Colleges of Haryana, Punjab and the Union Territory of Chandigarh was according to the needs of the time or not, (ii) to find out whether the contents of the curriculum were related to the actual teaching of science in the schools, (iii) to know whether teaching of modern concepts was given due place in the schools, (iv) to ascertain if the traditional methods were still dominating the teaching of physical sciences, (v) to verify if there was great gap between old and new knowledge which was being imparted to the students, and (vi) to suggest improvements in the B.Ed. curriculum with regard to the objectives of the science education curriculum and validation of the same. Keeping these objectives in view, it was hypothesized that the present curriculum for teaching science in B.Ed. colleges was not up to date and relevant to the present needs of the students, teachers and society.

The sample for the study consisted of three groups of people, viz. school teachers, teacher educators and educational administrators. The sample comprised 300 school teachers, all the teacher educators teaching science in the colleges of Haryana, Punjab and Chandigarh, 50 educational administrators working in Haryana, Punjab and Chandigarh as district science supervisors, district education officers, heads of high and higher secondary schools, having more than ten years of experience. The sample subjects were administered a questionnaire which was specifically developed to know the reactions of the subjects about functioning of the B.Ed. science curriculum. The data were supplemented by the scheduled interview of the sample subjects. Further, the activities followed in practical work in skills of teaching and science laboratory were observed by the investigator. Chi-square used for examining the hypothesis.

The findings of the study were: 1. School teachers, teacher educators and educational administrators fully agreed that the objective—to understand the importance of teaching physics and chemistry—concerning knowledge and understanding was being fully realized. 2. According to teacher educators and educational administrators, the objective—to understand the interrelation and interdependence of different branches of science and their relationship with other school subjects—concerning knowledge and understanding was being fully realized. 3. They were unanimous that the objectives—to acquire knowledge about the contribution made by eminent scientists and to acquire competence for understanding scientific literature—were not being realized. 4. According to the school teachers and educational administrators the objective concerning interrelation and interdependence of different branches of science and their relationship with other school subjects, was not fully realized while administrators agreed that it was being fully realized. 5. In case of the objectives concerning skills and abilities, the school teachers and educational administrators rated that these were being fully realized but teacher educators did not agree to this. 6. The objectives concerning personal qualities were being fully realized in the opinion of the educational administrators and school teachers, but were not fully realized in the opinion of the teacher educators. 7. The school teachers and teacher educators rated the use of theory papers in science education as low. 8. The school teachers, teacher educators and administrators rated the use of the practical part of the theory papers as low. 9. The school teachers, teacher educators and educational administrators rated the practical work in skill of teaching as quite low. They thought it not at all useful for teaching in the classroom.

The study implied the need for change in the practice teaching programme with longer duration, less workload of practice teaching for supervisors, and recruitment of teacher educators from among the senior school teachers.

813. BAJRACHARYA, R.K., *Study of Science Education in the Secondary Schools of Nepal with a View to Evolving a Functional Model for Improving the Science Education,* Ph.D. Edu., Del. U., 1986

The objectives of the study were (i) to study the existing conditions of secondary science education in Nepal, (ii) to identify the problems of the existing secondary science education in Nepal, and (iii) to evolve a functional model for improving secondary science education in Nepal.

The study was designed in three phases. The first phase was conducted with a view to knowing the conditions of the existing secondary science education programme. In this phase a sample of 75 secondary science teachers and ten science teacher educators was selected. They were administered the following tools: (i) a survey questionnaire for science teachers, (ii) a survey questionnaire for science teacher educators, (iii) a class observation sheet, and (iv) documentary analysis of relevant materials. The data so collected were processed with descriptive analysis first and then the rank difference correlation coefficient was found out. The second

phase was concerned with formulation of a model. The model included formulation of curricular objectives, formulation of curricular content, identification of methods and materials for effective teaching-learning process, formulation of evaluation procedure and formulation of criteria for entering behaviour. The third phase covered evaluation of developed models and formulation of a functional model. An evaluative schedule was developed for the experts so as to get the model evaluated by them. After evaluation, the necessary modifications were done and a functional model was formulated.

The findings of the study were: 1. The existing curricular objectives (general as well as specific) of the secondary science curriculum were unsystematic and insufficient. These objectives were not achieved as there was no practical work in the curriculum for the pupils. 2. The existing curricular content of grades IX and X was theory-oriented and far from the pupils' daily lives. Some topics in the content were below and some were above the grade level. 3. The techniques of teaching science which were practised in most of the schools were traditional. The only teaching aid used in the classroom was the blackboard and chalk. 4. Some methods such as discovery and free choice activity were not known to many teachers. 5. Most of the secondary schools (except residential schools) did not have a science room or laboratory, adequate materials and science teachers. Some schools had certain materials most of which were irrelevant to the course content. Aids such as aquarium, microscopes, films, slides, tapes, etc. were absent. 6. In most of the schools there was no provision for replacement of expendable materials in science. 7. Teachers' guides and manuals were not available in most of the schools. 8. The prescribed textbook contained inappropriate topics and diagrams. It reflected only reading skill and did not provide for practical skill and concept development. 9. Teaching time per day for one class was 40-45 minutes. All science teachers had expressed that this was not enough for demonstration and other activities in the class. There was a need for more time per day. 10. Most of the science teachers felt that they were overloaded with teaching and the classes were crowded, so they did not get time to prepare the lessons properly. 11. In some schools, the administration was not helpful to the science teachers as a result of which they were dissatisfied with their jobs. 12. In most of the schools (except residential schools) co-curricular activities were non-existent. 13. The existing evaluation procedure was inappropriate and needed to be changed. 14. There was no set procedure or basis for deciding which pupils should be permitted to take science. 15. The school supervisors were not efficient. Science teachers did not get professional help from them. 16. Science teachers felt the need for in-service training in construction of apparatus from local materials, techniques of teaching, curriculum development and test construction. 17. From the class teaching it was seen that teaching in most of the schools was very dry. There was no interaction between students and teachers which could help pupils to develop their interest in and attitude towards science learning. 18. The existing science curriculum indicated the need for content specialists in the field of curriculum development and other areas of secondary science education. 19. As expressed by all science teachers, science educators and experts, science should be made a compulsory subject up to grade X.

The study had its implications for educational planners and administrators, that proper study materials and appropriate facilities should be provided to the science teachers, science educators and students.

814. BANDYOPADHYAY, J., *Environmental Influence, Academic Achievement and Scientific Aptitude as Determinants of Adolescents' Attitude towards Science Stream*, Ph.D. Psy., Cal. U., 1984

The objects of the study were (i) to assess adolescent students' attitude towards science, and (ii) to find out the environmental and academic factors that influenced their attitude towards science. The dependent variable was attitude towards science, and three categories of independent variables were environmental influence measured by parental education, income and socio-economic status, influence of teachers and peers, and vocational value of science; achievements in language, physical science, life science and social study; and scientific aptitude measured by numerical ability, mechanical reasoning and space relations. The hypothesis was: There is no significant difference between the pupils having a highly positive attitude towards science and those having a highly negative attitude towards science with respect to any of the independent variables stated above either in isolation or in interaction.

The sample, drawn on the basis of stratified random technique, consisted of 420 adolescent students, 221 boys and 199 girls, from 21 schools of Calcutta. The tools used were a researcher-made Information Schedule to know the respondents' generalities, leisure activi-

ties, family background, relations with parents, peers and teachers, and social influences, and sub-tests of the DAT battery on numerical ability, mechanical reasoning and space relation. Achievements in school subjects were obtained from the annual examination records for last three years. The scientific attitude was measured by Science Attitude Scale of Avinash Grewal (Published). The data were represented by charts and tables, and analysed by statistical tools like t-test, ANOVA and chi-square test.

The major findings of the study were: 1. Pupils having a high positive attitude towards science and a negative attitude towards science were different with respect to the independent variables either in isolation or in interaction. 2. The obtained causal factors were environmental, attitudinal and achievement related. Parent education, and SES led to favourable attitude towards science. Teachers' influence, peers' influence, vocational value of science and future aim of life were other contributory factors. The pupils who had a favourable attitude to science possessed higher ability in mechanical comprehension and visualization of objects in space. They were higher achievers in physical and life sciences. 3. There existed significant interactions between (a) source of inspiration and achievement in physical science, (b) source, achievement in physical science and space relations, (c) source, achievement in life science and space relations.

815. BANERJEE, T., *Rorschach Whole Responses, Intelligence and Achievement in Science, The Bureau of Educational and Psychological Research,* Govt. of West Bengal, Calcutta, 1972

The purposes of the study were (i) to investigate more systematically the relationship of the Rorschach whole responses to intelligence and science achievement by examining the qualitative features of the W (whole) responses over a broad range of intelligence and achievement level, and (ii) to determine the relative contributions of intelligence and whole responses towards science achievement so that a prediction of achievement may be made from the knowledge of scores of these two variables.

It was hypothesized that a significant positive relationship would emerge when qualitative features of the W responses were considered. The sample included 300 students (280 boys and 20 girls) of class XI, with modal age of sixteen years eight months, who ultimately passed the Higher Secondary Examination in 1967 and 1968. Numerical Ability, Abstract Reasoning and Verbal Reasoning (West Bengal Adaptation) Tests were administered. A fair estimate of general intelligence was obtained by adding the scores on these three tests. The Rosrchach group method was also applied to the groups by administering the tests to small groups of 30 at a time by means of a slide projector. The criterion of science achievement was the total marks obtained by these students at the final Higher Secondary Examination of the Board of Secondary Education, West Bengal. The W responses were classified into three categories according to their quality. The assessment was based on both levels of cognitive complexity, and degree and accuracy of adherence to reality. Multiple regression analysis was carried out to determine the relative weightage of intelligence and W+ responses in determining science achievement.

The study revealed the following : 1. Total W response had no relationship with both intelligence and science achievement. W + response was significantly and positively related to both the variables, while W − (response) was negatively and significantly related to them. 2. If qualitative features of the W response were considered, W + response could offer valid estimates of intellectual level and science achievement.

***816.** BARVE, M.V., *Preparation Field and Testing of Filmstrips for the Teaching of Science—a Course in Standard IX, and a Study of Their Comparative Effectiveness in the Teaching-Learning Process as Compared to the Traditional, Practice,* Ph.D. Edu., SNDT U., 1986

The objectives of the study were (i) to prepare filmstrips on selected topics from the science course of standard IX, (ii) to teach the selected units of the science course of standard IX by using these filmstrips, (iii) to compare the effectiveness of teaching with the help of filmstrips and the traditional practice of teaching science in terms of the achievement of the learner, (iv) to compare the effectiveness of teaching with the help of filmstrips and the traditional practice of teaching science in terms of achievement of the learner, considering sex and level of achievement as parameters, and (v) to compare the effectiveness of teaching with the help of filmstrips in terms of achievement of the learner considering age, liking and availability of gadgets at home as parameters.

The researcher developed ten filmstrips based on units of science from the syllabus. In order to study the effectiveness of the filmstrips, the researcher used untreated control group design with pretest/post-test. The students for the experiment were chosen by the incidental sampling method. Pre-achievement and post-tests were administered to both the groups. The test scores were analysed by using analysis of variance.

The major findings of the study were: 1. Filmstrip was more effective than the traditional method for teaching the facts, principles and concepts in science. 2. Filmstrip and the traditional methods were equally effective for teaching abstract concepts in science. 3. Filmstirp was an effective teaching aid for all levels of learners, i.e. low, medium and high achievers. 4. Filmstrip was more effective for the learners between 13 and 16 years of age than for learners between 17 and 21 years of age. 5. Filmstrip was a more effective method of teaching science for both sexes, i.e. males and females.

817. BHARGAVA, S.N.L., *A Study of Some Cognitive Processes in Science Learning with Reference to Physics for Students of Higher Secondary Classes,* Ph.D. Edu., Bhopal U., 1983

The major objectives of this study were (i) to identify significant processes of science with special reference to physics and detail them in depth, (ii) to develop and use the tests of processes of science incorporating the various processes identified for the study, (iii) to develop and use a test of achievement in physics based on certain educational objectives, (iv) to determine the interrelationships between the scores on tests of science processes and the variables of SES, intelligence, and achievement in physics in the context of residence, and age levels of the pupils, (v) to determine mathematically the factor structure of the science processes along with other variables, and (vi) to study the longitudinal development of the processes of science as children grow up.

The study was conducted on 944 boys and 403 girls, studying in classes XI to XII who were randomly drawn from 20 schools. The tests used for the collection of data were Jalota's General Mental Ability Test, a Battery of Tests of Science Processes—observing, measuring, drawing inferences and making predictions, hypothesis-making and hypothesis-testing, self-developed objective-based achievement test in physics, adapted from of SES scale, and a bio-data form. Statistical techniques used for the analysis of data and hypothesis testing were analysis of variance, t-test, product-moment coefficient of correlation, and factor analysis.

Significant findings and conclusions of the study were as follows: 1. The scores on science processes were found to be correlated with intelligence and also with the components of SES. 2. A moderate relationship of achievement in physics was observed with the three processes of science, namely, observing, measuring, and drawing inferences, and a low level of correlation was observed with the remaining processes. 3. Boys were found to be superior to girls on the processes of observing, measuring and drawing inferences. 4. With growth in age, a decline in ability to perform on science processes was observed. 5. Urban students outperformed their counterparts in rural areas on science processes. 6. The five factor structures which were extracted were named hypothesis-making ability, SES factor, maturity factor, abstract reasoning and the factor of convergent thinking.

818. BHATTACHARYA, P., *A Critical Study of Science Education in Assam and Meghalaya Schools,* Ph.D. Edu., Gau. U., 1979

The investigation was an endeavour to determine the position as to where Assam and Meghalaya stood in science education and also to find how they could go forward more effectively and more vigorously.

The study was of a descriptive survey type. Ten different categories of sample were drawn, viz. (i) school science teachers of Assam, (ii) school science teachers of Meghalaya, (iii) heads of schools of both Assam and Meghalaya, (iv) education officers, scientists, teacher educators and retired persons, (v) trained teachers, teacher trainees and untrained teachers, (vi) schools for field study, (vii) college teachers of Meghalaya, (viii) Meghalaya colleges teaching science, (ix) examination results in arts and science subjects in four big colleges in Shillong, and (x) tribal and non-tribal college students in Meghalaya. Questionnaires, interview schedule, rating scale, checklist, observation schedule, Flander's Interaction Analysis Category System (FIACS), Kuppuswamy's Socio-Economic Status (SES) Scale (Urban), etc. were used. A field study was also carried out.

The major findings of the study were: 1. Assam and Meghalaya respectively had 70.65 per cent and 86.85 per cent of teachers eligible to teach science in sec-

dary classes. 2. The average teaching experience of science teachers in Assam and Meghalaya stood at 6.04 and 8.57 years respectively. 3. All the teachers qualified to teach science taught other subjects as well. 4. The economic condition of science teachers was poor. Most of the teachers had, besides salary, other sources of income. Private tuition was the most common source. 5. About 54 per cent and 46 per cent of the teachers of Assam and Meghalaya were prepared to give up teaching for other better jobs. The headmaster's job was also not very attractive. 6. The Bengali, Assamese, tribal and other teachers did not differ in teacher effectiveness. Male and female teachers did not differ significantly in teacher effectiveness. The trainees and trained teachers and the married and unmarried teachers ranked about the same in teacher effectiveness but the untrained did very badly. 7. On Flander's tool the married teachers became the obvious choice. 8. Science was more popular among the non-tribals in the pre-university courses. The wastage of tribals and non-tribals in science education differed significantly. The tribal students' attitude towards science education was influenced by their general aspiration level and also affected their enrolment in science. 9. Science education in the schools and colleges in Assam and Meghalaya had defects. Assam and Meghalaya together had laboratories in 79.96 per cent schools. The position of Meghalaya was better. 10. The number of books in the school library varied from 200 to 2,500 and the average came to 1240 books. The schools had hardly any freedom for purchasing books. Most of the schools did not subscribe to science journals. None of the schools had a trained librarian.

819. BRAHADEESWARAN, D., *An Analysis of the Effectiveness of Chemistry Curriculum of the Polytechnics*, Ph.D. Edu., Kar. U., 1986

The objectives of the study were (i) to determine the extent to which the objectives of the polytechnic chemistry curriculum were achieved by the students, (ii) to judge the relative contribution of each of the clusters of objectives of the curriculum to its total effectiveness, (iii) to identify the factors influencing the effectiveness of the chemistry curriculum, and (iv) to suggest changes to be made in the curriculum to make the 'second generation programme' more effective. A total of 19 factors were hypothesised to influence the effectiveness of the curriculum. These factors encompassed 30 variables pertaining to students, teachers and instructional environment.

