CHAPTER 1

INTRODUCTION

Factors responsible for the change in attitude.

Impact of industrial psychology.

The role of college and universities in scientific research.

The factors influencing scientific productivity.

Research directly related to scientific productivity.

Productivity of Ph.D. Graduates.

Research in the context of industry.
A common concern of educationists, administrators, scientists and several others has been the question of falling standards in scientific achievements and productions. Important scientific and technological breakthroughs are being achieved every day in different parts of the world, but such achievements have involved the active participation of very few researchers. At the average level the productivity of scientists and researchers has been steadily falling. It is this which has attracted the attention of a number of agencies and individuals particularly in developing countries where the main hope for growth is based on scientific development.

As one goes through the history of science, characteristic changes can be seen over the centuries. Historical and classical discoveries depend mainly on the achievements of great individuals. Such responsibility has been dispersed now-a-days. Contemporary society probably does not produce a giant scientist, achieving a scientific revolution, but a large number of professionally trained researchers working in an institutionalised set up supported by different agencies. They apply themselves to specific problems or issues. It is this which has resulted in the content of scientific manpower. The concept of scientific manpower is essentially a modern concept, the corollary of a technological society. Perhaps
a hundred years ago nobody would have thought of scientific 'manpower', but probably of Edison or Marconi.

The result of this has been deliberate planning of scientific productivity and creativity. The establishment or organisations like research councils, research directorates, Centres of Advanced Learning etc. reflect this. The assumption behind this is that suitable strategies can be evolved to promote and facilitate scientific and technological productivity through institutional efforts. The general consensus therefore appears to be that scientific productivity can be organised on a mass basis through careful planning and support and can be quantified and monitored. As a result, remedial action is possible. While modern society will not disown a Newton, Darwin or a Lavoisier, it nevertheless believes that groups of lesser mortals can put their heads together and serve as a substitute through a process of arithmetic summation, if giant scientists become rare commodities.

Factors responsible for the change in attitude

While the above change in perception of scientific productivity is unmistakable one cannot attribute this change to a single factor. During the past century or more, scientists, particularly psychologists and educationists have been investigating the problem of productivity or creativity among scientists. The classical efforts in this direction were those of Galton in England and Terman in the U.S.A. These
two investigators were concerned with the identification of the various factors that could be associated with the scientific achievements of eminent men. A major consensus that emerged from these classical studies was that scientific productivity was associated with a number of factors, personal, social, psychological and experiential. It could not be accounted for by a single factor of superior intelligence or creativity. While the products of scientific creation is by and large intellectual the process involves the interaction of a large number of factors, intellectual, non-intellectual, personal and environmental. The advent of Freudian Psycho-analysis and the rapid growth of the field of motivation as a field of study and research culminating in the elaborate motivational theories of Murray and Maslow gave a fillip to the investigation of the role of motivational, dynamic and attitudinal factors in scientific productivity. The development of field theory and cognitive psychology opened up the possibilities of investigating the role of perceptual factors in scientific productivity.

In recent years particularly following the work of Guilford, Mednik, Getzells, Torrence and others in the field of creativity, a new dimension has been added, namely the nature of creativity as an independent factor and its association with other factors both intellectual and non-intellectual. As a consequence creativity has come to be
regarded as a bipolar normally distributed variable which could be manipulated just like intelligence or any other psychological variable.

**Impact of industrial psychology**

While the concept of scientific productivity has been no doubt influenced by the above-mentioned developments, an equally significant influence has been felt from the changing approach to the problem of productivity in the industrial setting. Modern Industrial Psychology and management science have shifted their emphasis from production to productivity. Scores of investigations in these fields have emphasised the fact that productivity is a result of multiple factors and not a single factor like ability or reward. Productivity in organisations has been found to depend on a variety of factors, individual, organisational, situational, psychological and non-psychological. It has further been demonstrated that these factors could be manipulated to influence the level of productivity through planned and institutionalised efforts in the form of training, motivation, counselling etc. This approach to productivity has had its impact on the understanding of scientific productivity. Management techniques found useful in the manufacturing sector, are being increasingly applied to research institutions, universities and laboratories.
It may therefore be seen that the contemporary approach to scientific productivity rests on the following premises:

(a) Scientific productivity is influenced by a number of factors.

(b) It rests on the efforts and activities of a large number of scientists rather than on the historic achievements of a few.

(c) The best way to promote scientific productivity would be through institutional strategies rather than individual strategies.

(d) Productivity can be influenced by manipulating any or many of the factors that are found to be associated with it.