The sample of the study comprised 267 students from three polytechnics in Madras and five teachers of chemistry who taught the students constituting the sample. The instruments developed and used in the study were (i) Student Information Blank, and (ii) Criterion Referenced Tests (CRTs) in chemistry. Forty-six CRTs, one for each of the curricular objectives (selected from a total of 218 objectives by 'Domain sampling' technique) were developed. Each CRT was either four or six items long. The reliability of the 46 CRTs as determined by Subkoviak's Group Coefficient of Agreement ranged from 0.54 to 0.95 with a mean of 0.77. The other tools were a pretest in chemistry, Instructional Environment Student Scale (IESS), Chemistry Objectives (Teacher and Student) Rating Scales, Dimensional Rating Scales of students' psychomotor skills and effective behaviours. Besides the above instruments, Raven's Standard Progressive Matrices and polytechnic examinations were also utilized to collect the required data. The data for the study were collected in six phases spread over one academic year (1984-85). The CRTs were administered in three sets with an interval of three months between successive administration. Likewise the IESS and IETS were also used to collect data pertaining to the topics taught in those intervals of time.

The major findings of the study were: 1. Total effectiveness of the curriculum calculated in terms of gain percentage was 50.58 per cent. 2. In each CRT, students who secured a score equal to or above the cut-off point specified were classified as masters. Further, an objective mastered, (i.e. correctly answered for at least 3 out of 4, or 4 out of 6 questions in the respective CRTs by at least 51 per cent of the students) was considered a 'mastered objective'. Applying these criteria it was found that only 57 per cent of the objectives had been mastered by the students. Achievement of objectives representing higher order abilities was far from satisfactory. Curricular topics in which operational effectiveness was lacking were identified. 3. To judge the relative contribution of each cluster of objectives of the curriculum to its total effectiveness, the gain percentage, possible contribution percentage and actual contribution percentage for each of the eight clusters of objectives were computed. This revealed that 'Knowledge' objectives were being emphasized at the expense of 'Comprehension' and 'Application' objectives and objectives of chemistry practicals contributed more to the total effectiveness of the curriculum than the theory. 4. To identify the factors influencing the effectiveness of the curriculum, the intercorrelation matrix of the variables was

subjected to a principal component solution, followed by varimax rotation of the factor matrix. This led to the extraction of seven principal factors which were identified as Students' Perception of Teacher Created Instructional Environment, Engineering Skill, Chemistry Aptitude, Students' Perception of the Appropriateness of Curricular Objectives, Learning Difficulties due to Inadequate Entering Behaviour, Verbal Interpretation Ability in English and Non-verbal Verbal Task Orientation. These factors explained 63.98 per cent of the variance of which Chemistry Aptitude alone explained 11.89 per cent. 5. The syllabus was also analysed using network analysis technique. Based on the multiple perspectives obtained from the study, suggestions for improving the curricular effectiveness were made.

820. CHHIKARA, M.S., *An Investigation into the Relationship of Reasoning Abilities with Achievement of Concepts in Life Sciences,* Ph.D. Edu., JMI, 1985

The hypotheses formulated for the study were: (1) It is feasible to identify the hierarchy of concepts in life sciences into seven levels of organization of biological phenomena and to measure achievement of these concepts through objective tests. (2) It is feasible to identify reasoning abilities that secondary school students (15+) possess with the help of cognition and convergent production of semantic classes, relations and implications tests. (3) There exists a definite positive relationship between conceptual achievement in life sciences and reasoning abilities. (4) It is possible to predict conceptual achievement in life sciences on the basis of reasoning ability tests.

The tools used in the study were battery of Concept Achievement Tests and a battery of Reasoning Ability Tests developed by Girish Bala. The subject content of classes VI to X was analysed and 274 concepts were found out. These concepts were divided under seven levels of organization of biological phenomena. The content was further categorized under the seven themes identified by the BSCS for its curriculum model. Five alternative multiple choice items to measure knowledge, comprehension, or appplication were constructed. For pretry-out it was given to ten students of class X and three teachers for criticism. On the basis of their responses the language and instructions were further modified. All the 280 items were divided into seven parts (tests). This battery of seven tests was administered to 370 students for try-out. The discrimination and difficulty values of each item were calculated and 175 items were selected for the final form of the battery. The KR-20 reliability coefficient for the Concepts Achievement Tests of life sciences was found to be 0.848 while split-half reliability was 0.886. Nearly 200 students selected from four government boys' senior secondary schools of South Delhi constituted the sample.

The findings of the study were: 1. A slight modification was made in the hierarchy levels of organization of biological phenomena when concepts in secondary school life sciences were identified and the concept achievement test was found reliable and valid. All these supported the first hypothesis, i.e. it was feasible to identify the hierarchy of concepts into seven levels of organization of biological phenomena and to measure achievement of these concepts through objective tests. 2. The results of factor analysis of reasoning ability supported that it was possible to identify reasoning abilities that the secondary school students possessed, with the help of cognition and convergent production of semantic classes, relations and implications tests. 3. Indian children did not differentiate as clearly as inferred according to the structure-of-intellect theory. 4. A definite positive relationship between conceptual achievement in life sciences and reasoning ability was found. 5. The fourth hypothesis, i.e. the possibility to predict conceptual achievement in life sciences on the basis of the reasoning ability test, was supported to a large extent by the results of regression analysis.

*821. DEOPURIA, R.P., *A Comparative Study of Teaching Science through Environmental and Traditional Approach in Schools of Madhya Pradesh,* Ph.D. Edu., Jab. U., 1984

The objectives of the study were (i) to compare the cognitive achievement of students of classes V, VIII, IX and X towards science taught through the environmental versus the traditional approach, (ii) to compare the environmental awareness and attitude of students when taught by the above two methods, and (iii) to compare the attitudes of the teachers towards the environmental approach of teaching. The investigator formulated 15 null hypotheses around the dependent variables related to knowledge, understanding, and application scores, environmental awareness scores, attitude towards environment, environmental problems, and environmental approach.

The study employed a two-group design having the environmental approach in the experimental group and the traditional approach in the control group. The study was conducted at three levels: primary school, middle school, and higher secondary school. At the primary level, 50 schools having 500 students and 100 teachers in the experimental group and another set of 50 schools, 500 students and 100 teachers in the control group were included. At the middle level, the experimental group consisted of ten schools, 250 students and 40 teachers and the control group also included another ten schools, 250 students and 40 teachers. At the higher secondary level, the experimental group included one school, 125 students and ten teachers and the control group at this level also had one school, 125 students and ten teachers. The experimental group represented project schools assisted by UNICEF and NCERT. The non-project schools formed the control group. The control group schools were within the vicinity of 10 km of the project schools. The curriculum was chosen from the Hoshangabad Science Teaching Programme (Kishore Bharti). Some of the sample topics were root, stem, leaf, crops, earth, soil, animals, personal hygiene, health and disease. Three types of tools were standardized. These were achievement tests for classes V, VIII, IX and X; attitude scale for class X; and attitude scale for teachers towards the environmental approach. Statistical techniques such as mean, standard deviation, and t-test were worked out for testing the hypotheses.

Some of the major findings were: 1. The students of the experimental group of classes V, VIII, IX and X obtained higher achievement scores due to teaching of science through the environmental approach. 2. The environmental approach showed greater cognitive gain in knowledge, understanding and application of science concepts related to environmental education at primary, middle and secondary school levels. But it was not effective in the teaching of factual recall type concepts at middle and secondary school levels. 3. The students of primary schools of the experimental group showed considerable improvement towards environmental awareness. 4. The environmental attitude inventory showed significant positive gains in attitudes towards the environment for the entire experimental group of students. 5. The obtained value of 't' showed that teachers of the experimental group of schools had a very high positive attitude towards the environmental approach for teaching science. 6. No significant difference between male and female teachers' attitudes towards the environmental approach revealed that sex had no effect on the attitude towards the environmental approach. 7. There was no significant difference between the attitudes of teachers towards the environmental approach followed at different grade levels.

The educational implications of the study are: (1) The teacher can use the environmental approach for improving the teaching-learning process. (2) This study will be highly useful to the teacher educators to train the pre-service and in-service teachers in science teaching through the environmental approach. (3) Environmental awareness developed in the students as result of the environmental approach will help in the quality improvement of the environment. (4) This study will help in the development of positive attitudes in students towards environmental protection. (5) The study will also be useful for curriculum framers and administrators in the field of environment.

822. DESAI, SHANTADEVI S., *A Critical Study of Science Teaching Programme at Middle School Level in Karnataka State*, Ph.D. Edu., Kar. U., 1986

Setting up 16 objectives, the study proceeded to investigate into aspects of science teaching touching the sufficiency of science teachers' qualifications, understanding of the course content, effect of teachers' workload, practical work competence, methods and aids of teaching, evaluation procedures, co-curricular activities, teacher reaction to the syllabus and its efficiency, sufficiency of laboratory and library facilities, in-service training, effect of handbook, problems of syllabus implementation, and suggestions for improving science teaching.

The study used two specially constructed questionnaires addressed to headmasters and assistant teachers as tools in the collection of data mainly in the form of opinions. The sample consisted of 348 headmasters and 667 assistant teachers belonging to 460 higher primay schools from the four educational divisions of Karnataka, viz. Belgaum, Bangalore, Gulbarga and Mysore. The analyses of the data were presented in 104 tables following the frequency percentage method.

Finding separately 36 opinions from the headmasters and 21 from the teachers as having considerable percentage strength, the investigator presented a list of eight opinions in which both agreed. The opinions were: 1. Teachers had the practice of writing lesson plans. 2. Schools did not have science clubs. 3. Schools had no laboratory. 4. Experiments performed by teachers were

helpful in learning. 5. There was no help from higher authorities to improve the laboratory. 6. Scientific knowledge in the science text was suitable in day-to-day life. 7. Teachers were not specialized to teach science subjects. 8. The science textbook was attractive.

823. DIGHAL, K.C., *Improved Method of Teaching Biological Sciences in Schools of Tripura and West Bengal,* Ph.D. Edu., Cal. U., 1985

The objectives of the study were (i) to explore how to make life science teaching lively, realistic and interesting to the students, (ii) to attempt scientifically the improvement of the present methods, (iii) to remove drudgery in the teaching of biological science, and (iv) to prepare a better method, which was an extraction from the existing methods, and more scientific and refined.

The sample consisted of 500 students of class IX from five schools, four in Tripura and one in West Bengal. The tools used were two questionnaires. The design of the study was a survey and it was comparative in nature. The statistics used were graphical representations and product-moment correlation.

The major findings of the study were: 1. There was a significant difference in the effectiveness of 'self activity method', 'life science club method', and 'audio-visual method'. 2. Two or three methods when combined, formed an improved one on the basis of their similar nature. Combination of methods could be made according to the needs of a teacher. 3. Preparation of charts and models, collection of specimens through local excursions, organization of science exhibitions by the students, arrangement of film shows by the school, and orientation programmes for life science teachers brought better results.

824. GADKARI, A.A., *Construction of Diagnostic Tests in General Science for the Students Studying in Standard V of Marathi Medium Schools of Kalyan, Dombivali and Thane Region,* Ph.D. Edu., Bom. U., 1982

The major objectives of the study were (i) to identify pupils who were deficient in general science with reference to specific units, (ii) to discover the areas of difficulty, (iii) to prepare a remedial teaching programme based on the analysis of errors committed by the pupils, and (iv) to measure the outcomes of the remedial teaching programme.

In order to collect the relevant data the method of simple random sampling was used for the selection of the sample. The investigator constructed 11 sub-tests for the pre-pilot testing on the basis of the analysis of errors of answerbooks of 500 students of the terminal/annual examinations and unit tests of standard V in general science. The pre-pilot tests were divided into two groups. The first group consisted of five sub-tests and the other of six sub-tests. Each group of tests was administered to 50 students. Items having ambiguous structures were modified and then pilot tests were administered to 370 students for item analysis. After analysis, the final tests were prepared. The final tests were administered in two groups. The five tests of the first group were administered to 1289 students of standard V (653 boys and 636 girls) from 14 different schools from Kalyan, Dombivali and Thane region. The six tests of the second group were administered to 1335 students of standard V (675 boys and 660 girls) from 13 different schools of the same region. The remedial teaching tests were also prepared and administered to 165 students who failed in the annual examination in general science on the basis of the findings of diagnostic test. The booklets (answer sheets) of the final tests were assessed and analysed with the help of statistical techniques, viz. mean, standard deviation, and percentages.

The major conclusions of the study were: 1. Students of standard V had developed wrong concepts in the subject of science. 2. The wrong concepts were identified with the help of diagnostic tests in science which were constructed by the investigator. Diagnostic tests helped to find out the nature of errors, on the basis of which the remedial teaching programme was framed for each unit. 3. The effectiveness of the remedial teaching programme was evaluated by finding out the significance of difference between the pre- and post-remedial test scores of students who were found to be weak in the subject and on whom the programme was administered. The difference was found to be highly significant for each unit. It showed that the remedial teaching programme helped to improve the teaching-learning process and thereby the correct or rectify wrong concepts formed by the students.

825. GANGOLI, S.G. and GURUMURTHY, C., *A Comparative Study of the Effectiveness of Open-ended Approach of Doing Physics Experiments versus Traditional Approach at Higher Secondary Stage,* RCE, Mysore, 1985 (NCERT financed)

The primary objective of the study was to compare the effectiveness of doing experiments in physics at the higher secondary stage by the open-ended approach vis-a-vis the traditional approach. The specific objectives were (i) to compare the knowledge and understanding of concepts, principles and facts, and ability to apply knowledge and understanding developed by students conducting physics practicals by the guided open-ended approach with those by the traditional laboratory approach, (ii) to compare the skills in observation, classifying, drawing, tabulating, computing, etc. developed by students following the above two approaches, (iii) to compare some aspects of creative thinking ability like fluency, flexibility and originality of students doing the experiment by the above two approaches, and (iv) to compare within the groups, viz. the guided open-ended group and the traditional laboratory group, subgroups of (a) high and low creativity level, (b) high and low SES level, (c) high and low creativity level, and (d) boys and girls, with respect to the acquisition of knowledge, understanding, application and development of skills and creative abilities. The following directional hypotheses were formulated: The students of the guided open-ended group are superior to those in the traditional laboratory group, (1) in the acquisition of knowledge, understanding, and application of certain facts, principles and concepts in physics; (2) in the development of skills in observation, drawing graphs, tabulating, computing, classifying, etc; (3) in the aspects of creative thinking abilities—fluency, flexibility and originality; (4) with respect to their achievement, skill and creativity both in (a) high and low intelligence level groups, (b) high and low SES groups, (c) high and low creativity level groups, and (d) boys' and girls' groups.

This was an experimental study wherein the experimental group followed the guided open-ended approach, and the control group followed the traditional laboratory approach for doing the experiments. The students were allocated to the experimental and control groups after matching them on the scores of intelligence test, SES scale, creativity test and achievement test (pre-test level). The other variables—age, sex, contact hour, interest and instructor, were also partially or fully controlled to make both the groups comparable. Both the groups were exposed to the laboratory work wherein the experimental group performed the experiments by the guided open-ended approach, and the control group by using the traditional approach in the selected five topics in physics. The duration of the experimental period was about 38 contact hours over a period of a year. At the end of the laboratory work, both the groups were tested (post-test) on achievement, skill and creativity tests. The sample of the study consisted of 92 students (46 in each group) consisting of 66 boys and 26 girls selected from two colleges of Mysore city. The tools used to get the required data were: Baqer Mehdi's Creativity Test, Raven's Progressive Matrices, Kuppuswamy's SES scale (urban) as modified by Parashivamurthy, and achievement and skill tests developed by the investigator.

The findings of the study were: 1. The students of the guided open-ended group showed better performance in the achievement test and in the skill test than those of the traditional laboratory group. 2. Students of the experimental group were found to be superior to students of the control group in (i) high and low intelligence level groups, (ii) high and low SES level groups, and (iii) high and low creativity level groups. 3. Within the experimental as well as control groups, high intelligent, high SES and high creativity students differed markedly from students of low intelligence, SES and creativity. 4. In both groups, girls were found to be superior to boys.

On the basis of the results discussed it was concluded that the guided open-ended approach was superior to the traditional laboratory approach in developing the content matter and practical skills in physics. Though in general the development of creative abilities was shown to be independent of the approach, the development of the fluency aspect of creativity seemed to be enhanced by doing experiments in the open-ended way. It could also be concluded that the two approaches were not affected by the intelligence, SES, creativity level, and sex of the students.

*826. GHOSH, G.P., *A Study of the Achievement of the Students in Chemistry and Finding Relationship with some of its Determinants,* Ph.D. Edu., Kal. U., 1985

The main purposes of the study were (i) to appraise the achievement of the students in physical science, (ii) to appraise the extent of academic motivation, intelligence, and socio-economic status of the students, (iii) to

find out sex-wise and strata-wise differences, if any, in the achievement in physical science, (iv) to determine relationships among the scores of the Achievement Test in Physical Science, the Intelligence Test, the Academic Motivation Test and the Socio-economic Status Scale, and (v) to develop regression equation of the achievement in science on intelligence academic motivation, and socio-economic status.

An achievement test in chemistry was standardized on 450 boys and girls (just promoted to class X) reading in nine schools in West Bengal. Test-retest reliability, content, predictive and concurrent validity and T-score norms were developed Bhattacharya's Academic Motivation Test and Group Intelligence Test, Kuppuswamy's (Urban) and Pareek's (Rural) SES Scale were used along with the achievement test. Mean, SD, ANOVA test, Mann-Whitney U-test, correlation, etc. were used. Two multiple regression equations were developed.

Some of the major conclusions were: 1. Urban students did not show better performance in the Achievemet Test in Chemistry (ATC) than rural students. 2. Boys did not show superiority in ATC over girls. 3. There was a positive correlation between the scores in ATC and Academic Motivation Test, ATC and Group Intelligence Test, urban and rural students' scores in ATC and 'Income of the Parents', rural students' scores in ATC and 'Education of the Parents' as well as 'Occupation of the Parents'. 4. Scores in ATC could be predicted from the scores in Academic Motivation Test, Group Intelligence Test and SES of the parents through multiple regression equation. 5. The ATC was reliable and valid. Norms were also satisfactory.

*827. GHOSH, S., *A Critical Study of Scientific Attitude and Aptitude of the Students and Determination of some Determinants of Scientific Aptitude,* Ph.D. Edu., Kal. U., 1986

The main purposes of the study were (i) to ascertain the aptitude of the students in science with the help of a specially developed scientific aptitude test, (ii) to appraise the extent of scientific attitude of the students with the help of a specially developed attitude test, (iii) to find out the extent of academic motivation of the students with the help of a standardized test, and the SES of the parents of the students with the help of an SES questionnaire, (iv) to find out sex-wise and strata-wise differences, if any, in the scientific aptitude and scientific attitude of the students, (v) to determine relationships between the scientific aptitude and variables such as scientific attitude and academic motivation of the students, and (vi) to develop a regression equation of the scientific aptitude on the independent variables identified by the researcher.

A scientific aptitude test was standardized on 620 boys and girls (just promoted to class IX) reading in 13 schools situated in urban and rural areas in different districts of West Bengal. A scientific attitude test was also developed (N=200). Bhattacharya's Academic Motivation Test, Kuppuswamy's (Urban) and Pareek's (Rural) SES scales were used. Central tendency, variability, ANOVA, correlation, F-test, and t-test were used.

Some of the major findings were: 1. Urban students did not show better performance in the scientific aptitude test than rural students. 2. Boys did not possess more scientific aptitude than girls. 3. Boys did not possess better scientific attitude than girls. 4. There was a positive relationship between scientific aptitude and scientific attitude; scientific aptitude and academic motivation; and scientific attitude and academic motivation. Scores in the scientific aptitude test could be predicted from scores in scientific attitude, academic motivation, and socio-economic status of parents through multiple regression equation. 6. Students having high scientific attitude were superior to those having low scientific attitude with respect to their scientific aptitude. 7. Urban students belonging to the high SES group had more scientific aptitude than urban students belonging to the low SES group. 8. Rural students belonging to the high SES group did not show better scientific attitude than rural students belonging to the low SES group.

828. GIRI, B.K., *Measurement of Aptitude for the Study of Physics of the High School Science Seniors of the State of Bihar with special reference to the Students of Chota Nagpur Division,* Ph.D. Edu., Ran. U., 1976

The main purpose of the study was to develop a test battery to measure the aptitude for the study of physics of the high school science seniors of the state of Bihar.

A battery of tests having four main parts (Parts I, II, III, IV A and IV B) covering different areas (viz. functional knowledge, conceptual understanding of physics, creative thinking in physics, knowledge of the nature

and structure of physics, and scientific attitude) was developed. Difficulty level, discriminative power and internal consistency of items were found out. The final version of Parts I, II, III, IV A and IV B included 30, 30, 30, 16 and 16 items, respectively. The standardization sample was derived from seven institutions of Palamau, Ranchi, Patna, Dhanbad and Singhbhum by adopting the purposive-incidental sampling technique. The scores on the full test battery were available for 177 students. Central tendency, variance and nature of distribution of scores were computed. Reliability was calculated through spilt-half, K-R formula-20 and Flanagan's formula. Content, criterion-related and factorial validity were determined. Scales and norms (standard scale, T-scale, P.R., Percentile, Stanine and letter gradings) were prepared. Multiple correlation(R) was computed and prediction equations were prepared. Forecasting efficiency of the test was determined. The Doolittle test selection method was used to select tests to form the present test battery. A test manual was prepared.

829. GOYAL, K.M., *A Comparative Study of Summative Evaluation of Science Curriculum: Board of Secondary Education, Rajasthan and Central Board of Secondary Education*, Ph.D. Edu., Raj. U., 1982

The objectives of the study were (i) to assess the secondary school science curricula of the Board of Secondary Education (BSE), Rajasthan and the Central Board of Secondary Education (CBSE) in terms of the understanding of the nature of science among different categories of students and teachers, measuring attitude towards science and scientists, determining awareness towards social aspects of science, and attitude towards science teaching, (ii) to compare both curricula in terms of the above mentioned variables, and (iii) to conduct a theoretical study of the curricula prescribed by the Board of Secondary Education, Rajasthan and the Central Board of Secondary Education.

The sample consisted of 500 science oriented students, 200 non-science oriented students and 100 science teachers. Out of this sample half of the science oriented students, half of the non-science students and half of the science teachers were from the Board of Secondary Education, Rajasthan and the other half were from the Central Board of Secondary Education. The sample students were eleventh grade students of both the boards. The performance of the sample subjects was tested on (a) nature of science, (b) attitude towards science and scientists, (c) social aspects of science, and (d) attitude towards science teaching. For this purpose the sample subjects were administered the following tools: (i) The Kimball Nature of Science Scale (1967). The scale had split-half reliability 0.76 in the Indian set-up and was scored on a three-point scale; (ii) The Sood Attitude towards Science and Scientists (1975). The instrument had four areas—(a) nature of science, (b) scientists, (c) scientific work, and (d) science and society. The split-half reliability of the scale was 0.76 and it had been validated against the test on understanding science which gave a validity coefficient 0.98. The scale is scored on a five-point scale from 'strongly agree' to 'strongly disagree'; (iii) The Goyal and Sood Attitude towards Science Teaching Scale (1978). The scale had 22 items representing four areas—lecture method, laboratory method, demonstration method and discovery method. The split-half reliability of the scale was 0.76. The validity coefficient of the scale against the Test on Nature of Science Scale was 0.36; (iv) The Social Aspects of Science Scale, developed to measure the understanding of social aspects of science. The scale had 30 items belonging to four areas, viz. science, society and politics, science as a social boon, science as a social curse, and science, technology and society. The split-half reliability of the scale was 0.76. The scale was validated against the test on attitude towards science and the validity coefficient was 0.21

The findings of the study were: 1. The comparison of scores on understanding of the nature of science showed that differences were not significant between (a) science oriented students of the Board of Secondary Education, Rajasthan and science oriented students of the Central Board of Secondary Education; (b) non-science oriented students of both the boards; (c) science teachers of both the boards, (d) science oriented and non-science oriented students of the two boards, (e) science oriented students and science teachers of the two boards. 2. The comparison regarding the attitude towards science and scientists revealed that differences were significant when the groups compared were (a) science oriented students of the Central Board of Secondary Education and the Rajasthan Board of Secondary Education, (b) non-science oriented students of the Central Board of Secondary Education and non-science students of the Rajasthan Board of Secondary Education. 3. The difference between science teachers of the Rajasthan Secondary Board of Education and science teachers of the Central Board of Secondary Education on attitude to-

wards science and scientists was not significant. 4. The comparison regarding understanding of the social aspect of science between different groups showed that (a) the difference was significant between the science oriented students of the two boards, (b) the difference was not significant between the non-science oriented students of the two boards, (c) the difference was not significant between the teachers of the two boards, (d) the difference was not significant between total science oriented students and non-science oriented students, (e) the difference was also not significant between science oriented students and science teachers. 5. The comparison regarding attitude towards science teaching between different groups revealed that (a) the difference was significant between science oriented students of the two boards, (b) the difference was not significant between the non-science oriented students of the two boards, (c) the difference was not significant between the science teachers of the two boards, (d) the difference between the total science oriented students and the total non-science oriented students was significant, (e) the difference between total science oriented students and science teachers was not significant.

The study has its implications for curriculum makers and teachers. The curriculum needs to be structured as per historical, social and cultural influence on society. The demands made by rapid technological developments in the society need to be incorporated in the science curricula of both the boards of secondary education. Above all, researchers need to develop a proper instrument for evaluating the science curriculum rather than simply examining the content of the curriculum.

830. JAIN, S.C., *A Study of the Problem Solving Behaviour in Physics among certain Groups of Adolescent Pupils,* Ph.D. Edu., Raj. U., 1982

The objectives of the study were (i) to identify the basic problems in physics having a direct bearing on the various reasoning patterns, (ii) to study the nature of difficulty faced in the process of problem solving and the need for selected hints, at various stages of problem solving, (iii) to analyse and interpret the responses on the problem solving ability test, Piagetian Tasks, Raven's Progressive Matrices and tests of creativity and academic achievement, (iv) to study the problem solving ability of adolescent pupils, boys and girls at high, average and low I.Q. levels, high, average and low creativity levels and formal, postconcrete and concrete levels, (v) to study the relationship between the scores on different problems before providing hints and after providing hints, (vi) to study the relationship between the problem solving ability and some outside variable—intelligence, creativity, levels of intellectual development, academic achievement in physics and science, (vii) to study the multiple correlation between the scores of problem solving ability in physics test with the I.Q. creativity and level of intellectual development, (viii) to study the differences in the number of successful, partially successful and unsuccessful problem solvers at high, average and low I.Q. levels, high, average and low creativity levels, and formal, postconcrete and concrete levels, (ix) to study the difference between the scores before and after providing hints concerning each problem, (x) to determine the mathematical structures of problems and other variables included in the study, and (xi) to point out the main educational implications for problem solving in curriculum reconstruction and methods of teaching based upon this study.

The study was confined to the higher secondary schools of Ajmer City. A sample of 180 pupils (90 boys and 90 girls) of class XI (Science) was selected randomly from these schools. Their age ranged from 16+ to 18+ years with a mean age of seventeen years and two months. The sample subjects were administered the following tools: (i) The Raven's Progressive Matrices Sets A, B, C, D & E; (ii) The Baqer Mehdi Verbal Test of Creativity; (iii) The Four Piagetian Tasks—(a) 'Conservation of Volume' using the metal cylinder task, (b) 'Exclusion of Irrelevant Variables' using the pendulum task, (c) 'Proportional Reasoning' using the equilibrium in the balance task, (d) 'Separation and Control of Variables' using bending of rods tasks; (iv) academic achievement scores in physics, chemistry and science in the high school examination conducted by the Rajasthan Board of Secondary Education; (v) ten problems in physics based on different reasoning patterns arbitrarilty framed to measure problem solving ability.

The findings of the study were: 1. Piagetian tasks scores showed that out of 180 students only 65 were at formal level, 83 at postconcrete level, and 32 were still at concrete level. 2. A large number of students, who initially failed to solve problems correctly, were able to solve most of the problems completely correct or partially correct after being provided hints in relation to the strategies for problem solving. The hints when presented systematically and logically were helpful in making the students conscious about the analysis of the

problem and recalling of the relevant knowledge, and to some extent for the correct use of reasoning patterns. 3. Problem solving scores differed significantly among the three groups of I.Q. levels and also among the three groups of the level of intellectual development. The same results were obtained when problem solving ability scores after providing hints were compared among these groups. No significant differences for problem solving ability scores were observed among the three groups differing in creativity. The same results were obtained when the scores obtained after providing hints were compared among these groups. 4. No sex differences were noticed among the groups differing in I.Q., creativity and level of intellectual development. 5. Before and after providing hints, scores for each problem showed a highly significantly difference in each group, selected separately, at three levels of I.Q., three levels of creativity and three levels of intellectual development. 6. Out of the 45 correlations among the ten problems 37 were positively correlated having 13 significant correlation coefficients, whereas eight coefficients of correlation were negative having one significant coefficient. Similar results were obtained when the correlations among the problems after providing hints were considered. 7. There was a significant relationship between the score of each problem and the total problem solving ability score. 8. There was a significant relationship between the score of each problem after providing hints and the total problem solving ability scores after providing the hints. 9. The correlation coefficient of problem solving ability test scores 'before' and 'after' providing hints with I.Q. level of intellectual development and achievement in science was positive and significant, while with creativity both had a positive but non-significant relationship. 10. When the scores were classified under successful problem solvers, partially successful problem solvers, and unsuccessful problem solvers for each of the problems, no uniform pattern was observed with regard to the classification of pupils at three levels of I.Q. creativity and the levels of intellectual development. However, in most of the problems, the higher level of intellectual development, as measured by Piagetian Tasks, favoured problem solving. 11. The mathematical structure of the variables selected for the present study using the principal axis method indicated the existence of 12 factors having eigen values greater than one. After further analysis the last six factors were eliminated. The first six factors were: (a) General Schematic Learning, (b) Creative Thinking, (c) Academic Achievement or Experience in Science, (d) Probabilistic Reasoning, (e) Proportional Reasoning, and (f) Piagetian Cognitive Development.

The implications for teaching physics are as follow: (1) For effective classroom instruction, curriculum and methods of teaching have to be planned in such a way that the structure of content is in accordance with the level of intellectual development of students. (2) The teachers need to help the students in solving particular problems by asking logically arranged questions. But there has to be a limit beyond which hints do not remain effective. (3) Boys and girls need not be segregated in the classroom on the basis of sex. Further, girls need to be given more freedom and recognition so that they could also avail of equal opportunities required for problem solving ability. (4) A set of well organized probing questions need to be asked so as to lead the students to think in the right direction. (5) Choice of curriculum and teaching method need to be matched so as to achieve the desired results in teaching science to adolescents.

831. JOSHI. A., *Evolvement of an Instructional Strategy for Teaching Elements of Science to Class IX Students of M.P. State,* Ph.D. Edu., DAVV, 1987

The objectives of the study were (i) to develop an instructional strategy and study its effectiveness in terms of students' performance on criterion tests and students' reactions towards various components of the instructional strategy as a whole, (ii) to compare the mean achievement scores of students taught through the developed instructional strategy with those taught through the traditional method by taking intelligence as a covariate, (iii) to compare the mean scores of higher mental ability in science of students taught through the developed instructional strategy with those taught through the traditional method by taking intelligence as a covariate, (iv) to study the relationship of overall achievement through the instructional strategy with personality and various aspects of adjustment, viz. adjustment towards home, school, peers, teachers, general and total separately, (v) to study the effect of treatment, intelligence and their interaction on overall achievement of students, (vi) to study the effect of treatment, personality and their interaction on overall achievement of students, (vii) to study the effect of treatment, total adjustment and their interaction on overall achievement of students, (viii) to study the change in reactions of students towards various components of the

instructional strategy and the instructional strategy as a whole, and (ix) to compare the reactions of students belonging to different levels of intelligence, personality, and adjustment. The hypotheses were: (1) The adjusted mean achievement scores of students taught through the developed instructional strategy will not differ significantly from those taught through the traditional method when intelligence is taken as a covariate, (2) The adjusted mean higher mental ability scores of the students taught through the developed instructional strategy (IS) will not differ significantly from those taught through the traditional method when intelligence is taken as a covariate. (3) There will be no significant relationship between personality and overall achievement of students studying through the developed IS. (4) There will be no significant relationship between various aspects of adjustment, viz. adjustment towards home, school, peers, teachers, general and total overall achievement of students studying through the developed IS. (5) There will be no significant effect of treatment on overall achievement of students. (6) There will be no significant effect of intelligence on overall achievement of students studying through the developed IS. (7) There will be no significant effect of interaction between treatment and intelligence on overall achievement of students. (8) There will be no significant effect of personality on overall achievement of students studying through the developed IS. (9) There will be no significant effect of interaction between treatment and personality on overall achievement of students. (10) There will be no significant effect of total adjustment on overall achievement of students studying through the developed IS. (11) There will be no significant effect of interaction between treatment and total adjustment on overall achievement of students. (12) There will be a significant change in interaction of students towards the various components of the IS and the IS as a whole. (13) The students belonging to high and low levels of intelligence will not differ significantly in their reactions towards the various components of IS and the IS as a whole. (14) The extraverts and introverts will not differ significantly in their reactions towards various components of the IS and the IS as a whole. (15) The students belonging to high and low levels of total adjustment will not differ significantly in their reactions towards various components of the IS and the IS as a whole.