This last premise highlights the importance of investigating the various factors associated with scientific productivity so that manipulatory strategies can be formulated and implemented as in the industrial context. It must however be stated that while fairly conclusive knowledge is available on the various associated factors of industrial productivity the same cannot be said of scientific productivity. While the models may be similar one cannot say that they are identical. The present investigation is an attempt in this direction to explore the relationship of certain factors, mostly non-intellectual scientific productivity.

The role of college and universities in scientific research

Universities and colleges have by and large remained the major centres of scientific research in most countries, particularly in developing countries like India. These
institutions were assigned the responsibility of imparting, promoting and generating new knowledge. To a large extent however universities and colleges, particularly in India, for a long time tended to emphasise the function of teaching to the detriment of research and generation of knowledge. Of course Indian universities and colleges did produce a few great scientists at sporadic intervals.

This dismal picture resulted in the establishment of national laboratories and research institutions on the one hand and promotional organisation like the CSIR, ICMR, ICSSR, etc. on the other. The University Grants Commission was also established in independent India to promote the standards of teaching and research in the universities and colleges. There was a period however where there were controversies on the role of colleges and universities on the one hand and research laboratories on the other in the field of scientific research. The view was often put forth that advanced research could be carried out at the national laboratories, basic research at the university and teaching at the colleges. It was also suggested that 'basic and fundamental research could be the legitimate concern of universities and applied research that of the national laboratories'.

While such a view was probably not explicitly stated by anybody, it was implicitly accepted by everybody. In fact
there was a period when it was widely believed that a college teacher was not expected to undertake any research. Certain developments however led to a change in their approach. There was growth in research in the field of humanities and social sciences which did not depend on sophisticated and expensive laboratories and led to an expansion in the concept of scientific research. Secondly the growth of universities in the country resulted in a large number of individuals being added to the cadre of scientific manpower. Thirdly there was an increasing need felt to enlarge the number of productive and scientific men in various fields contributing to a change in the approach. Fourthly the rapid rate of knowledge explosion as a global phenomenon cast a responsibility on everyone to be aware of these developments even if they were only teaching machines. As a result the UGC, as well as the various commissions on education came to the conclusion that teaching and research cannot be separated as separate functions, while one could think of a researcher who does not teach, the converse would be detrimental. The UGC evolved certain policies to link the salary status to demonstrate scientific productivity and also evolved a number of schemes to facilitate creative and productive efforts among college teachers. While one is not sure of the extent of success of these efforts today research and scientific production is no more regarded as the exclusive privilege of the national laboratories or
the universities and college teachers are welcome to work in these areas. Equally so college teachers cannot claim total immunity from any responsibility for scientific productivity even though they may manage to evade it through questionable means. In view of this scientific productivity has become not only a legitimate but an essential expectation from college teachers. They are no more regarded either by themselves or by others as mechanical transmitters of information.

This development of course is of recent origin, perhaps two decades old and as such has been subjected to very little scientific research. Some major questions which face us are: how far have college teachers been scientifically productive? Has the new culture of research and scientific productivity gained ground in our colleges? What are the various factors associated with scientific productivity among college teachers? Does scientific productivity of college teachers differ according to their discipline? These are precisely the questions for which an attempt has been made in the present investigation to find answers. In simple terms, the present investigation poses the following questions and tries to answer them: (a) how productive are our college teachers? (b) what are the factors associated with the scientific productivity of college teachers? (c) are there differences among groups of college teachers depending on their discipline of study and teaching?
The factors influencing scientific productivity

A survey of available research on scientific productivity reveals that very little research has been undertaken in this area. This is particularly so in the Indian context. While isolated attempts have been made to study the problems of scientists, little research has been directed to a study of productivity as such and its relation in other factors. To a large extent ideas and action programmes have been based on research in the context of industrial productivity, though as already mentioned there can be a point of controversy regarding the degree of similarity between productivity in the industrial setting and in the scientific setting. Perhaps a brief review of some of the major research problems in this area will give us an idea of the available knowledge on this problem. These researches can be considered under two broad categories, namely research directly related to scientific productivity and research related to productivity in the industrial context.

Research directly related to scientific productivity

Scientific investigation in the area of scientific productivity is of recent origin. In view of this the amount of research in this area is meagre and materials embodying results are scarce. The classical investigations of Carlsen, Terman and even Haveloc were based on data collected without
a scientific rationale, though some of the findings of these early investigations may still be relevant. Nevertheless these studies can be utilised on the ground that they lacked in methodological rigour. But when the investigator really gets down to the task of locating research studies directly concerned with scientific productivity, it is realised that this is an area where little research has been undertaken. If one were to eliminate the bulk of research on creativity which has been concerned primarily with the nature of creativity as such and not productivity, there is almost a total absence of relevant studies of this category. One of course, comes across investigations on the problem of the scientists, personality factors, organisational conditions in academic institutions, etc. But research directly concerned with scientific productivity is rather conspicuous by its absence.