The study was experimental in nature and conducted in two stages—try-out stage and field study. The sample at the try-out stage comprised 30 students of class IX studying in Kamala Nehru Higher Secondary School, Indore. All students were female. The sample for the field study comprised 109 students studying in class IX. The design of the study was post-test only control group design. Intelligence was controlled statistically. Achievement, higher mental ability in science and the reaction of students were the dependent variables while personality extraversion and introversion, adjustment towards home, school, peers, teachers, general and total were the independent variables. The experiment continued for 70 working days. Intelligence was measured by using A Group Intelligence Test by Mehta. Personality (extraversion-introversion) was measured by using the Hindi version of the Maudsley Personality Inventory (MPI). The split-half reliability coefficient ranged from 0.42 to 0.71. Adjustment was measured by using the Hindi version of the Pre-Adolescent Adjustment Scale (PAAS) prepared by Pareek and Rao. The reliability coefficient ranged from 0.22 to 0.66 in different areas. Higher mental ability in science was measured by using a test specially prepared. Achievement was measured by criterion tests and reaction of students was measured by using a reaction scale developed by the investigator. Data were analysed through ANOVA followed by t-test, chi-square technique and percentiles.

The findings of the study were: 1. The developed Instructional Strategy (IS) was found to be effective in terms of achievement of students on criterion tests and reactions of students towards different components of the IS and the IS as a whole. 2. The developed IS was found to be significantly superior to the traditional method when the students' mean achievement scores were not adjusted with respect to intelligence. Also the developed IS was found to be significantly superior to the traditional method when their mean achievement scores were not adjusted with respect to intelligence. 3. The developed IS found significantly superior to the traditional method in terms of the development of higher mental ability in science when their mean scores on the test of higher mental ability in science were adjusted with respect to intelligence. 4. The overall achievement of students studying through the developed IS was not significantly correlated with personality (extraversion-introversion), adjustment towards home, school, peers, teachers, general and total respectively. 5. Intelligence significantly influenced the academic achievement of students. High as well as low intelligent students could benefit equally through the developed IS. 6. Personality (extraversion-introversion) significantly affected academic achievement. Extraverts benefited significantly more through the developed IS as compared to intro-

verts. 7. The total adjustment of students significantly affected academic achievement of students. Highly adjusted students benefited significantly more through the developed IS as compared to low adjusted students. 8. There was no significant effect of interaction between treatment and intelligence on overall achievement of students. 9. There was no significant effect of interaction between treatment and personality on overall achievement of students. 10. There was no significant effect of interaction between treatment and total adjustment on overall achievement of students. 11. There was no significant change in reactions of students towards various components of the IS and the IS as a whole. 12. The majority of students belonging to different levels of intelligence, personality, and total adjustment expressed their favourable reactions towards the majority of components of the IS and the IS as a whole.

*832. JOSHI, B.P., *Development of Science Education for Upper Primary Classes Based on the Environmental Approach,* S.I.E., Rajasthan, 1981 (NCERT financed)

The objectives of the study were (i) to locate environmental problems, particularly in the state of Rajasthan, which might have a bearing on the rural and semi-urban life, (ii) to analyse and enumerate the scientific viewpoints and the implications of the problems so located and thereafter grade them according to their sophistication and to inject them into the school curriculum and thus make the programme environment oriented, and (iii) to prepare instructional material and supplementary reading material, both for the students and teachers.

A normative survey relating to the school curriculum was conducted in different areas, viz., industrial areas, agricultural areas, areas with poor water resources, non-agricultural areas, desert regions where problems of blown sands were the most important, areas which were interposed by rivers, socially backward areas and hilly tracts. Areas were further categorized on the basis of economical, geographical and cultural conditions and 18 representative blocks were selected from each region. Five per cent of the upper primary schools from each block were selected randomly. In each block 50 per cent of the selected schools formed the control group. From each school one section each of the classes VI, VII and VIII was included in the study. The environmental characteristics of each region and block were identified from secondary sources. The data were collected with the help of questionnaires and interviews. Group discussions, short discussions, short duration seminars and meetings were conducted and views expressed by the participants were recorded and analysed.

The major findings of the study were: 1. Environmental education at the upper primary level was essential and vital to develop insight and skills needed to influence not only the environmental attitudes and behaviour in the students, but also to stimulate their reorientation of values regarding the importance of environmental studies. 2. Children at the primary stage were interested in and learnt from experiences with real things that they could manipulate in some way. 3. The teachers did not identify the objects outside the classroom which might be usually brought inside for study. 4. The environment outside the school was potentially significant for educational purposes. 5. The syllabus was not environmentally oriented, lacked in field studies, did not contain information about ecological balances, protection of fauna and flora, did not include topics like conservation of resources, pollution of water and air, and preservation of wild life, was not interesting and motivating, and did not have relevance to real life.

833. KHALWANIA, N.S., *Effectiveness of Concept Based Science Curriculum in Developing Cognitive Structures and Acquisition of Process Skills among High School Students,* Ph.D. Edu., Pan. U., 1986

The objectives of the study were (i) to develop a concept based science curriculum to teach a few important science concepts, (ii) to study its efficiency as compared to a conventional curriculum in terms of development of cognitive structures and acquisition of process skills, (iii) to study the interaction of the curriculum with the level of intelligence, (iv) to study the effect of socio-economic status of the learner on the development of cognitive structures, and (v) to study the relationship of self-concept of the learner with his cognitive structure.

This was an experimental study where pretest/post-test randomized group design was employed. The study involved four independent factors, namely, curriculum types, self-concept, intelligence and socio-economic status. There were two criterion variables, namely, process skills and cognitive structures. The sample of the study

consisted of 160 students divided into two groups of 80 students each. These groups were assigned to two different types of curriculum, viz. the concept based science curriculum and the conventional one. The tools employed in the study were: (i) The Sodhi and Tejinder Self Concept of Ability Scale, (ii) The Hundal Intelligence Test (1962), (iii) The Kuppuswamy Socio-Economic Status Scale, (iv) The Sodhi Content Comprehension Test, (v) The Sodhi Logical Operation Test based on Piagetian Tasks, (vi) The Process Skill Test having 15 items belonging to five areas, viz., observation, measuring, sensing a problem, interpreting data, and formulating hypotheses and conclusions. The data so collected were analysed with the help of $2\times2\times2\times2$ factorial design of analysis of variance, where each of the four independent variables varied in two ways.

The findings of the study were: 1. The concept based curriculum was more effective than the conventional curriculum in terms of acquisition of process skills as well as in developing better cognitive structures. 2. Students having high self-concept did not differ in process skill scores from students having low self-concept. 3. Levels of intelligence did not affect mean scores on the process skill test. 4. Intelligence acted as a redundant variable as far as development of cognitive structure was concerned. 5. The high socio-economic status group and the low socio-economic group did equally well in the acquisition of process skills in science. 6. Levels of self-concept did not affect the development of cognitive structures. 7. Curriculum types did not interact significantly with levels of intelligence, levels of self-concept and levels of socio-economic status. 8. The low socio-economic group following the concept based curriculum scored significantly higher on process skills than the high self-concept and high socio-economic groups using the conventional curriculum. 9. Low ability students having low socio-economic status when taught the concept based curriculum performed better on the cognitive structure test than high ability and high socio-economic group students. 10. Students having high self-concept and high socio-economic status when taught the concept based curriculum scored higher on the process skill test than students having high self-concept and high socio-economic status but taught through the conventional curriculum. 11. Students with high self-concept and low socio-economic status differed significantly from students with high self-concept but low socio-economic status under the two types of curricula used in the study.

834. KRISHNAN, K., *A Critical Comparative Study of the Secondary School Science Curricula of Kerala and Tamil Nadu*, Ph.D. Edu., Ker. U., 1981

The major objectives of the study were (i) to develop comprehensive evaluative criteria for assessing the secondary school science curricula, and (ii) to assess the secondary school science curricula of the states of Kerala and Tamil Nadu and to compare them in terms of the developed criteria.

The analysis was attempted in terms of evaluative criteria consisting of five dimensions, namely, functional-utilitarian, behavioural-developmental, conceptual-disciplinary, pedagogical-curricular and methodological-instructional. Twenty sets of the guidelines prepared for analysis and the specially developed evaluative criteria both in the original form and the rating scale form, and the original documents of the science curricula and science textbooks prescribed for standards V through X of both the states were supplied to 20 specialists. The assessment and comparison of the curricula were done on the basis of the specialists' rating.

The major findings were: 1. The science curricula of the states of Kerala and Tamil Nadu were both 'moderately statisfactory' with respect to all dimensions except methodological-instructional. 2. The science curricula of the two states did not statisfy most of the criteria prescribed for both traditional and modern science curricula. 3. The science curricula of Kerala State was better than that of Tamil Nadu in meeting four criteria and 14 sub-criteria developed for the study, while the latter was found superior in meeting two criteria and three sub-criteria. 4. The curricula of both the states were found weak in the dimensions of 'methodological-instructional', understanding of the evolution of major concepts and systems of science, and the instruction of major systems of developments of science. The curriculum of Kerala was found to be additionally weak in provision of experiences for developing general manipulative skills and provision of teachers' handbooks. The curriculum of Tamil Nadu was found to be additionally weak in the provision for understanding of basic science-based social functions, provision for accepted forms of curricular organization, representation to important scientific movements, basic laboratory work and comprehensive evaluation of learning outcome, and provision of textbooks and audio-visual materials. 5. The two curricula did not give adequate importance to self-study or practical work. They were

found to be too rigid to provide for meaningful experiences outside the classroom.

835. LAMBHATE, M.V., *Development of Instructional Material for Teachers Teaching Science to Class VI in Rural Areas of M.P.*, Ph.D. Edu., DAVV, 1987

The objectives of the study were (i) to make a survey of the rural area in which the schools were situated, (ii) to analyse the content of the science textbook prescribed for class VI, (iii) to identify the relevant village based material, activities and situations for the teaching of science in the classroom, (iv) to develop the written instructional material with the help of the identified relevant rural material, incorporating in it the necessary aids with graphic materials, models, etc., and (v) to develop a Science Teaching Competence Scale to find out the effectiveness of the developed instructional material in terms of teacher's science teaching competence. The hypothesis was that there would be no significant difference between the mean scores on the science teaching competence scale of the experimental group and the control group.

A random sample of 12 middle schools was selected out of all the middle schools of Depalpur Tehsil. Again, it was randomly assigned to the experimental and control groups. The teachers teaching science to class VI in one group of six middle schools formed the experimental group while teachers teaching science in the other six middle schools formed the control group. In each school two teachers taught science to class VI pupils. Thus in all 24 teachers were in the sample. Pretest/post-test control group design was used. The Science Teaching Competence Scale was developed on the pattern of the Baroda General Teaching Competence Scale (Passi, 1976). There were 25 components in the scale which were grouped under categories like planning, presentation, closing, evaluation, and classroom management. The data were analysed with the help of ANOVA.

The findings of the study were: 1. The use of experimental instructional material by the teachers of the experimental group contributed towards the improvement of their performance. 2. The teachers of the experimental group performed better than those of the control group on (i) selection and organization of contents, (ii) use of proper scientific terminology, teaching aids and experimentation, and (iii) maintaining the classroom discipline by sustaining the attention of students with the help of instructional material. 3. The experimental instructional material could not equip teachers to enable their pupils to think critically. 4. The effectiveness of the environment based material in the teaching of science to grade VI pupils in rural schools was demonstrated.

836. MEHNA, V.H., *An Investigation into Some Factors Affecting Academic Achievement in Science of Standard IX Students of Greater Bombay*, Ph.D. Edu., Bom. U., 1986

The major objectives of the study were (i) to find out the predictors of achievement in science as a whole, physics, chemistry and biology, and (ii) to study sex differences in case of predictors of achievement in science as a whole, physics, chemistry and biology.

The independent variables selected for the study were nonverbal intelligence, verbal intelligence, abstract reasoning, mechanical comprehension, numerical ability, scientific aptitude, interest in medicine, engineering, commerce, arts, fine arts, motivation for learning science, physics, chemistry, biology and students' liking for teachers of science, physics, chemistry and biology. The criterion variables were achievement in science, physics, chemistry and biology. The various tools used were Nafde's Non-verbal Test of Intelligence, OTIS Self-Administering Test of Mental Ability, Bennett's Mechanical Comprehension Test-Form A A, Abstract Reasoning Test-Form A of the D.A.T., Numerical Ability Test of D.A.T., Mascarenhas Interest Inventory, Chatterjee and Mukherjee Test of Scientific Knowledge and Aptitude-Form 1064, Students Liking Scale by S.P. Malhotra and B.K. Passi, Rating Scale on Motivation for learning science and achievement tests in physics, chemistry and biology constructed by the researcher. The sample comprised 308 girls and 376 boys of class IX of English medium schools of Greater Bombay selected through the cluster sampling method. Stepwise multiple regression analysis was applied for data analysis.

The major findings of the study were: 1. Six variables, viz. verbal intelligence, motivation for learning general science, scientific knowledge and aptitude, numerical ability, liking for teachers of science and interest in medicine were significant predictors of achievement of class IX students in general science ($R=0.5773$). The significant predictor variables for boys were scientific knowledge and aptitude, motivation for

general science, verbal intelligence, interest in commerce, numerical ability and liking for science teachers (R=0.5463). The significant predictors of achievement in general science for girls were verbal intelligence, motivation for general science, scientific knowledge and aptitude, liking for teachers of general science and numerical ability (R=0.6500). 2. The significant predictor variables for achievement in physics for students of class IX were the same as those found in the case of general science with the addition of one more variable—abstract reasoning. The significant predictors of achievement in physics in the case of boys were scientific knowledge and aptitude, motivation for learning physics, verbal intelligence, interest in commerce, motivation for learning general science (other than physics), and numerical ability (R=0.5798). In the case of girls, the predictors for physics achievement were scientific knowlege and aptitude, motivation for learning general science other than physics, verbal intelligence, numerical ability and liking for physics teachers (R=0.6184). 3. The significant predictors of achievement in chemistry of students of class IX were verbal intelligence, motivation for learning chemistry, scientific knowledge and aptitude, numerical ability, interest in medicine, liking for chemistry teachers and interest in fine arts (R=0.5573). In the case of boys, all the above variables with the exception of interest in medicine were found to be significant predictors of achievement in chemistry (R=0.5283). In the case of girls, the predictor variables were the same with the exception of numerical ability and interest in fine arts (R=0.6026). 4. Six significant predictors of achievement in biology in the case of students of class IX were verbal intelligence, liking for biology teachers, motivation for general science subjects other than biology, scientific knowledge and aptitude, interest in medicine, interest in commerce (R=0.4938). Significant predictors of achievement in biology in the case of boys were verbal intelligence, motivation for learning biology, liking for biology teachers and interest in commerce (R=0.4191). In the case of girls the predictor set included verbal intelligence, liking for biology teachers, motivation for general science subjects other than biology, scientific knowledge and aptitude and interest in medicine (R=0.6066). 5. Abstract reasoning was found to be a significant predictor only for physics achievement. Numerical ability was a significant predictor of achievement in physics and chemistry but not biology.

The research findings imply that the pupils' performance in science subjects can be improved, (1) if teachers succeed in generating a feeling of liking for them among pupils, (2) if teachers develop aptitude for science among children by providing scientific information, and (3) if teachers can motivate children to learn science subjects. This needs adequate training for teachers in making science teaching interesting and in training them in the techniques of arousing pupils' motivation for learning science.

*837. MENON, S.B., *The Study of a System of Science Education in the Perspective of the Process of Science Inquiry*, Ph.D. Edu., MSU, 1986

The major objectives of the study were (i) to arrive at the norms of development of the process skill of scientific inquiry among students of secondary and higher secondary classes of the English medium schools which followed the curriculum system framed by the Gujarat Secondary and Higher Secondary Education Board, (ii) to study the overall impact of the curriculum system on the development of the process skills of scientific inquiry, (iii) to examine the science textbooks for standards VIII to XII for their suitability to develop skills of scientific inquiry, and (iv) to examine the instruction and evaluation practices in relation to scientific inquiry.

In order to develop the norms of development of the process skills of scientific inquiry, a multi-cross-sectional survey was conducted among a sample of 1448 students of standards VIII to XII belonging to the English medium schools in the city of Baroda. Data were collected with the help of the Test of the Process of Scientific Inquiry (TOPSI) which was constructed and validated by the investigator. To study the overall impact of the curriculum system on the development of the process skills of scientific inquiry, a similar multi-cross-sectional survey was conducted using TOPSI among a sample of 238 students of standards VIII to XII studying in English medium schools of Baroda affiliated to the Central Board of Secondary Education (CBSE). The information generated through this survey was contrasted with that generated in the first survey. A benchmark survey was undertaken to identify the extent to which the various forms of curricular material were utilized in instruction. The respondents for this purpose were students and teachers. The obtained data were subjected to content analysis. A sample of 44 lessons given by science teachers of the English medium schools following the curricula under study were observed using

the System of Observation of Cognitive Processes in Science Instruction (SOCOPSI). In addition to this a sample of practical lessons in the laboratory were also observed and 220 questions asked in the classroom tests were content analysed.

The major findings of the study were: 1. The overall proficiency in the process skills steadily increased as students went up from standard to standard. 2. There was a sudden transition in the overall development of process skills between standards X and XI (around the age of 16 years). 3. The skill of identifying variables had been developed by the time students reached standard VIII. 4. The skill of interpreting observational data was developed around 15 years of age. 5. The skill of controlling the variables did not develop among the students in the system at 17 years of age. 6. Children of the schools affiliated to the CBSE were found better in the development of the process skills. 7. Textbooks were the only curricular material through which the curriculum guidelines percolated up to practising schools, and questions mostly tested the product aspects and not the process aspects.