Investigation of scientific productivity has been hampered by certain practical problems: every subject of investigation is ill-defined; its definition is also elusive. There is yet no clearly settled agreement upon the choice of models of behaviour and characteristics of products for defining and justifying the scientific productivity. With these inadequate criteria, judgement has been guided by impressions and by rationalizations of impressions mainly on proximate criteria. The proximate criteria most often resorted to have been the judgements of experts and the measurement of scientific production in terms of
Segal, Busse and Mansfield (1980) studied from a sample of 400 biologists drawn from American Men and Women of Science, and 335 of them supplied information about their pre-doctoral experiences and accomplishments. These accomplishments and experiences were related to two measures of adult scientific achievement: (1) the number of published articles, and (2) the total number of citations received over a 5-year period. The number of published articles correlated significantly with 14 items, most of which could be classified into three conceptual groups:

1. pre-doctoral productivity,
2. excellence in pre-doctoral science work, and
3. budding interest in science.

A scientist attempts to select problems that are worthy of investigation and amenable to solution within a reasonable time frame. The success with which a scientist copes with these problems is an indication of productivity. One measure of this productivity is the number of published journal articles. An article is usually reviewed and
approved by other scientists in order to be published. Such publication, then, is an indication of recognition in the scientific community.

Statistical analysis of experimental effects and correlations in extensive empirical literature of the last decade in science education (Kramer et al., 1980) and in other subjects (Haertel and Walberg, 1980) as well as a collection of 35 other quantitative research syntheses (Walberg and Haertel, 1980) reveal considerable evidence of the positive relationships of learning with seven constructs of factors identified earlier (Walberg, 1976, 1980) - age, ability, and motivation; the quality and quantity of instruction (including self-instruction) and the social-psychological environments of morale of the class room (and two other possible factors that emerged in the course of the syntheses - the peer-group environment and exposure to mass media).

In a study by Taylor, Smith and Ohselin (1959) on scientists the latter were asked, in a questionnaire to list all the disturbing factors that had kept them from publishing to the best of their ability. It was surprising to find that 90% of the scientists complained about organisational factors. Some were tangible ones in which the organisation could make immediate changes as a means of determining whether these changes would remedy the publication problems of the scientists.
Such changes may prove to be merely treatments for symptoms instead of remedies affecting the basic causes inhibiting publication.

Some tangible hindrances mentioned were the lack of organisational incentives to publish; deficiencies in certain services to scientists, such as inadequate support and cooperation, lack of clerical assistance and the indifference of the publication department. Other interferences mentioned are lack of time; occupational hazards and the impediments due to the frequent changes in the research programme and the methodology recommended frequently by large research teams and other organisational demands, and attitudes of other persons around their colleagues which adversely affect their tendency to publish. The other complaints of scientists are directed more toward themselves; absence of interest in publishing, the tackling of difficulty with their supervisors or peers, who make it hard to complete any work worthy of publication, and also personality traits such as laziness, diffidence and procrastination in writing reports. The score developed for each individual on his reported degree of freedom-from-publication hindrances is generally unrelated to other criterion scores, although it is related very slightly to the number of research reports in two years and to the total number of journal articles.
A utilization study of the scientists has also been initiated by Vernon Carter which is based upon 17 characteristics stated by the scientists to be important in their jobs. These 17 characteristics are drive, mathematical ability, resourcefulness, cognition, integrity, desire for facts, desire for principles, desire for discovery, informative ability, skill, flexibility, persistence, independence, discrimination of value, cooperation, intuition and creativity.

An analysis of approximately 50 different measures of contributions of scientists has been completed on a sample of 166 scientists at one large physical science research organization. The finding was that a somewhat different picture of contributions of scientists is obtained according to different sources of information. The total act of contributions was also analysed to yield the following 15 creative and other categories (types) of contributions: (1) originality of written work; (II) creativity ratings by higher-level supervisors; (III) supervisor's rating on overall performance; (IV) judged total work output; (V) Productivity in written work; (VI) recognition for organisational contributions; (VII) quality (without originality) of written work; (VIII) likeableness as a research team member; (IX) visibility; (X) scientific and professional society membership; (XI) status-seeking "organisational-man" tendencies; (XII) current organisational status; (XIII) contract-monitoring load;
(XIV) two-year productivity of research reports; and (XV) a control factor, including the control scores of age, total experience, and experience at this research organisation. One surprising result was that none of these control scores appeared strongly in any other category. Another control scores on freedom from publication hindrances was related significantly (barely at the significant level) with only two of three of the nearly 50 measures of contributions. The number of years of education, another control score which can alternately be thought of as a possible basis of selection, is related only to the first category of effectiveness in completing paper work and to the category pertaining to scientific and professional society membership (which usually involves some educational pre-requisites (Taylor et al., 1959).

Barron (1955) examined the following five hypotheses:

1. Original persons prefer complexity and some degree of apparent imbalance in phenomena.
2. Original persons are more complex psychodynamically and have greater personal scope.
3. Original persons are more independent in their judgements.
4. Original persons are more self-assortive and dominant.
5. Original persons reject suppressions mechanism for the control of impulse.
This would imply that they allow themselves a wide range of thoughts, they dislike policing of their work by others, they are disposed to entertain impulses and ideas that are commonly taboo, and in general they express in their persons the sort of indiscipline which psychoanalytic theory would ascribe to a libidinal organisation in which derivatives of the early anal rather than of the late anal stage in psychosexual development predominate and substantiates them with his results. According to his freedom of expression and movement, lack of fear of dissent and contradiction, a willingness to break with custom, a spirit of play as well as of dedication to work, purpose on a grand scale, these are some of the attributes which a creative social entity, whether vast or tiny, can be expected to have.

In another study, Barron (1963) makes the following observations on individuals who are scientifically productive:

1. Scientifically productive people are more observant, and value accurate observation and truth telling.
2. They often tell or express only part truths, but vividly, and the part they express is the generally unrecognised - they point to the usually unobserved,
3. They see things as others do, but also as others do not.
4. They are thus independent in their cognition and also value clearer cognition, so that they will suffer great personal pains to testify correctly.
5. They are motivated by both this value and this talent (independent, sharp observation) for self-preservation reasons (the ego instincts at work).

6. They are both with a greater brain capacity—more ability to hold a lot of ideas in their head at once, and to compare more ideas with one another, hence to make a richer synthesis.

7. In addition to unusual endowment in terms of the age instincts, they have much sexual drive as well (both pregenital and genital) because they are by constitution more vigorous organisms and more sensitive (nervous).

8. Their universe is thus naturally more complex, and in addition they usually have more complex lives, leading them to prefer much tension in the interest of the pleasure they obtain upon its discharge.

9. Hence, they also have more apprehensions of unconscious motive, fantasy life, etc. They note or observe their impulses more and allow them expression in the interest of truth.

10. Creative people have exceptionally strong egos. The self is strongest when it can go far back regressively (allow primitive fantasies, tabooed impulses into consciousness and behaviour) and return to a high degree of rationality. The creative person is both more primitive and more cultured, more destructive and more constructive, crazier and saner, than the average person.
11. When the distinction between subject (self) and object is most secure, this distinction can with most security be allowed to disappear for a time (mysticism, love). This is based on true sympathy with the not-self, or with the opposite of the things which compress self-definition. The strong ego realises that it can correct itself.

12. The objective freedom of the organism is at a maximum when this capacity exists, and the creative potential is directly a function of objective freedom.

The scientifically productive individual is someone who has an exceptionally strong need to find order where none appears, and who as a result of his own abilities and personal experience honours the apparently unclassifiable with his devoted attention.

Biglam (1973) examined the social structure and output of university scholars in terms of the characteristics of their academic subject matter, on the basis of an earlier multidimensional analysis. Academic areas were clustered according to their concern with a single paradigm (hard Vs soft) application (pure Vs applied), and life systems (life system Vs non-life system). Depending on the characteristics of their area subjects were found to differ in the degree to which they were socially connected to others; their commitment to teaching, research and service; the number of journal
articles, monographs and technical reports that they published; and the number of dissertations that they sponsored.

Friedkin (1978) described the pattern of research communication among faculty members in the 6 physical science departments of an elite US university, providing a basis for modifying and extending. Blau (1973) analysed the relationship between the university social structure and the pattern of communication in the faculty. Blau regards the formation of integrative, multidisciplinary social networks within university communities as highly problematic; and he suggests that academic departments are the primary site of integrative social networks within universities. But the findings suggest that academic departments are not appropriate units for describing the pattern of research communication among university faculty and also that university social structure can foster an integrative social network which is multidisciplinary.

Hicks (1974) noted that critical analysis of studies of the relationship between research productivity and student ratings of teacher effectiveness showed that they contained for the most part methodological difficulties which made any conclusions unwise. The research attempted to establish the presence of a relationship between publishing and teaching effectiveness in as powerful a manner as possible. The mean student rating of the effectiveness of 147 professors who had published is significantly higher than the mean
rating of 312 professors who had not published. While these data demonstrate the existence of a positive relationship between publishing and teaching effectiveness, this relationship was estimated to be slight and of little real value.