838. MUDDU, V.M., *A Study of the Effectiveness of the Use of Motion Pictures as Aids in the Teaching of Biological Sciences as Compared to the Usual Methods, Dept. of Education, Osm. U.*, 1978 (UGC financed)

The objective of the study was to test the following hypotheses: (1) Films provide the elements for vicarious visual experiences. (2) The use of effective and appropriate films results in more learning in less time and better retention of what is learned. (3) Films help in increasing factual knowledge, teaching skills, building attitudes, changing motivation, retention of knowledge, etc. (4) Films are the most powerful, prolific, popular, pointed and polished of all the media that penetrate into the conceptualistic skeleton of the human mind.

This was an experimental study comprising pretest/post-test, experimental group and control group design. The sample of the study consisted of 60 students of class VIII of the age group 12-14 years. The sample students (30 students to each group) were assigned to the experimental and control group randomly. The two groups were taught the same topics in biology. The controlled group was taught by the usual method making use of charts and models, and the experimental group was taught with the help of motion pictures as teaching aids. Both the groups were pretested and post-tested on an achievement test in topics taught to them. The mean pupil achievement gain of both groups was compared.

The findings of the study were: 1. There was a significant improvement in the post-test performance of students in both the groups over the pretest. 2. There was significant improvement in post-test performance over pretest performance in higher ranges of scores particularly in the case of the experimental group. 3. There was a definite improvement in the pass percentage in case of the experimental group. 4. The sound pictures helped to a great extent the above average students to comprehend the subject matter in biology. 5. The use of films in teaching of biological sciences helped in more learning in lesser time and better retention of what was learnt. 6. Instructional films stimulated the scientific interest of the students. 7. Instructional films had immense potentialities in teaching and provided the elements for vicarious visual experiences which in turn made the lessons more vital and further made the language used in lessons more meaningful.

839. MUKHOPADHYAY, B., *The Relationship between Comprehensibility of Language Used in the Science Textbook and Science Achievement in Terms of Learning Objectives at Primary Level in the State of Rajashthan*, Ph.D. Edu., Mee. U., 1983

The objectives of the study were (i) to make a linguistic analysis of the textbook prescribed for the subject of science for grade III, (ii) to make a content analysis of the same textbook, (iii) to compare the linguistic content of the textbook with the spoken and written language of children of the particular grade, (iv) to measure the comprehensibility of language used in the science textbook, (v) to measure the achievement of science in terms of knowledge and comprehension categories, (vi) to study the relationship between comprehensibility of language used in the textbook of science and the science achievement, and (vii) to study the relationship of different components of the comprehensibility of language with knowledge and comprehension categories in science achievement.

The purposive sampling technique was used for selecting the sample. For try-out of tests a sample of 250 students from ten schools, reading in grade III (125 from urban and 125 from rural areas) was taken. T

final tests were administered on 400 children reading in 16 primary schools in the district of Jaipur. The sample covered eight urban schools and eight rural schools. Twenty-five students, both boys and girls, reading in grade III were taken randomly from each school. The Comprehensibility of Language Test was developed on the basis of the linguistic analysis of the science textbook and the Science Achievement Test was developed on the basis of the content analysis of the science textbook. The Socio-economic Questionnaire was developed for the collection of some relevant socio-economic information. Conclusions were drawn on the basis of results of chi-square test, product-moment correlation, multiple correlation and analysis of variance.

The findings of the study were: 1. The science textbook maintained some sort of consistency in using the number and types of parts of speech in relation to the spoken and written language of urban children. 2. Urban children had a significantly better capacity in using parts of speech in their spoken and written language than rural children. 3. Significant inconsistency existed regarding the use of sentences in their number and types between the written language of the children and the science textbook. 4. Urban children used significantly more sentences than rural children in their spoken and written language under the given situation and within the same context. 5. Comprehensibility of language used in the science textbook was significantly related to different levels of science achievement. These levels were recall, recognition, translation, interpretation and extrapolation. Comprehensibility of vocabulary, syntax and paragraph—each of these components of comprehensibility of language, was significantly related to science achievement. 6. There was no significant difference in comprehensibility of language between rural and urban children. There was a significant difference in science achievement in terms of learning objectives between rural and urban children. Urban children were superior to rural children with respect to science achievement. 7. There was no significant difference in the comprehensibility of language between boys and girls. There was no significant difference in science achievement between boys and girls. 8. There was no significant difference in comprehensibility of language among children coming from different backgrounds in relation to their fathers' occupations. 9. Different educational backgrounds of fathers had a significant effect on the comprehensibility of language of their children. 10. Children coming from different income levels of parents exhibited no significant difference in comprehensibility of language. 11. There was no significant difference in comprehensibility of language in relation to types of family.

840. NATARAJAN, M.R., *Evaluation of District Level Science Fair and Educational Exhibitions*, SCERT, Andhra Pradesh, 1983

The objectives of the study were (i) to evaluate the organization of district level science fairs in the districts of Andhra Pradesh and (ii) to evaluate the achievement of the objectives of the science fairs and exhibitions organized at district level.

The study was a survey of opinions of teachers and students who participated in the school science fairs and exhibitions organized in 12 different districts of Andhra Pradesh. A sample of 200 teachers and 400 students of different schools was taken. They were administered two questionnaires. The first questionnaire for teachers was to know their opinion about the science fairs and educational exhibitions in which they had participated. The second questionnaire for students was to know their opinions about the benefits of the science fairs and educational exhibitions to which they had gone as observers or participants.

The findings of the study were: 1. Many students felt that they benefited from the books of science and made use of their own efforts in the organization of science fairs. 2. Students felt that these fairs not only motivated them but also motivated their teachers to use innovations in the classroom. 3. Teachers as well as students felt that the science fairs helped in using local resources easily. 4. With the science fairs and organization of exhibitions, the teacher-student interaction and participation of both teachers and students increased. 5. The science fairs and exhibitions helped in building rapport among administrators, teachers and pupils. 6. With the organization of science fairs cognitive insight of teachers and pupils increased. 7. Teachers expressed that the scheme was good and it helped them to make their teaching easier for pupils. 8. In case of organizational aspects of science fairs, 66 per cent of teachers opined that winners should be given certificates but most of them favoured that participants should be provided scholarships. 9. Pupils, teachers and the organizers were of the view that there was a need for separate committees for arrangement of science fairs and a different committee was required for speedy judgement.

841. PILLAI, A.S., *An Experimental Study of Gagne's Conditions of Learning for Instruction in Physics at Secondary Level,* Ph.D. Edu., MSU, 1987

The objectives of the study were (i) to design an instructional strategy based on Gagne's conditions of learning, (ii) to experimentally validate the instructional strategy developed, (iii) to examine whether the acquisition of higher order capabilities necessarily included lower order capabilities also, and (iv) to determine whether the instructional strategy adopted brought about any change in cognitive preference of the learner.

Two divisions of the standard IX with 38 and 37 students in them, of a higher secondary school of Baroda affiliated to the Central Board of Secondary Education, were randomly chosen as the experimental and control groups for the study. The experimental group was provided with instructional events in physics developed in accordance with the conditions of learning as enunciated by Gagne. The instructional events consisted of (1) informing the learner of the objectives, (2) stimulating the recall of pre-requisite learning, (3) presenting the stimulus material by way of instruction, (4) providing learning guidance by way of hints, (5) eliciting performance through individual practice, (6) providing feedback about the performance correctness, (7) enhancing retention through self-learning, (8) providing feedback about individualized self-learning exercise, (9) assessing performance, and (10) providing feedback based on the assessment. Instruction in the control group was through traditional lectures based on the textual material. The teachers teaching the two groups were interchanged after half the programme was over. The instructional materials developed by the investigator were (1) classroom learning material, (2) home assignment material consisting of self-learning material and self-evaluation material, and (3) assessment material. For studying the cognitive preferences, 20 suitable items were selected from the Science Cognitive Preference Inventory developed at the Science Education Centre, University of Iowa. The experimental strategy was validated through criterion tests for each unit and a comprehensive test and also the annual examination. The data were analysed using percentiles, mean, standard deviation, analysis of covariance, chi-square test and t-test.

The study generated the following major findings: 1. The instructional strategy developed based on Gagne's conditions of learning was found feasible for normal classroom teaching. It was found more effective than the traditional method of instruction in terms of student performance. 2. Successful problem solvers were those who had shown better performance at the concept and the rule levels. Hierarchical relationship was found in the learning of intellectual skills with problem solving at the apex followed by rules and concepts. 3. The hierarchy in learning did not depend on the types of instructional input and their sequencing. 4. The instructional strategy based on Gagne's conditions of learning was found to change the cognitive preference from facts and applications to principles and problem solving.

The major implications of the study were that: (1) there is a need for identification of various intellectual skills present and required in a subject-matter study, (2) complex concepts have to be split into smaller elements making it easier for children, and (3) alternative instructional strategies should be developed to first master the lower order skills and then proceed for the acquisition of higher order skills.

842. RAJRANI, *A Factorial and Validational Study of the Abilities Involved in Learning Chemistry at the Secondary Stage,* Ph.D. Edu., Del. U., 1986

The objectives of the study were (i) to find out the Guilford's intellectual abilities involved in learning chemistry at the grade XI stage, and (2) to find out the validity of Guilford's intellectual abilities in predicting success of students in a chemistry course.

In the study stratified sampling technique was followed. The basis of stratification was achievement of students in the public examination held by the Secondary Board of School Education. The students were selected from five strata ranging from very high to very low achieving students. The actual number of students who completed all the tests from five strata was 250. The Guilford's 'Structure of Intellect' Model and achievement test of chemistry were used as tools. The raw scores obtained on the chemistry achievement test were used as criterian scores. Chemistry achievement was used as a dependent variable.

The findings of the study were: 1. Out of 29 Structures of Intellect (SI) Abilities, only seven Structure of Intellect (SI) abilities predicted achievement of students in the class XI chemistry course. These SI abilities were NMU, CMT, DMR, CMS, DSU, NST and DMC. 2. Out of seven statistically significant SI abilities, six were positively related (NMU, CMT, DMR, CMS, DSU and NST) and one (DMC) was negatively related

with chemistry achievement at the class XI stage, 3. On the basis of a student's scores on NMU, CMT, DMR, CMS, DSU, NST and DMC tests, his performance on the chemistry test could be predicted. 4. On factor analysis, seven factors were identified. Only the first factor was associated with chemistry achievement and was named the chemistry achievement factor. Eleven SI abilities, namely, DMR, DSR, NMU, CMU, NMC, DMS, NMR, CSS, CMS, DMT and DSU, supported this factor. Out of these 11 abilities, four (NMU, DMR, DSU and CMS) abilities were supported by regression analysis also. 5. The first factor had maximum contribution towards common variance. 6. The SI abilities supporting the 'Chemistry Achievement Factor' had two types of content, i.e. symbolic and semantic. This was supported by regression analysis also. Therefore the content in the chemistry course reflected by the chemistry achievement test was symbolic and conceptual in nature. 7. Six other factors were identified but these six factors were not associated with chemistry achievement.

843. RAJU, SANTHAMMA, *A Study of the Interaction of the Cognitive and Affective Outcomes in Secondary School Biology*, Ph.D. Edu., Ker. U., 1982

The main objectives of the study were (i) to obtain evidence of any possible overlap of the cognitive and affective variable taken up for study, in terms of relevant interconnections and shared variances, (ii) to examine any possible interdependence of the cognitive and affective variables of the study by comparing the mean scores of the cognitive and affective variables for high and low cognitive and affective achievers respectively, (iii) to examine any possible interaction of the cognitive and affective variables of the study in terms of the dissimilarity of the cognitive and affective factor structures of high and low affective achievers, and (iv) to examine the possible evidence for any direct overlap of the cognitive and affective variables of the study in terms of the presence of common factors. The major hypothesis of the study was that the different cognitive outcomes used in the study were not independent of the affective outcomes, and hence there would be significant interaction between the two groups of variables.

The sample for the study was made up of a representative sample of 513 secondary school students drawn from class X of selected schools in Kerala. The 13 cognitive and affective variables investigated were measured by the administration of two comprehensive tests—The Kerala Test of Biology Achievement for Standard X (based on Bloom's Taxonomy of the Cognitive domain and The Kerala Test of Biology Achievement for Standard X (based on Bloom's Taxonomy of the Affective domain), developed by the investigator. The statistical techniques applied for analysis of the data were testing the significance between means of relevant groups, calculation of product-moment correlations, estimation of shared variance of correlated variables and factor analysis by principal axes method and varimax factor rotation.

The main conclusions were: 1. Evidence of the overlap of the cognitive and affective outcomes were obtained in terms of relevant correlations and shared variance, and in terms of factors with loadings on both groups of outcomes. 2. Evidence of the interdependence of the cognitive and affective outcomes were obtained in terms of significant mean differences and in terms of differing factor structures of correlated achievement groups. 3. Factor analysis of the seven cognitive and affective factors in combination provided two factors, one of which was a purely cognitive factor, while the other was a purely affective factor.

844. RAMESH, *Development of Objective-based Science Curriculum and to study its Efficacy in the Acquisition of Process Skills among High School Science Students*, Ph.D. Edu., Pan. U., 1984

The objectives of the study were to find out (i) whether the objective-based curriculum was superior to the conventional curriculum of science at high school level in terms of achievement, (ii) whether intelligence contributed to achievement, (iii) whether the objective-based curriculum was superior to the conventional curriculum of science at high school level in terms of acquisition of process skills, (iv) whether intelligence contributed significantly to the acquisition of process skills among high school science students, (v) whether personality traits (extraversion and introversion) contributed to the acquisition of process skills among high school science students, (vi) whether there was a significant effect of the interaction between types of curriculum and intelligence on achievement, and acquisition of process skills, (vii) whether the effect of the interaction between intelligence and personality traits was significant, (viii) whether personality of the learner interacted with the mode of curriculum, and (ix) whether there was signifi-

cant interaction between the learner's characteristics (personality and intelligence) and the design of the curriculum.

A sample of 150 students was selected randomly from class X students from government and privately run schools of Ropar district. A 2 × 3 × 2 factorial design was followed in the study. Independent variables in the study were curriculum design (objective-based and traditional), intelligence (high, average and low) and personality (extraversion and introversion). The criterion variables were achievement in science (knowledge, comprehension and application) and acquisition of process skills. The students were exposed to an objective-based curriculum developed in three topics of chemistry, keeping in view educational objectives expressed in behavioural terms. The tools used in the study were: (i) an achievement test developed locally; (ii) a test to measure process skills of observing, measuring objects and phenomena, seeing a problem and seeking ways to solve it, formulating hypotheses, solving the problem by giving reasons, interpreting the data and drawing conclusions. The test-retest reliability of this test was 0.70 and it had content validity, (iii) the Jalota Group Test of General Mental Ability, and (iv) the Nymann-Kohlstedt Diagnostic Test for Introversion and Extraversion.

The findings of the study were: 1. The objective-based curriculum and conventional curriculum in chemistry were equally effective so far as achievement in science was concerned. However, students taught through the objective-based curriculum scored significantly higher on comprehension than those taught through the conventional curriculum. 2. The high ability group performed better than the average and low ability groups. 3. The high ability group following the objective-based curriculum achieved higher mean scores than the group following the conventional curriculum. 4. For average and below average ability students, the conventional curriculum was equally suitable. 5. The extraversion and introversion traits were not responsible for any variance in achievement. The personality of the learner did not account for differential achievement. 6. The mean scores of the group taught through the objective-based curriculum was more effective with respect to acquisition of process skills than the traditional curriculum group. 7. The above average intelligence group had higher mean scores on the process skills test than average and below average intelligence groups. 8. The personality of the students, namely extraversion and introversion, did not affect the acquisition of process skills.

845. RAVEENDRANATHAN, A.K., *A Comparative Study of the Impact of Medium of Instruction on the Science Achievement, Science Interest and Mental Health Status of Secondary School Students,* Ph.D. Edu., Ker. U., 1983

The objectives of the study were (i) to compare the science achievement, science interest and mental health status of secondary school pupils in the English medium and Malayalam medium classes, and (ii) to determine the relationship between the medium of instruction and science achievement, science interest and mental health for the total sample and sub-samples. The main hypothesis was that the pupils studying in the English and Malayalam medium classes differed significantly in their science achievement, science interest and mental health status.

The study had a sample of 890 secondary school pupils chosen by the application of stratified random sampling method. The tools used were the Achievement Test in Biology by Chandrika (1981), the Achievement Test in Physical Science by Vimala, the Science Interest Inventory by Muthu Pillai, Mental Health Status Scales by M. Abraham, Raven's Standard Progressive Matrices, and the Socio-economic Status Scale of Kuppuswamy. The statistical techniques applied included calculation of means and standard deviations, testing the significance of the differences between means, for correlated and uncorrelated groups, and calculation of the point biserial correlation coefficient.