Rothman and Preshaw (1975) tested the hypothesis that in the context of a large health science heavily committed to scientific activity, there would be a positive relationship between the scientific productivity of faculty members and their effectiveness as teachers. Subjects were 118 3rd year undergraduates and 39 4th year undergraduates. Counts of citations by others and counts of publications are used as indices of scientific productivity. The index of teaching effectiveness is derived from the subjects' perceptions of teaching effectiveness, elicited in a questionnaire that asked subjects to rate teachers in terms of the presence or absence of a series of behaviours grouped under 5 headings called the "components of effective teaching." The results of it supported the notion that research and teaching are not separate and adversary phenomena each working to the disadvantage of the other, but under certain conditions are interrelated with research activity supporting the effective teaching.

McCullagh and Roy (1975) administered a questionnaire about the degree of faculty involvement in noninstructional activities (e.g., research, professional organizations,
publications, and consulting) to 52 college teachers 1,500 undergraduates also completed a questionnaire on teacher characteristics and effectiveness. Correlational analysis and regression analysis indicated that non-instructional activities did not have predictive value when student-perceived teacher effectiveness is used as the criterion. Time spent in consulting had a negative effect on classroom effectiveness. It is suggested that a revaluation of the responsibility of the university to the community and of education to society may be necessary.

Effective research is a product, first, of a socio-cultural climate; second, of a sufficiency of individuals gifted with an uncommon combination of abilities and character qualities, third, of a satisfactory economic-administrative matrix; fourth, of special acquired research skills and thought processes; and, last, of daily working conditions which, at the least, must not hamper creative minds. Out of all these the personality and dynamics of the research worker has received attention in the present research.

The results on the analysis of multiple contributions of scientists plus the other fruits that have been or can be obtained from this project clearly indicate the merit of doing scientific studies on scientists and on their working environment. In fact, research in such areas may prove to be not only the most basic but also among the most fruitful that can
be accomplished in science, since it can yield important implications for the entire scientific venture.

**Productivity of Ph.D. Graduates**

Bloom (1954) found that eliminating the graduates in physics and chemistry, approximately two-fifths of the Ph.D.'s have produced no research publications other than the dissertation publication.

The subjects numbered about 100 Ph.D. graduates. Although there is some variation from field to field, with the exception of physics and chemistry, the variation among the divisions of the biological sciences, social sciences, and humanities is relatively small. Graduate institutions produce a very small number of research-oriented people. To emphasize this only one out of three of our graduate students gets the Ph.D. This suggests that nine students enter graduate school to produce one individual likely to attain at least a minimal level of research productivity.

Very few individuals, less than 10%, account for approximately two-thirds of the research publications of our Ph.D. students, while approximately two-thirds produce four or less publications during the 8-year period under consideration. When a criterion of five or more research publications is applied over this period, it is found that approximately 30% of the Ph.D. graduates can be classified as
research oriented, while the remaining 70% may be said to produce such a small amount of research as to be considered non-
research-oriented people.

Some of the conclusions which ensue from these pilot studies follow. Firstly, usually high achievement in the graduate career is a very good index of later productivity and creativity. However, it is found that mediocre achievement in the graduate career may be followed either by later productivity and creativity or by lack of such productivity and creativity.

Another generalization which seems to follow from the studies is that graduate students with unusually great drive, are preoccupied with problems rather than with the subject matter of courses. The attitude of seeking ideas and methods, some independence (although not too much or too little), as well as skill in organizing research efforts and analysing problems appear to be related to later productivity and creativity. The lack of some of these characteristics seems to be predictive or diminished levels of productivity and creativity in later years. Another generalization is that relatively complete acceptance of the role of research worker and scholar (rather than the role of student), and efforts to find the kinds of training and research experience in keeping with this role, appear to be most striking predictors of later productivity and creativity. An individual who
comes to university with problems that he really interested in, with some notion of himself as a research worker or scholar, and who is able to resist the student role of doing things because they are required or because he is told to do them is likely to be a productive individual in his postgraduate career.

As the perception and acceptance of this role become ambiguous, it competes with other roles (of student, teacher, or administrator), individuals who do not produce much in the way of research in their post-Ph.D. careers. Another factor that seems to differentiate productive from non-productive graduates is the lack of competing activities and interests which might interfere with the role of research worker or scholar. Thus the family and personal life, the social relations of the individual, the quest for status, money, prestige, all appear to be relatively subordinate for the research-oriented individuals, whereas such competing interests and activities seem to be present to a large degree in the graduates who do not produce any other research work. Such competing activities and interests may be found both when the individual is a graduate student and when he is in his professional career.