The main findings of the study were: 1. Science achievement, science interest and mental health status of pupils of English medium classes were higher than those of pupils of Malayalam medium classes. 2. Science achievement, science interest and mental health status of pupils of English medium classes were higher than those of pupils of Malayalam medium classes for sub-samples equated on the basis of intelligence, interest and mental health status. 3. For sub-samples equated on the basis of high socio-economic status and high mental status, the differences between English and Malayalam medium classes in science achievement and science interest were not significant.

The study suggested that the choice of medium of instruction for science should be made on the basis of individual assessment of pupils.

*846. SAXENA, A.K., *Attitude towards Physics and Cognitive Preference Styles among Different Groups of Science Students*, Ph.D. Edu., Raj. U., 1985

The main objectives of the study were (i) to develop a Physics Cognitive Preference Styles Test (PCPST) and Attitude Towards Physics Scale (ATPS), (ii) to assess cognitive preference styles of different groups of science students of both sex studying in classes X and XI of central schools and schools of Rajasthan, (iii) to assess the students' attitudes to physics, (iv) to study the relationship between attitudes and cognitive preference styles, and (v) to study the main and interaction effects of 'class', 'sex' and 'type of school' on attitudes and cognitive preference style.

The $2 \times 2 \times 2$ factorial design was considered. One thousand and seventy six students constituted the sample of the study. 'Recall', 'Principles', 'Questioning' and 'Application' were the dimensions of the Physics Cognitive Preference Styles Test whereas 'enthusiasm in physics learning', 'views on physics as a process', 'views on physics learning' and 'attitude towards physicists' constituted the dimensions of ATPS.

The findings were: 1. The cognitive preference style of the entire sample was found to be R⟶P⟶A⟶Q with maximum preference for 'Recall' and minimum preference for 'Questioning'. 2. The science students of different groups differed only in their 'principles' and 'application' preferences for the second and third ranks only. 3. 'Class' and 'type of school' had no effect on choices of preferences. However, male and female students were found to have R⟶A⟶P ⟶Q and R⟶P⟶A⟶Q preference styles respectively. 4. The science students of all the eight groups were found to possess a favourable attitude toward physics. 5. The correlation coefficients between attitude towards physics scores and respective R, P, A and Q scores were found to be 0.58, 0.102, −0.25 and 0.005 respectively.

847. SCERT (Andhra Pradesh), *Evaluation of In-service Training of Secondary School Teachers in Science Teaching Centres attached to the Colleges of Education—in Content and Methodology*, 1980

Science teaching centres were started by the Science Teaching Department of the Directorate of School Education, Hyderabad, in 1977. This study was done to evaluate the in-service training programme run by the science teaching centres with respect to academic and administrative aspects. The training programme was of one month duration.

A sample of 86 participants in physics teaching, and 87 participants in biology teaching were administered a questionnaire. The questionnaire had four parts. Part I was intended to collect general information, Part II was to study feelings about theoretical and explanatory aids to cover the course content, Part III was about the feelings regarding components of the course, and Part IV was regarding the general impression about the course.

The findings of the study were: 1. The proportion of participants who understood the concept, principles and facts was 50 per cent in physics, 64 per cent in chemistry and 45 per cent in biology teaching. 2. Participants indicated that many of the concepts were dealt with in an impressive manner in physics and biology. 3. The demonstrations were conducted in different units satisfactorily. 4. The explanatory aids were not used satisfactorily in the classroom in biology teaching. 5. Many of the participants felt that the laboratory techniques employed during the training programme were useful to improve professional competency. 6. The course was useful in teaching in the classroom and many simple techniques were given to make improved apparatus for teaching science. 7. The duration of the course was quite short. 8. According to the participants, time devoted to practicals was not satisfactory. 9. Though the course had high academic value, the syllabus prescribed for teaching in the schools was very heavy. Some of the topics prescribed in the syllabus in biology were not relevant to the age group of the students. 10. Several activities and projects undertaken during the training programme made many participants enthusiastic to undertake such projects in their schools also.

848. SCERT (Andhra Pradesh), *Evaluation Study of In-service Training of Secondary School Science Teachers in Improvisation Techniques in Science Teaching Courses of the Colleges of Education*, 1982

The objectives of the enquiry were (i) to study the relevance of course content of the in-service training programme, (ii) to study the relevance of activities of the in-service training programme to the objectives of the training programme, (iii) to study the relevance of improvisation techniques being taught in the in-service training programme, and (iv) to study the attitude of in-

service teachers towards improvisation of science equipment for science teaching in secondary schools.

The study was conducted with a sample of 400 participants of two sessions who attended the in-service training programmes in the colleges of education in Andhra Pradesh. They were administered a questionnaire. The first part of the questionnaire was concerned with assessing the relevance of the course content and the activities being followed during the course. The second part of the questionnaire was about the attitude of the respondents towards improvisation of science equipment.

The findings of the study were: 1. More than 60 per cent of the participants felt that the course was good and acquainted the teachers with new developments in science. 2. Most of the participants felt that there was not adequate staff and individual attention was not given during the course. 3. The participants felt that they could not attend the course properly because of too much interference from the education officers and other supervisors. 4. The participants felt that the course was theoretically relevant but practically many of the problems of science teaching in the classroom were not taken into account. 5. The participants felt that the teacher-educators did not consider them as equals but treated them as students. 6. The participants had a feeling that even the teacher-educators were not fully acquainted with modern concepts and development in science. 7. Most of the teaching activities being practised during the in-service training programme were not usually applicable in the classroom situation. 8. The methods of teaching being preached for science teaching in the training programme were already practised by the participants in one way or another. 9. Improvisation of the science apparatus was a good activity but it was not fully relevant to the environmental set-up of the schools in which they worked. 10. Because of the interference of the headmasters and other colleagues it was not possible to use the improvisation techniques. 11. The improvisation of science apparatus was not possible as much of the time was used in covering the prescribed syllabus. 12. The improvisation of science apparatus as taught in the course was mostly for the cheaper items. For costlier items improvisation was rarely used.

849. SCERT (Andhra Pradesh), *Evaluation Study of State Level Science Fair and Educational Exhibition*, 1980

The objectives of the study were (i) to examine the science fair and educational exhibition with a view to evaluating creativity, (ii) to evaluate the science fair and educational exhibition from the point of view of organizers, teachers and participant pupils, and (iii) to assess the effectiveness of the science fair and educational exhibition from the point of view of teachers and students with respect to attainment of new knowledge and using innovations in teaching.

The study was conducted with a sample of ten organizers, 60 teachers and 200 pupil participants. They were administered different questionnaires. The questionnaire for organizers was used to know about the organization of the science fair. The questionnaire for teachers and pupils was used to know about the theme and use of the science fair. The sample organizers were also asked to observe the creativity level of the participants in the science fair.

The findings of the study were: 1. More than 50 per cent teachers felt that the main themes selected for the science fair for high school and upper primary classes were clearly brought out. 2. Almost all participant pupils felt that the science fair was helpful to clarify their understanding of various concepts in science. 3. The organizers felt that creativity of the pupils was fully exhibited in the science fair. They also opined that creativity was more in physical sciences than in life sciences. 4. The teachers felt that the science fair was helpful in bringing out creative talent among the students. 5. The innovations brought out in the science fair were of high standard. 6. The teachers felt that the prizes given in the science fair were not adequate. 7. The pupil participants felt that the criteria of judgement was suitable and appropriate. 8. The organizers indicated that students who showed their talent in the state level exhibition should be given extra coaching by the state to compete for science talent examinations held at national level. 9. The organizers and the teachers felt that the science fair was very effective as the students were able to learn many new concepts which otherwise could not be easily clarified in the classroom. 10. The pupil participants felt that after the science fair the teachers used many new methods of teaching to teach concepts in science.

850. SCERT (Andhra Pradesh), *Evaluation Study of Textbooks in Environmental Studies of Classes III and V Based on Revised Curriculum in Science*, 1980

The objectives of the study were (i) to compare the old

and new science curriculum of classes III and V with respect to the cognitive load on the students, (ii) to assess the revised science curriculum with respect to instructional objectives attained, and (iii) to assess each unit of the revised curriculum with respect to its emphasis on modernity.

The sample of the study consisted of 20 headmasters, 200 teachers and 100 educated parents of the pupils. The sample subjects were administered a checklist about the revised curriculum and the old curriculum in science as was being used in classes III and V. The checklist had six areas. These were: relevance to the environment in which the children lived, relevance to educational objectives, relevance to age level of the children, modernity, enrichment in knowledge of the child, and relevance to the needs of children.

The findings of the study were: 1. Most of the headmasters and teachers felt that the old curriculum was not relevant to the child's cognitive level as well as needs, but contrary to this, parents felt that the old curriculum was easily understandable to the children. 2. The teachers and headmasters felt that the new curriculum was relevant to the environment in which the children lived, but the parents of the children felt that the new curriculum increased the cognitive load of the children. 3. According to the teachers and headmasters, the new science curriculum fulfilled the educational objectives as prescribed by the Directorate of Education. 4. The headmasters felt that the new curriculum was relevant to the age level of the children. But the teachers and the parents felt that the new curriculum was above the cognitive level of the children of classes III and V. 5. The headmasters and teachers opined that the new science curriculum was helpful in developing modernity amongst pupils. The view of the parents did not indicate anything in this direction. 6. The teachers, parents and headmasters opined that the new curriculum was more helpful than the old one in enriching the knowledge of the children. 7. The parents, teachers and headmasters indicated that the new curriculum was relevant to the needs of the children.

851. SCERT (Andhra Pradesh), *Evaluation of UNICEF Aided Science and Mathematics Pilot Project Scheme for Classes VI and VII*, 1981

The objectives of the study were (i) to evaluate the textbooks prescribed for science and mathematics for students of classes VI and VII, (ii) to examine the views of parents, teachers and students about the textbooks of science and mathematics, and (iii) to examine the views of teachers about handling of the subject matter through questioning technique in the class.

The sample for the study consisted of ten principals, ten inspectors, 40 teachers, 100 pupils and 100 parents of pupils studying in the experimental schools. The data were collected with the help of four questionnaires— (i) questionnaire I was for principals and inspectors for their evaluation of the textbooks, (ii) questionnaire II was for teachers to know their reactions about handling of the subject through questions in the class, (iii) questionnaire III was to know from pupils their opinion about the textbooks, and (iv) questionnaire IV was for parents of pupils to know their opinion about the textbooks.

The findings of the study were: 1. All teachers, parents and pupils were of the opinion that there was continuity in the development of content in mathematics textbooks. 2. In the case of physics textbooks, all teachers agreed that the syllabus was based on modern concepts in physics, was catering to the needs and interests of the pupils, and was in conformity with the principles of syllabus construction. 3. In the case of biology textbooks, teachers, parents and pupils felt that modern concepts had been included in the text-books and they were in conformity with the principles of syllabus construction. 4. The teachers were of the view that the question technique as used in the class did not help the students to grasp the new concepts. 5. The parents were of the view that mathematics textbooks had a continuity but were confusing to the students. Further, they felt that they were not able to help their wards in solving the exercises given in the mathematics textbooks.

852. SHARMA. H.L., *A Critical Study of the Development of School Science Education in India from 1947 to 1977*, Ph.D. Edu., JMI, 1984

The study was conducted assuming that such a study of school science education policy over a period of 30 years of post independence would be of some value to the policy makers and planners, if focused on analysing the experiences gained during the period 1947–77.

Information was collected mainly from the following sources: (i) reports of various commissions, committees, Ministry of Education, NCERT, Five Year Plans, CABE's reports and reports of the ministers and secretaries' conferences, (ii) personal interviews (unstruc-

tured) with persons involved in various committees for framing the policies and with science education workers, (iii) visits to institutions connected with implementation of policies on science education such as the State Institute of Science Education/SCERT, and (iv) a filled in questionnaire received under the Science Education Project by the Department of Education in Science and Mathematics of NCERT.

The major findings of the study were: 1. After the imposition of imperial authority of India only those persons had access to learning modern science who studied in English medium schools. During the British period vacillations, uncertainty and aimless compromise were found both the making a school science policy and in its execution. 2. During the period of 1947-52 two views regarding teaching science were advocated. The syllabus for basic schools visualized the general science approach to teaching science at the elementary stage in an integrated way and not as a separate school subject, while another view was to teach science as systematized knowledge according to the concept approach. The debate for having the same science curriculum for rural and urban schools also continued. The teaching of science was found to be not satisfactory. Whatever it was proposed to achieve could not be put into practice. One reason was inertia of the educational system. 3. The period 1952–57 was the period when national efforts to improve secondary education were mounted. The Secondary Educational Commission of 1953 was against specialization and recommended a general science course, i.e. a general introduction to all the broad and significant fields of scientific knowledge, while at the same time it desired an understanding and appreciation of the fundamental principles of science. This ambiguity in policy decision was subjected to different interpretations at the implementation stage by the decision makers at the national and state levels. Due to this, the school science education policy appeared to be bandied around from one idea to another, and from one recommendation to another, leading to vacillations in policy implementation. 4. During the period 1957-62, the major school science curricular trend was still general science. However, the echo of the concept approach could be heard in various seminars. This happened because of the absence of proper experimentation in the field of school science education for effective planning and implementation and a clear cut school science education policy could not emerge because of parallel and continuing viewpoints on school science. 5. The period 1962-67 was a watershed for the school science education policy. The Indian Parliamentary and Scientific Committee (IPSC) 1964 recommended the uniformity of courses and class structure as well as the upgrading of the content of science. The Education Commission (1964-66) criticized the general science approach and said that it was somewhat formless and without structure. It suggested the disciplinary approach. 6. During the period 1967-72, efforts were mounted to implement the recommendations of the UNESCO Planning Mission (1964) and Education Commission (1964-66). The National Policy on Education was declared in 1968 according to which emphasis was to be laid on the development of science and technology education. On the one hand, instructional materials were prepared under a UNESCO-UNICEF project in which Russian and Indian experts trained in the USSR contributed, and on the other hand instructional material were prepared by study group projects in which Indian university professors contributed under the structure of discipline movement in America. 7. Again the period 1972-77 was a watershed for the school science education policy. Efforts were made to implement the recommendations of the Indian Parliamentary and Scientific Committee, UNESCO Planning Mission, and Education Commission. In 1973 the Ministry of Education appointed an expert group to prepare model curricula for ten years. These model curricula recommended that school science be taught as environmental studies at the primary stage, as an integrated course at the middle stage, and as integrated groups of subjects at the high school stage. The environmental study programmes were tried at national level and at regional level. The guide prepared for teachers of the Municipal Corporation of Delhi observed that 'any environmental study should include some of the skills and knowledge of history, geography and science'. So the environmental studies concept became much more formless and diffuse than the general science concept. At the middle stage the syllabus was based on the unit approach. However, some units were also based on correlation of ideas from different disciplines and some units were based on a fused curriculum. This was done due to a compromise between the decision makers who desired a national policy as well as maintaining the autonomy of states and local bodies. The same thing happened at high school stage. Thus no concerted effort at formulation of a clear cut and consistent school science education policy was made during all these years.

853. SHARMA, V.S., *Comparative Study of the Achievement of Boys and Girls in General Science and Mathematics at Delta Class in Rajasthan*, SIERT, Rajasthan, 1975

The main objective of this study was to compare the achievement of pupils of delta class in general science and mathematics.

The institutions selected for the administration of the tests comprised 24 each of the four types of institutions, viz. rural, urban, boys' and girls' of the state of Rajasthan. The final form of the test in general science had 149 items and that in mathematics 100 items. The reliability of the tests was calculated by the application of split-half method on the scores of 200 boys and 200 girls. Guttman formula and Kuder-Richardson-21 formula were used. The coefficients of concurrent and congruent validities of the tests were obtained by correlating test scores with marks of pupils in the annual examination, and also with the ratings of the pupils made by their respective teachers on a predetermined five-point rating scale. The coefficient of correlation was calculated by the application of product-moment correlation technique taking the entire sample of 1708 pupils into consideration. In order to find out the variance in attainment of the different strata of the samples, analysis of variance was used.

The study revealed the following: 1. The prevalent syllabus in general science and mathematics for the students of the delta class in Rajasthan was highly effective, outmoded and wanting in a proper process of evaluation. There was no proper relationship between the course content prescribed in the syllabus and that presented in the textbook for the delta class pupils. 2. The reliability of the test prepared by the investigator in general science ranged from 0.91 to 0.93 and that in mathematics from 0.96 to 0.88. 3. The validity coefficients of the test in general science ranged from 0.45 to 0.58 and that for the test in mathematics from 0.44 to 0.57. 4. The performance of the pupils in general science was highest in Sirohi, Sikar and Tonk districts, and lowest in the districts of Bikaner, Udaipur and Bundi. 5. The performance of the pupils in mathematics was highest in Alwar, Ajmer and Sirohi districts, and lowest in Bundi, Sawai Madhopur and Udaipur districts. 6. There was a significant difference between the performance of boys and girls on the test in general science and mathematics. The girls were superior to the boys in both the subjects. 7. There was also a significant difference between the performance of the rural and urban population on the test in general science whereas there was no significant difference between the performance of the rural and urban population on the mathematics test.