Many of these unproductive graduates appear to have great feelings of guilt about their lack of research. They usually spend some time talking to their sponsor whenever
they see him explaining why they are not doing research this year - citing lack of money, heavy teaching load, administrative chores, or the lack of good graduate students. Although they appear to have feelings of guilt and inadequacy, they are not sufficiently motivated to alter the situation.

Still another factor which must be taken into consideration is the kind of position which the individual finds after his Ph.D. degree. Positions which demand research and which supply problems and facilities for research appear to be essential to productivity and creativity. Many of the non-productive graduates appear to be content with positions in which the research role is not central; and although they appear to have great feelings of guilt and inadequacy about their lack of research productivity, these individuals do not seem to be highly motivated to alter their present duties or to seek and accept, when available, positions which would make the research role more central. It is found that there is a small number of individuals who seem to be able to resist the demands and pressures of their work so as to produce research despite almost adverse circumstances, while others working under what appear to be almost ideal conditions for research seem to be able to resist such pressures and to occupy quite different roles.
Finally, this leads to certain inferences about the system of rewards and research opportunities available to individuals during their graduate training. Where the research role is emphasized, where the individual is given many opportunities to do research as a graduate student, he becomes highly productive and creative in his post-Ph.D. career. Individuals who seek the student role of ingesting as much knowledge, information, and skill as possible but whose only research during their graduate work appears to be the Ph.D. dissertation and especially a Ph.D. dissertation which is done at great cost in terms of time and energy and is not very fruitful—appear to be discouraged about the desirability of a research career and regard their Ph.D. dissertation as a necessary evil in their professional careers having no real place in their lives. Such individuals do not turn out to be very productive in their post-Ph.D. careers.

The general conclusion which we derive from this study is that the research role needs to be developed and encouraged during the graduate career and needs to be seen as very central in the individual's employment in his post-Ph.D. career if productive scholarship is to be the result. Where such a role is clear and unambiguous and the individual accepts it, productivity is high; where the role and other possible roles, are unclear and ambiguous the individual turns out to...
be quite unproductive and clearly uncreative in later years.

From these survey researches directly related to scientific productivity, it is shown clearly that only a few attempts in this direction have been made and such attempts lack in focus and perhaps even in depth. In fact, practically no investigation has been undertaken of direct relevance to our study on the role of psychological factors in scientific productivity. Such investigations, though not directly useful as points of departure for the present investigation still serve to bring out clearly the emerging interest in the study of scientific productivity.

One may wonder at this lengthy discussion and on almost exclusive dependence on the study by Bloom. This may be answered as follows:

1) Bloom's investigation was mainly concerned with Ph.D. students and post-Ph.D. graduates. The present investigation is concerned with a population very similar to this. Primarily this investigation is directed towards college teachers who are either Ph.D. graduates or working for their Ph.D.'s or expected to work for a Ph.D. In fact acquisition of the Ph.D. degree is considered a major element in productivity.
Research in scientific productivity in India is at a very elementary stage and to embark on an exploratory study, such as the present one, Bloom's investigation provides a suitable model.

A major reason for the lengthy consideration of Bloom's investigation is the relative paucity of other researches in the area, not only in India but elsewhere too. In fact this investigator attempted to make a review of all possible research in the area of scientific productivity carried out, anywhere. As per the information supplied by the American Psychological Association (PsycINFO/PASAR) Washington, only the following investigations were listed as being at least reasonably related to the subject under investigation herein up to 1982.


It may be seen from the above that hardly one or two out of even these appear to be related to the problem of scientific productivity as such, particularly to the present investigation.
Research in the context of industry

It is true that to a large extent the concept of productivity, performance evaluation and other related ideas have grown primarily in the context of industrial production and manufacture. Earlier attempts to study industrial productivity are primarily concerned with the influence of hygiene factors and environmental factors on performance in which the industrial engineer is directly involved. Subsequently it was realised that psychological factors played a vital role. Following the Hawthorne experiments research relating to psychological factors to productivity has tended to expand rapidly. Among the psychological factors studied, there are motivational factors, attitudinal factors, perceptual factors, perceived organizational factors and several others. The motivational theories of Murray, Maslow, Herberg, the work of Lipitt and White on organisational climate and the development of cognitive psychology have all contributed to the growth of a whole body of knowledge on the psychological factors related to productivity. A brief review of some of the more recent studies may be helpful.