854. SHINDE, Y.K., *A Study of Non-formal Science Activities in Secondary Schools of Maharashtra State with Special Reference to Their Impact on Scientific Attitude and Achievement in Science*, Ph.D. Edu., Bom. U., 1982

The objectives of the enquiry were (i) to study the involvement in non-formal scientific activities of secondary school students, (ii) to develop a scale to study the scientific attitude of students at the secondary stage, (iii) to study the scientific attitudes of secondary students, (iv) to inquire into the relationship between the extent of involvement in scientific activities, scientific attitude and achievement in science, and (v) to study the science teachers' role in encouraging non-formal science activities.

The sample comprised 1600 secondary students of Maharashtra selected on a random basis from all the regions of the state. It also included 300 experts. The tools used were a scale to measure involvement in scientific activities, scientific attitude scale, and a checklist. Descriptive statistics were used for data analysis.

The study revealed the following: 1. The means of non-formal science activity scores achieved by adolescents differed from region to region. 2. The boys were better than the girls in their non-formal science activity involvement. 3. The correlation between the scientific attitude scores and non-formal science activity scores was negligible and not significant. Thus scientific attitude of the secondary students was not related to their involvement in non-formal activities. 4. Academic achievement of the students was not related to their involvement in non-formal activities. 5. Field observations, activity participation, and activity independence of the students were related to one another. 6. The boys and girls did not differ in their scientific attitudes. 7. Students with high academic achievement had high scientific attitude, students with average academic achievement had average scientific attitude, and the low achievers had a low scientific attitude. 8. Girls showed a better relationship between scientific attitude and academic achievement than boys. 9. Scientific attitude of the students differed from region to region. 10. The boys and the girls from the same cultural group did not differ significantly with respect to their scientific attitude.

*855. SINGH, S., *An Investigation into the Relationship between Achievement of Certain Concepts of Physical Chemistry and Cognition and Convergent Production of Semantic Classes, Relations and Implications of the Morphological Model of Structure of Intellect,* Ph.D. Edu., JMI, 1988

The major objectives of the study were (i) to identify through analysis of content, conceptual hierarchies of the concepts of atomic structure, periodic properties of elements, and chemical bonds and molecules, according to the sequential learning model of Gagne, (ii) to construct an achievement test in order to assess achievement in concepts of physical chemistry selected for study, (iii) to study the relationship between concept achievement, composite and reasoning ability composite, concept achievement composite and convergent production of semantic classes, relations and implications (iv) to identify the factors that would explain the common variance, and (v) to study the contribution of various measures of reasoning abilities to the variance in various sub-tests of concept achievement in physical chemistry.

The sample of the study consisted of 200 students of class XI. In order to collect relevant data, two test batteries, one constructed by the investigator, i.e. Concept Achievement Test-Battery, and the other Bala's Battery of Reasoning Ability Tests, were administered to class XI students when they completed the selected physical chemistry components of the curriculum. The data obtained from this sample were tabulated and analysed in order to identify the relationship between these variables. Coefficient of correlation was computed in order to identify the relationship amongst variables; on the basis of an inter-correlation matrix, factor analysis according to varimax criterion was carried out. Finally, multiple regression analysis was carried out to determine the contribution of reasoning abilities to the variance in achievement.

The major findings of the study were: 1. A significant positive relationship was found between reasoning ability and achievement of concepts in physical chemistry. 2. A significant positive relationship was found between concept achievement composite and reasoning abilities represented by six SOI categories. 3. In the correlations between 19 reasoning ability tests and composite of concept achievement in physical chemistry, except for apparatus test (CMI), word grouping and figure concepts (NMC), all the other correlations were significant at .05 level. 4. Out of 190 correlations between 19 reasoning ability tests and ten concept achievement tests, 149 correlations were positive and significant at .05 level. 5. As a result of the factor analysis six factors were identified, viz. Education of Categories and Relations, Cognition of Semantic Implications, Deduction of Relations and Implications, Deduction of Categories and Implications, Deduction of Categories and Relations, and Education Categories and Implications. In addition to this, several other factors were identified by analysing different intercorrelation matrices.

856. SINGH, SURENDRA PRATAP, *A Study of Courses, Their Objectives and Methods of Teaching Followed at the Undergraduate Level in Biological Science,* Ph.D. Edu., BHU, 1985

The study was undertaken to find out if the objectives as conceived by educationists in the reports of commissions, the conferences of vice-chancellors, the UGC Policy Frame, etc. were actually taken into account while drawing up undergraduate courses in sciences and in teaching. The objectives of the study were to find out, (i) how far the general and specific objectives in biological sciences were relevant and realized, (ii) which items of study were prescribed for realizing the objectives of foundation, core and elective courses and of applied studies and extension programmes, and how far they were relevant, (iii) what combinations of studies were prescribed and how far they were relevant, (iv) which version of the BSCS was prescribed and how far it was relevant, (v) what was the opinion of students about the standards of current courses, (vi) which methods and teaching aids were used and were useful, and (vii) in what ways were experiments conducted.

The survey method was adopted, and a questionnaire was filled in by 94 teachers and 534 research scholars, students of M.Sc. and B.Sc. from BHU, Allahabad, Lucknow and Awadh University colleges. The data were analysed and percentages were used for data analysis.

The findings of the study were: 1. Excepting one, all general objectives were considered to be relevant, but none were realized. 2. All the specific objectives were considered relevant, and except for a few, many were thought to be realized by teachers and students. 3. Teachers and students were not in agreement regarding division of courses as foundation, core and elective courses and extension programmes and applied studies. Items were not prescribed under foundation and elec-

tive courses, though they might be relevant. As to core courses, items had been prescribed, and they were relevant also. Only some items under applied studies had been prescribed. All were relevant. None under extension studies had been prescribed. The relative weightages given by the UGC Policy Frame for these five courses were broadly acceptable to teachers and students. 4. All suggested combinations of courses were not available for students in many universities. 5. They opined that all versions of BSCS were relevant, and they were also prescribed at undergraduate level. 6. A majority believed that the current courses were of an advanced type and they did not provide opportunity for an inter-disciplinary programme of teaching. 7. Lecture, experimental and lecture-demonstration methods were generally used. 8. Except for demonstration, microscopes, maps and charts, other important teaching aids were not used. 9. Experiments from prepared lists were done. Students were not free to conduct their own experiments. 10. The majority of students had favourable opinions regarding teachers' preparation and presentation in the class.

*857. SINGHAL, K.N., *Physics Education Using Non-Formal Methods,* Dept. of Physics, M. Sukh. U. 1983, (NCERT financed)

The objectives of the study were (i) to identify academic problems of science students and teachers at the higher secondary stage and first year of colleges, and (ii) to conduct action oriented programmes according to the requirements of the respondents.

In order to identify the academic problems of students and teachers, a questionnaire was circulated among physicists/educationists working in higher secondary schools, colleges, universities, and research institutions mostly in Rajasthan and also in a few places outside the state. After identifying the problems a number of programmes were organized to meet the requirements of the students and teachers. The programmes included competitions, inter-disciplinary talks, physics through thought questions, short duration courses, library use, arranging talkes on modern topics at the schools, and evaluation of the courses.

The major conclusions of the study were: 1. Students did not read beyond the syllabus and did not inculcate the habit of understanding the basic concepts of physics. 2. Science students were found very weak in numerical work. 3. Expression was very weak as they did not prepare their own notes. 4. The idea of introducing a question bank at all public examinations was suggested by a large number of respondents. 5. Special classes by experts in their fields were needed to meet the requirements of a few intelligent students during holidays/vacations. 6. Competitions like prepared talk, extempore talk, essay competition, and intelligence test, were suggested first in individual schools in a district and then at the state level. 7. Interdisciplinary talks were needed to be frequently arranged in each department to keep the students up to date with a variety of topics. 8. Thought questions created interest in physics and a large number of respondents appreciated this effort. 9. Short duration courses organized for teachers and the cyclostyled materials prepared for them were found useful by the teachers. 10. There was very little interest among students and teachers in taking books for reading even when arrangements were made to send books to their addresses. 11. Talks on modern topics by students and experts were found useful and needed further extension. 12. No logical and scientific way was found to improve the syllabus.

858. SRIVASTAVA, KUM KUM, *Impact of Science Teaching on the Child's Concept of Physical Causality—An Experimental Study,* Ph.D. Edu., Luc. U., 1987

The study was designed to investigate the effect of selected science experiences on the fourth grade child's concept of Piagetian physical causality.

The sample for the study consisted of 300 grade IV childern ranging between the ages of eight and 11 years. Of these, 170 were boys and 130 girls. Vocabulary abilitity and Piagetian development stages were assessed through the use of the Hindi Vocabulary Test of the Allahabad Adaptation of the Stanford-Binet Scale and a Hindi Version of the Concept Assessment Kit Conservation Form A. The subjects were randomly assigned to the experimental and the control groups. There were 150 students in each group. During the treatment phase, 300 minutes were devoted to the teaching of the cause of 'floating' to the experimental group. The second 150 minutes were devoted to the teaching of the definition of the term 'living'. The control group was given 300 minutes of Language Arts instruction as a placebo. On completion of the treatment phase, post-testing was conducted.

The main findings of the study were: 1. The perform-

ance of the experimental group was superior to the performance of the control group. 2. Male and female students in the experimental group did not differ on the concept of 'floating' but they differed significantly on the concept of 'living'. 3. There was no significant difference in the use of causal relation of animism and dynamism when the independent variables of vocabulary level and stage of development were considered. 4. There was no significant difference between the children who showed a change in cognitive stages and those who did not show such a change in the level of understanding of the concept of 'living'. 5. The two groups, however, differed at .05 level in their understanding of the concept of 'floating'.

859. SUSHMA, *Effectiveness of Concept Attainment and Biological Science Inquiry Models for Teaching Biological Sciences to Class VIII Students*, Ph.D. Edu., BHU, 1987

The objectives of inquiry were (i) to study the effects of Concept Attainment Model based teaching on pupils' achievement, (ii) to study the effects of Biological Science Inquiry Model based teaching on pupils' achievement, (iii) to compare the effectiveness of Concept Attainment Model based teaching, Biological Science Inquiry Model based teaching, and the traditional teaching approach on pupils' achievement, (iv) to study the effects of Concept Attainment Model based teaching on pupils' attitude towards biological science, (v) to study the effects of Biological Science Inquiry Model based teaching on pupils' attitude towards biological science, and (vi) to study the difference in change in attitude towards biological science when taught through different models of teaching, (Concept Attainment and Biological Science Inquiry Models) and conventional teaching.

Purposive sampling was done for the study. The final sample consisted of 78 students of class VIII, i.e. 26 students in each section after removing irregular students. The study was conducted on two expcrimental groups. One group was taught through the Concept Attainment Model, and the other group through the Biological Science Inquiry Model. The control group was taught through the traditional approach. All the students included in the sample were girls in the age group of 13-14 years. The tools used in the study were: (i) Samanya Mansik Yogyata Parikshan by M.C. Joshi, (ii) Socio-Economic Status Index Scale by R.P. Varma and P.C. Saxena, (iii) Uplabdhi Parikshan (in Jeev Vigyan) constructed by the researcher, and (iv) Jeev Vigyan Ke Prati Chhatra Abhivriti Mapan Suchi, constructed by the researcher. Data were analysed by applying ANOVA and t-test.

The major findings of the study were: 1. The Concept Attainment Model and Biological Science Inquiry Model were found effective at 0.01 level when the means of pretest and post-test scores were compared by applying t-test. 2. The Concept Attainment Model was found more effective than the Biological Science Inquiry Model. 3. The Biological Science Inquiry Model was found more effective than conventional teaching. 4. When the means of pretest and post-test attitude scores were compared, both the models had significant effects. 5. The Concept Attainment Model changed the attitude more favourably than the Biological Science Inquiry Model. 6. No significant difference was found between the gain scores of attitude with the Biological Science Inquiry Model based teaching and conventional teaching.

***860.** UCHAT, D.A., *Study of the Reactions regarding the various Syllabi Units of Biology, Chemistry, Mathematics and Physics Subjects of Standard XII*, Dept. of Education, Sau. U., 1982

The main objectives of the study were (i) to determine the difficulty level for various units of the syllabi of biology, chemistry, mathematics and physics subjects of standard XII as viewed by high achieving students and low achieving students according to the results of SSC and the results of the respective subjects of standard XII, and (ii) to determine the difficulty level for various units of four science subjects of standard XII as viewed by all students and teachers of the respective subjects.

The sample consised of 485 students of standard XII from all the higher secondary schools of Rajkot. The sample also comprised 48 teachers of biology, 45 teachers of chemistry, 45 teachers of mathematics and 49 teachers of physics—selected from higher secondary schools and science colleges of Gujarat state. With the help of textbooks, syllabi and qualified and experienced teachers of each subject, four lists of instructional units were carefully prepared. In all 173 units in biology, 142 units in chemistry, 100 units in mathematics, and 143 units in physics were listed in the final schedules. A five-point rating scale was used for getting the opinions re-

garding the difficulty level of various units of each subject. The difficulty level of each unit was determined on the basis of these opinions.

The major findings of the study were: 1. In the subject of biology, out of 27 chapters, six were difficult, while 50 units (out of 173 units) were found most difficult in various chapters of biology. 2. In the subject of chemistry, out of 15 chapters, seven were found difficult, while out of 142 units of the whole curriculum of chemistry, 50 units were found most difficult. 3. In the subject of mathematics, out of 11 chapters, five were found difficult and out of 100 units, 40 units were most difficult. 4. There were 18 chapters and 143 units in the curriculum of physics. Among these, seven chapters and 53 units were found difficult. 5. Among these four science subjects, physics was considered as the most difficult subject and biology was considered as the least difficult one.

861. VARDHINI, V.P. *Development of a Multimedia Instructional Strategy for Teaching Science (Physics and Chemistry) at Secondary Level*, Ph.D. Edu., MSU, 1983

The objectives of the study were (i) to develop a validated multimedia instructional strategy for teaching science (physics and chemistry) in Standard VIII, (ii) to study the relationship between achievement using the strategy and intelligence and scientific attitude, (iii) to develop alternative instructional inputs and study their effectiveness, and (iv) to study the feasibility of the strategy in terms of time and cost.

The instructional strategy was validated on a single group of 45 students of class VIII of an English medium school of Baroda City. The control group consisted of 47 students of another section of the same grade who were not exposed to the strategy. The inputs of the strategy were introduction, lecture, discussion sequence, discussion, guided discovery, audio-visual and biographical accounts, summaries, glossary, diagrams, exercises and assignments, criterion tests and feedback. The experiment was conducted for one academic year to cover 19 units of the subjects chosen for study. The instruments used in the study were: (a) criterion tests and comprehensive tests prepared by the investigator, (b) scientific attitude scale prepared by the researcher, (c) Madhooker Patel's Intelligence Test, (d) a reaction scale prepared by the investigator and (e) the examinations conducted by the school. Descriptive statistical techniques and the t-test were used for analysis and hypothesis testing.

The major findings of the study were: 1. Almost all the units indicated average/high level of performance on the total test. 2. The strategy was found valid against the criterion of scientific attitude in that significantly higher performance was noted for the group in the posttest over the pretest. 3. Validity of the strategy was established from reactions expressed by students for its continuance and also their improvement in science achievement. 4. Intelligence and achievement using the strategy presented a significant relationship. 5. A significant relationship was found between scientific attitude and achievement for the experimental group and control group. 6. Visual projections with teacher explanation and those with taped commentary were equally effective in terms of achievement. 7. Programmed material and discussion sequence were equally effective on the total test. 8. The strategy was found feasible when seen in terms of its reproducibility and the cost management by individual schools.

The educational implication of the study is that for achievement of different instructional objectives, a systematically validated multimedia strategy can be implemented at school level with suitable cost and time components.

862. VASHISHTHA, U.C., *Mechanistic and Organismic Viewpoints in Biology and Their Trace in Education*, Ph.D. Edu., DAVV, 1986

The objectives of the study were (i) to trace the origin and development of the mechanistic viewpoint in biology, (ii) to trace the origin and development of the organismic viewpoint in biology, (iii) to trace the arguments put forth by mechanists and organismists in biology, (iv) to examine the mechanistic and organismic viewpoints in biology with reference to certain issues in biology, and (v) to trace these mechanistic and organismic viewpoints of biology in education.

The philosophical method was followed. It incorporated library study, logical analysis, and ultimately synthesis.