Turner and Lawrence, in the year 1965 found that two clearly demographic and cultural environments had a substantial effect on the 'job' characteristics - 'job' satisfaction relationship.
Armstrong (1971) studied the job content and job context factors related to satisfaction for different occupational levels. The findings failed to support the hypothesis that higher level occupations show a dependence on context factors for satisfaction while lower level occupations do not depend on context factors. But satisfaction with content factors made the greatest contribution to overall job satisfaction regardless of occupational level. The Herzberg theory (1954) is found to be over-simplified.

Heckman and Lawler III (1971) conducted a comprehensive study on employee reactions to 'job' characteristics and found that in general, employees with moderately high desires for higher order need satisfaction tend to work harder and be more satisfied when they perceive their jobs as being relatively high on the four core dimension of variety, autonomy, task identity and feedback.

The findings of the study by Duane and Thompson (1971) revealed that subjects with a high level of favourable self-perception were less likely to perceive the supervising style of their boss as being supportive and reported lower levels of job satisfaction than people with lower level of favourable self perception. More supportive styles of supervision were found to be associated with higher levels of job satisfaction, although the effect was moderated by favourable self-perception.
It is commonly believed that a satisfied labour force is one of the essential requirements for the efficient functioning of an industry. The relation between job satisfaction of workers and their productivity is a more specific problem in this area. Psychologists have measured worker attitudes and tried to correlate these with productivity. The results are conflicting.

The Institute for Social Research isolated a number of attitudinal areas like (1) pride in group work; (2) intrinsic job satisfaction; (3) company involvement; (4) financial and job status satisfaction. When these attitudinal variables were correlated with shop productivity, the only significant relation was found with pride in work group. More workers in high productivity sections than in low productivity sections showed a high degree of group pride and loyalty. They have a better opinion of their own group and tend to have a distinct pride in belonging to it. On the other hand, none of their attitudes towards other aspects of the job like the nature of work done, financial and other advantages they get from their employment, or company policies as such showed any relation to their productivity.

A time-honoured method of increasing employee output is by tagging financial returns to the amount of work done. Systems of payment by results are called incentive systems.
of payment, because pay acts as an added incentive to produce more. In industries today different incentive systems of payment are practised like the Halsey system, the Bedaux system, Taylor Differential Piece Rate system, etc. To what extent these systems are effective in raising productivity and under what conditions is a pertinent question.

An experimental study was made by Wyatt in 1934 on the effects of three systems of payment—time-rate, bonus system and piece-rate on output. A group of girls served as subjects working on five different tasks in rotation, spending one day a week upon each of the five.

Several conclusions may be drawn from this study:
1. the different systems were effective in this order in raising output: piece-rate, bonus and time-rate systems;
2. the effect of the incentive systems varied from worker to worker and from job to job.

Wanous (1974) studied individual differences and reactions to job characteristics. According to him, although certain job characteristics tend to be more satisfying to employees than others, there are wide individual differences in reactions to them. The study as such was an attempt to compare (a) Urban Rural worker background scale, (b) the Protestant Ethic scale, (c) High Vs Low desire for higher order need satisfaction concerning how well each moderates the
relationship between the presence of certain job characteristics and reactions to these characteristics. The results showed that the Protestant Ethic was second to the higher order need strength as a moderator of the job-characteristics - job satisfaction relationship.

Brief and Aldag (1975) studied a set of propositions based on Hackman and Lawler's (1971) work and came to the conclusion that there are positive associations between a worker's perceptions of his job characteristics and his affective responses to that job.

Schneider and Snyder (1975) attempted to concept differentiate between organizational 'climate' and job satisfaction. The one is a global impression of what the organization is. The other is personalistic evaluation of conditions existing on the job. Thus, as the results bear out, people in an organization should agree more on their description of the climate than on their feelings of satisfaction. Also there should be no necessary correlation between climate and satisfaction measures.

Job enrichment (variety, autonomy, feedback and control) have a major impact on satisfaction but little impact on performance. Job Engineering (goal setting, time and motion studies) on the other hand, has a major impact on performance but less impact on satisfaction. Umstot, Bell
and Mitchell experimentally proved this in 1976.

Sims Jr. and Szilagyi (1976) substantiated the Hackman-Lewler study (1971) and found that individuals who have higher actualizing need strength are potentially better candidates for job enrichment. Occupational level is also found to be a significant moderator of job characteristic relationships.

Kaplan (1976) argued that Maslow's (1971) hierarchy of needs should be taken into account in the design and development of work environments.

In 1977, Muchinsky conducted a comprehensive study of the relationship between organisational climate and job satisfaction. All the correlations between the dimensions of job satisfaction and perceived climate are positive except those involving the climate factor standards.

Basically, a democratic functioning of an organisation means that no change shall be made in a person's working conditions without prior consultation with him; or better still, decision for changes should actually be made by the people who are going to be affected by it, under the guidance of the leaders. Every group develops, sooner or later, certain norms or standards of behaviour in different situations and members are expected to behave accordingly. A
member's resistance to change any aspect of behaviour contrary to group norms (e.g., level of production, food preference, etc.) may be overcome either by reducing the value of the group standard for the individual or by changing the group standard itself in the required direction. For changing the behaviour of an entire group of people, the latter is the only way. This can be best achieved by persuading the group itself to take a decision favouring the change.

Alex Bavelas did a very interesting study on change in productivity of operatives of a garment manufacturing factory following the decision made by the operatives themselves. Bavelas took separate groups of 4 to 12 women operatives each. He met each group separately in the management's conference room and using a friendly style of democratic leadership, discussed with them their previous individual production records, enquiring whether they might attain higher productivity if they worked together as a team, and finally got the group to decide on a new production level and the time they would take to reach it. The experimenter very carefully left all decisions to the groups.

Some groups took no decision to change their production; others did. In the months following, the experimenter maintained contact with the groups and showed them graphs
indicating changes in their production figures, etc. Production records of these months showed that the groups which had earlier decided to change their productivity did actually show the change. The groups which had not decided for an improvement did not improve.

Oldham, Hackman and Pearce (1976) studied the conditions under which employees respond positively to enriched work. Individuals who have a high need for personal growth and developments at work have been found to respond more positively to enriched work than people with low growth need strength. The results showed clearly that growth needs and satisfaction with work environment contribute both individually and in combination with performance at higher levels on enriched jobs.

Mehta (1977) collected data on employee motivation, work satisfaction and organizational climate from a nationalized public sector organizational variables for efficient working with particular reference to worker's participation in management. Results showed that managerial employees showed strong influence backed motivation for personal achievement. It was concluded that the patterns discerned in the analysis are likely to create interpersonal problems and conflicts and come in the way of workers' participation in management.
The type of leadership provided to a work group is perhaps the most important single factor in the determination of its morale and productivity. One of the earliest and classic studies on different types of leader behaviour has been reported by Ralph White and Ronald Lippit. The important findings regarding behaviour of groups are:

1. Laissez-faire and democratic leaderships:
   a) Less and poorer work was done under laissez-faire condition;  
   b) there were more task irrelevant and playful activities under laissez-faire;  
   c) boys preferred the democratic leader.

2. Democratic and authoritarian styles:
   a) the amount of work done was more in authoritarian groups;  
   b) the motivation for work was greater in democratic groups; for example, boys would not stop work when the leader left the room;  
   c) the originality and initiative of members were greater in democratic conditions.

3. Autocratic leadership created:
   a) Much hostility and aggression amongst group members, both against each other and against the leader;  
   b) discontent and hostility against the leader would very often be hidden and under the surface;  
   c) much dependence on leader and less individuality of members.

4. Democratic groups were more friendly and group-minded; most boys preferred this style of leadership to the others too.
Industrial Productivity and Scientific Productivity

In the foregoing pages an attempt has been made to examine researches in the area of scientific productivity and industrial productivity. This naturally may raise the question of the relationship between scientific productivity and industrial productivity. The answer to this question at this point, cannot be anything conclusive but only in the form of bunches.

It may be seen that the term productivity has essentially grown in the industrial context and is being adopted for use in the context of science. In view of the recency of this adoption, that concept of scientific productivity has not yet been conceptualised operationally and clearly. The only available model appears to be the industrial model. The term hitherto employed in scientific context was 'Creativity' rather than productivity. Creativity however was employed to indicate a potentiality rather than actual achievement. Further the term Creative and Creativity certainly implied a highly individualised and almost self-stipulated performance whereas the term productivity is always used against organisational norms and expectations.

The fact that the term productivity has been imported into the context of science shows that the performance of scientists is to be rated in a normative manner against institutional expectations and yardsticks rather than as unique products.
In view of this, it was felt that studies in industrial contexts in the area of productivity might provide a basic conceptual and methodological model for undertaking this investigation.

Beyond this, this investigation does not assume either any similarity or the absence of the same between productivity in Industry and in Science. Any statement of such a relationship can be made only after the completion of the study or perhaps after the completion of many more such studies. The studies in the area of Industrial Productivity offer a point of convenience to identify certain possible variables which may be related to the Scientific Productivity. Presently this appears to be the most obvious model. The only other model is offered by researches in the area of creativity, but here it should be mentioned that creativity is not identical with productivity and productivity is not creativity, though they may be related to some extent.