The findings of the study were: 1. The age old conflict between mechanistic and organismic viewpoints could be the reflections of the two opposite tendencies of the human mind—one to attribute life to mathematical and scientific laws and the other to some supernatural phenomena, such as God in earlier times, or a 'para-

meterial phenomenon' in the present. 2. The organismic viewpoint was placed before us by the writings of Hippocrates and Aristotle. Hippocrates worked on the health of man and talked of certain methods of curing men. Aristotle's 'entelechy' laid the foundation of all future vitalistic thought. Entelechy or the internal principle gave origin to all natural things and made them reach completion. He regarded the soul as the essence of the human body. Stahl (1660-1734) grouped the archei of Helmont into one sensitive soul, governing all chemical changes in the body. Gustaf Stromberg, a physicist, talked of Genii, the organizing principle governing life. In later years Bertalanffy, Haldane and Polanyi stand as the founder philosophers of the organismic point of view. Bertalanffy based his arguments on the theory of open systems, Haldane on the theory of coordination and maintenance, and Polanyi on the idea of boundary conditions. 3. The mechanistic viewpoint in biology was upheld by Oparin's theory of the origin of life, Watson's and Crick's DNA model and Schaffner's theory of reduction of biology. Oparin opined that life originated on earth in three phases—geogeny, chemogeny, and biogeny. Watson and Crick proposed in 1953 a molecular model of DNA, the basic hereditary material. DNA was deduced as a very large molecule, of high molecular weight, composed of two sugar phosphate strands, oriented in opposite directions and together forming a double helix making a complete turn every 34 angstron units. Schaffner regarded the reduction in biology similar to the reduction of physical optics to Maxwell's electromagnetic theory in physics. 4. The organismic viewpoint in biology was supported by J.B.S. Haldane, Ludwig Von Bertalanffy and Michael Polanyi. Haldane said that although every activity or part of any living organism or even of the environment was determined by its relation to other parts and activities, yet the determination was extremely coordinated with other parts and activities, to the extent that the specific structure and activities of the organisms were maintained and reproduced. Bertalanffy regarded the living systems not as closed but open systems since the living organisms continuously give up matter to the outer world and take in matter from it. Also, living beings maintained themselves in this continuous exchange in a steady state. Michael Polanyi's arguments for the irreducibility of biology to physics and chemistry were based on his principle of harnessing conditions which he applied to both machine and DNA and after comparing the two, drew conclusions. 5. Shapere pointed out that for the reduction of biology, analysis and techniques of idealization, approximation and simplification were required. Organismic biologists, like E.S. Russel, J.B.S. Haldane, and Ludwig Von Bertalanffy hold that for biology's autonomy, biological processes should be explainable in terms of fundamental principles which were themselves biological principles. With regard to theories and models in biology, the mechanistic and organismic viewpoints had different versions. To mechanists, biology was neither a theoretical subject nor did it have its own models and laws. Instead, it was merely an application of physics and chemistry. Organismists regarded biology as a subject not only exact but also having theories and models. While mechanists viewed organisms and even man as mere machines, organismists regarded them as much more than machines. The clashes between mechanistic and organismic viewpoints in biology could also be viewed as the difference between paradigms, the difference between seeking explanations in terms of physico-chemical principles and attempting to explain biological processes in terms of the system as a whole. With respect to the concept of life, organismists talked of the 'characteristics' of life while mechanists talked of the 'building blocks' of life. 6. The trace of mechanistic and organismic viewpoints in education was studied with reference to the meaning and concept of education, the method and content of teaching and the methodology of research in education. For arriving at the concept of education, an organismist would trace the development of education in all societies starting from when the concept of education emerged for the first time till today. Contrary to this, the educationist with a mechanistic bent of mind, cut the above mentioned stream of world from the time dimension and viewed it at one particular state which was devoid of time, culture and value. Mechanists would design the methods of training and teaching in a piecemeal, atomistic and value neutral approach. Instead, organismic content and method, besides a teleological background, would wrap in it characters like holistic, value laden historicism and non status quo. The trace of these viewpoints could be viewed in biology with regard to the nature of biological knowledge, the method of biological knowledge, the content and method of biology teaching, and the biology teacher and biology pupil.

863. VERMA, M.S., *Construction of a Diagnostic Test in Chemistry and Preparation of Remedial Measures*, Ph.D. Edu., DAVV, 1986

The objectives of the study were (i) to construct a diag-

nostic test in chemistry, (ii) to find out reasons for errors in chemistry, (iii) to prepare remedial measures in chemistry, (iv) to find out the effect of remedial instruction at different levels of intelligence, and (v) to study the typical cases.

The sample was selected by using purposive and multistage sampling methods. The sample comprised 250 class IX students following the All India Secondary School Certificate Examination Scheme, 50 teachers and 250 parents of the students. Four cases of high intelligence and low achievement, and vice versa were selected for case study. The descriptive survey method was applied for the location of errors, the efficiency of remedial instruction was tested by the experimental method, and case study method was used for a thorough study of certain cases. An open-ended questionnaire, structured scales for students, teachers and parents, and an observation schedule for class observation were used for identification of reasons for errors. Achievement test and intelligence test were used for efficiency of remedial measures. During case study the tools used were Adjustment Inventory by Sinha and Singh, Kulshrestha's Vocational Interest Record, and ISPT Personality Dimensional Test (PDT) developed by Kulshreshtha. The data were analysed through content analysis technique, and by computing central tendency, percentages and variability. t-test was used for testing the significance of difference between means.

The outcomes and findings were: 1. Two diagnostic tests were constructed by including ten topics from the chemistry theory course of class IX from the syllabus of the Central Board of Secondary Education under the All India Secondary School Certificate Examination Scheme. Each test consisted of 100 items having reliability coefficients ranging from 0.94 to 0.98. The validity coefficients ranged from 0.71 to 0.74 besides having high content validity in due proportional weightage. 2. A hierarchy of reasons for errors separately supplied by students, teachers, and parents was established on the basis of weighted scores allotted to them. 3. The effect of remedial measures on the experimental group even at different levels of intelligence was significant at 0.01 level. 4. The family background, interest, adjustment, and personality factors contributed significantly to their achievement. A highly placed father with sufficient income and a background of science, and proper care of the wards developed desirable interest and proper personality traits in students. These factors helped students in better adjustment and higher achievement.

864. YADAV, M., *Classroom Learning Behaviour of Pupils of Different Socio-economic Strata and Their Achievement in Science,* Ph.D. Edu., Mee. U., 1984

The objectives of the study were (i) to investigate the relationship between achievement of pupils of high and low SES and pupils' attention behaviour, pupils' response behaviour, pupils' seatwork behaviour, pupils soliciting teacher behaviour, pupil-pupil interaction, pupils' helping teacher behaviour, pupils' involvement in classroom managerial activity, pupils' out of school achievement related (POSAR) study time, POSAR library study time, home time, curricular study time, non-curricular study time, teacher explaining, questioning, helping, supervising, managerial behaviour, and (ii) to study the prediction of achievement of high and low SES pupils by their classroom behaviour, their achievement related efforts and their teacher behaviour.

The multistage sampling procedure was adopted in the study. The sample comprised 80 pupils. Pupil Classroom Learning Behaviour Observation Schedule (PCLBOS) was used for observation. Pupil Out of School Achievement Related Efforts Log (POSAREL) was developed and used in the study. Socio-economic Status Scale Questionnaire (SESSQ) developed by Kapoor and Singh was used for measuring SES. Intelligence was measured with the help of Cattell's Culture Fair Intelligence Test. The data were analysed with the help of product-moment correlation and stepwise regression analysis.

The findings were: 1. 'Listening attentively' had a positive correlation with achievement in science practicals in the case of high SES pupils, while in case of low SES pupils it was positively related with achievement in theory. 2. Correlations between pupils 'looking fatigued' and achievement in science practicals as well as total achievement were negative in case of low SES pupils in the beginning of the session. High SES pupils showed negative correlations with achievement in practicals at the end of the session. 3. 'Looking distracted and involved in disruptive behaviour' of pupils was positively related with achievement in science practicals in the beginning of the session in respect of low SES pupils, 'Involved in disruptive behaviour' of pupils was negatively correlated with achievement in theory and total achievement. 4. 'Volunteer response' and 'volunteer ideas' yielded positive correlation with achievement in theory and total achievement in the

case of low SES pupils in the beginning of the session. In high SES students, non-response behaviour was negatively correlated with achievement in theory and total achievement. 5. 'Reading book attentively' and 'pretending to read book' in the classroom were negatively correlated with achievement in science practicals in the case of high SES pupils in the beginning and low SES pupils at the end of the session. 6. 'Involvement in writing' had a positive correlation with achievement in science practicals and a negative correlation with achievement in science theory in both high and low SES groups at the end of the session. 7. 'Pupil copying from blackboard' showed a negative correlation with achievement in science theory in the case of the high SES group in the beginning of the session. In the case of low SES pupils, correlation with achievement in science practicals was negative at the end of the session. 8. 'Evading seatwork' was negatively correlated with achievement in theory and total achievement in both groups in the beginning of the session. 9. 'Reaching teacher for removing difficulties' behaviour was positively correlated with achievement in theory and total achievement in the beginning of the session while at the end of the session correlation with achievement in theory was negative in the case of low SES pupils. 10. 'Reaching teacher for completing seatwork' indicated a positive correlation with achievement in science practicals in both groups at the end of the session. 11. 'Pupil reaching teacher for clarifying doubts' behaviour had a negative correlation with achievement in practicals in the beginning of the session but a positive correlation with achievement in practicals at the end of the session in the case of low SES pupils. 12. 'Pupil interaction for discussing points' was negatively correlated with pupil achievement in theory in the case of the low SES group in the beginning and in the case of the high SES group at the end of the session. 13. 'Pupil discussing points' indicated a positive correlation with achievement in science practicals in the case of high SES pupils at the end of the session. 14. 'Giving help to peer' indicated a positive correlation with achievement in theory and total achievement of high SES pupils in the beginning of the session while towards the end of the session, high SES pupil exhibited a negative correlation. 15. 'Pupil response to other pupil questions' behaviour indicated a negative correlation with achievement in theory and total achievement in the case of low SES pupils in the beginning of the session. 16. 'Pupil helping teacher in handling of material' behaviour had a positive correlation with achievement in theory in the case of high SES pupils in the beginning of the session, while 'pupil helping teacher on blackboard' was positively correlated with achievement in practicals in the case of high SES pupils in the beginning of the session. 17. 'Teacher directed activities' indicated a positive correlation with pupil achievement in theory, practical and total achievement in the case of high SES pupils on both occasions, while low SES pupils exhibited a negative correlation with achievement in theory. 18. 'Pupil self-directed activities' were negatively correlated with achievement in theory in the case of high SES pupils in the beginning, but positively correlated at the end of the session. The low SES pupils' self-directed activity showed a positive correlation with achievement in science practicals in the beginning of the session as well as with total achievement towards the end of the session. The low SES group's self-directed activities showed a negative correlation with achievement in theory at the end of the session 19. 'Pupils out-of-school achievement related total time devoted' was positively correlated with achievement in practicals in the case of high SES pupils. Low SES pupils exhibited a positive correlation with achievement in theory. 20. Library study time, home task time, curricular study time, and co-curricular activity participation time were positively correlated with achievement in practicals in the case of high SES pupils. Newspaper and magazine study time, and time devoted to hobbies were positively correlated with achievement in theory, practicals and total achievement in the case of high SES and low SES students. 21. Teacher explanation plan was positively correlated with achievement in practicals in the case of high SES pupils. 'Teacher handling material' was positively correlated with achievement in practicals and total achievement in the case of low SES pupils. 22. 'Teacher asking question' was negatively correlated with achievement in science theory and total achievement and negatively correlated with achievement in practicals in the case of high SES pupils. 23. 'Encouraging pupils' was positively correlated with achievement in science theory, practicals and total achievement in the case of high SES pupils. 24. 'Supervising seatwork' was positively correlated with achievement in practicals in both cases, while 'corrective feedback' was positively correlated with achievement in theory and total achievement in both groups. 25. Management of disruptive behaviour was positively correlated with achievement in theory and total achievement, and negatively correlated with achievement in practicals in both groups. 26. High SES pupils' total achievement in science was predicted by teacher benaviour like correc-

tive feedback, PCLB and POSARE. 27. Low SES pupil achievement in science theory, practicals, and total achievement was explained by POSARE. 28. High and low SES groups indicated significant differences in respect of their 'volunteer response' 'soliciting teacher help for completing seatwork' behaviour and time devoted while out of school for receiving help by parents, tutors, or both. 29. There was no significant difference between the achievement of pupils belonging to high and low SES groups.

ALSO SEE

230. AZIZ, M.A., *A Study of Science Education Programme in Secondary Schools of Bangladesh*, Ph.D. Edu., MSU, 1984
615. BANMALIDAS, *Construction and Standardization of a Scientific Aptitude Test in Oriya for the Class X Students of Orissa*, Ph.D. Edu., U., 1987
52. BARMAN, S., *The Origin and Development of Modern Science in Pre-independence in India*, Ph.D. Hist., Gau. U., 1983
865. BASU, M.K., *Effectiveness of Multimedia Programmed Materials in the Teaching of Physics*, Ph.D. Edu., Kal. U., 1981
866. BHADWAL, S.C., *Effects of Interim Tests on the Performance and Test Anxiety of High School Students Following Programmed Instruction Material in a Segment of General Science*, Ph.D. Edu., HPU, 1984
653. CHAND, R., *Effects of Personalized System of Instruction and Bloom's Mastery Learning Strategy on the Retention of High School Students in a Segment of Science*, Ph.D. Edu., HPU, 1984
922. DAS, N.C., *A Psychometric Study of Low Achievement of School Final Candidates in General Science*, D.Sc. Psy., Cal. U., 1975
872. DESAI, R.M., *A Study of Effectiveness of Programmed Learning Strategy in Teaching of Physics in the Eleventh Grade*, Ph.D. Edu., SPU, 1986
871. DESAI, K.V., *An Investigation into Efficacy of Different Instructional Media in the Teaching of Science to the Pupils of Class VIII in Relation to Certain Variables*, Ph.D. Edu., SPU, 1985
875. DWIVEDI, S.K., *Performance on Linear Programme in a Segment of Biology in Relation to Level of Aspiration and Socio-Economic Status*, Ph.D. Edu., HPU, 1983
882. KALACHERRY, K.A., *Preparation and Experimental Try-out of Programmed Instructional Material in the Syllabus of Chemistry Prescribed for Class VIII (SSC) in Maharashtra State*, Ph.D. Edu., Bom. U., 1987
942. KHANAM, R., *Performance of High School Students in Biology as a Function of Personality Types and Instructional Designs for Concept and Rule Learning*, Ph.D. Edu., Pan. U., 1983
1100. MALIK, J.S., *A Comparative Study of Personality Factors and Learning Environments of Successful and Unsuccessful Science Teachers in Selected Schools of Rajasthan*, Ph.D. Edu., M. Sukh. U., 1984
241. MD. ANOWARUL AZIZ, *A Study of Science Education Programme in the Secondary Schools of Bangladesh*, Ph.D. Edu., MSU, 1984
244. MIAN, M.A., *Developing a Programme of Curricular Concept and Methodology in the Areas of Science and Agriculture Science for Teachers Training Colleges of Bangladesh*, Ph.D. Edu., Del. U., 1983
1129. RADHA, K.V., *A Comparative Study of the Personality Characteristics of High and Low Success Science Teachers in Teacher Training*, Ph.D. Edu., Ker. U., 1984
263. ROY, S., *A Critical Evaluation of the High School General Science Textbooks in Bangladesh*, Ph.D. Edu., MSU, 1988
1569. SACHDEV, P., *A Critical Study of Teaching in Higher Education in Bombay with Special Reference to Physics*, Ph.D. Edu., Bom. U., 1986
972. WILLIAMS, SARAH, SHANTA KUMARI, *A Study of the Attitude of High School Pupils towards General Science and its Relationship with Achievement in the Subject*, Ph.D. Edu., Anna U., 1983
567. SHARMA, R.D., *An Experimental Study of the Performance of High School Students of Low, Average and High Creativity as a Function of Instructional Media and Learning Tasks in Physics*, Ph.D. Edu., Pan. U., 1986
1648. SRIVASTAVA, N.N., *A Study of Scientific Attitude of Science and Arts Students Belonging to Scheduled Caste and Scheduled Tribes vis-a-vis Non-scheduled Caste Communities*, Ph.D. Edu., Raj. U., 1983
982. SINGH, D.R., *Study of Memory, Symbolic Representation and Some Other Mental Abilities in*

Achievement in Chemistry at Graduation Level, Ph.D. Edu., Gor. U., 1983

988. SONTAKEY, V.V., *A Comparative Study of Personality Factors and Achievement Motivation of High and Low Achievers in Natural and Biological Sciences*, Ph.D. Edu., Nag. U., 1986

1163. SWAMY NARSIMHA, N., *Diagnosis and Remediation of Differences in Basic Understandings of Prospective Teachers of Secondary School Physics*, Ph.D. Edu., Mys. U., 1984

576. TALEGAONKAR, A., *To Develop Teaching Strategies to Encourage Students to Solve Problems in Science Creativity*, Jnana Prabodhini, Pune, 1984 (SIE, Pune financed)

1175. YADAV, N., *Integration Analysis of Classroom Behaviour of High School Biology Teachers in Relation to Pupils' Achievement and Attitudes*, Ph.D. Edu., Gor. U., 1987