George, Pulivelil M.

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Pulivelil M. George (Canada)

CONCEPTUALIZATION: THE CENTRAL PROBLEM OF SCIENCE

INTRODUCTION

Science can not be understood or developed without an adequate understanding of the central process, conceptualization. The nature of science lies not in the facts that it discovers, but in the process by which they are discovered as Bronowski has noted. [1] Moreover, understanding of scientific conceptualization is highly helpful in getting a better view of society since science and society influence each other. The author intends to discuss the problem of conceptualization in science so that we may have a better understanding of it. Conceptualization is used here in the widest sense possible. Consequently, creation of models, axioms, assumptions, *etc.*, are treated under it. Every attempt is made by the author to relate conceptualization in science with history of science.

WHAT IS SCIENTIFIC CONCEPTUALIZATION?

Scientific conceptualization is basically a way of explicitly organizing one's thoughts and observations so that better understanding of reality can be obtained. A model represents a highly sophisticated level of conceptualization in which one's assumptions, axioms and postulates about a certain segment of reality are formally stated and their interrelationship specified. A conceptual framework is a less sophisticated organization of one's thoughts around a segment of reality. A model is more theory-oriented, whereas a framework is more methodology-oriented.

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[1] J. Bronowski, *The Conscience of a Scientist*, in: J. Fadiman (ed.), *The Proper Study of Man: Perspectives of the Social Sciences*, Macmillan, New York, 1971, pp. 49–50.

A variable is a special case of conceptualization, the applicability of which is highly limited to a particular type of observation.

To some extent, conceptualization represents a "beginning" and an "end" in scientific analysis. The conception of nature as something real, predictable and intelligible is the basis of science. Similarly, conception of man as a product of his social environment lies at the very heart of social science. Empirical research means that initial conceptual search has completed. Finally, the findings of empirical research have to be integrated with other findings into a theory, a process which is basically conceptual in nature, since findings do not add themselves up into a coherent system any more than bricks and cement would add up to a building.

A new concept is more than a new label. It is a new way of looking at problems. It becomes "new" only to the extent it provides new areas in research or new ways of organizing thoughts and findings so that new questions can be raised and new answers (presumably better than the old ones, if applicable) can be provided. In other words, every new word in the history of science does not involve a new conceptualization. In a publish-or-perish atmosphere, temptation is too high for scientists to coin new terms in their field for personal gains.

There are many ways of looking at a problem and there is no sacred way of doing so. Neither is there any intrinsically inferior or superior way of organizing our thoughts or observations. The utility of a particular way of looking at a phenomenon depends upon the problem to be tackled by it. The conception of man as a system of atoms may be very useful for a physicist, as an animal to a biologist, but such conceptualizations are not much of a value to a social scientist in his analysis. Conceptualizations such as man as an animal who lives in society, or with a history, or who is capable of using language, are likely to be highly useful in social science.

The realization that a phenomenon can be viewed in so many different ways, is one of the corner-stones of scientific humility, creativity and sense of community. The realization that there are so many ways of looking at a phenomenon not only makes us intellectually humble, but also helps our creative energies to be channelled for the construction of new ones. Moreover, to realize that there are other ways of conceptualizing besides one's own way, is to recognize that others also have their place in the house of science.

Often, modern science which is wedded to highpowered mechanical tools like computors, gives the impression that scientific activity at heart is a mechanistic process rather than an artistic, creative work. In reality, nothing is further from truth. Just as an artist chooses and creates his setting, background, tools and materials to produce certain aesthetic impressions or an engineer tries various combinations of materials to produce certain durability or other properties for the product, so does a scientist choose his analytical tools (concepts, models, frameworks and assumptions) to produce an understanding of a phenomenon. Scientific conceptualization is artistic in essence.[2] It is an internal debate or dialogue as Wilson puts it.[3]

Positivistically oriented philosophers of science in the past have often failed to realize not only the artistic nature of scientific work, but also the relationship between history and conceptualization in science. They treated scientific work as if it were above history. Moreover, in their over-concern against committing "genetic fallacy", they failed to realize the meaning of a historical framework. Scientific conceptualizations are a product of history as sociologists of knowledge have made it explicitly clear. A new dimension is added to scientific humility by the realization that scientific work is influenced by the socio-historical conditions within which it exists. However, that is not the whole story. A new dimension of understanding is also added by the above mentioned realization. As Gouldner has made it clear, understanding of a theory involves more than verifying its formal propositions. It involves a comprehension of the relationship between the theory and the socio-historical environment within which it emerged. For example, the question as to why a theory took a particular shape as opposed to another is part of the understanding of the theory.[4] In other words, history of a theory is inseperable from understanding it.

It is equally important to realize that the way we conceptualize in science has a tremendous bearing on history. The scientific conceptualization of nature as something to be conquered is partly and indirectly responsible for good many social revolutions of our age; it is responsible for many of the recent adaptations of liberal–radical reforms. Even the way we operationalize our concepts has a bearing on society. For example, different operational definitions given to the question "Who is a scientist?" will have differential impact on society. In other words, if a person with a B. A. is to be considered as a scientist in a society, it would have different impact on the social class structure as opposed to considering only the people with a Ph. D. or its equivalent as scientists.

The impact of scientific conceptualization on society is related to the way that society views science. The more positively science is viewed in a society, the greater the tendency on the part of society to give its values a "scientific colouring". In other words, pseudo-science

[2] For details see P. M. George, "Meaning of Artistic Orientation in Sociology", *Culture,* vol. 31, 1970, pp. 305–311.

[3] J. Wilson, *Thinking with Concepts,* Cambridge University Press, London, 1963, pp. 18–19.

[4] A. W. Gouldner, *The Coming Crisis of Western Sociology,* Basic Books Inc., New York, 1971, pp. 482–483.

is a phenomenon associated with societies where science itself is held in high esteem. On the other hand, the more negatively a society views its science, the greater is the former's tendency to create more prestige for its values at the expense of the latter's. In the history of science, for example, positivism tried to gain prestige at the expense of less quantitatively oriented approaches in science.

CONCEPTUALIZATION AND OBSERVATION

Science is a systematic attempt to make sense out of our experience. It is a search for empirically verifiable, comprehensive explanations (understanding) of reality. It operates at two levels, the abstract (conceptual) and empirical (observational). In general, the problems of utility, logic, clarity and operationalization, belong to the former, whereas the problems of verification, reliability and validity to the latter. However, there can not be any air-tight compartmentalization between the two levels. In reality, there is no sharp separation between the two levels. Analytical separations are imposed on experience by the mind to facilitate the process of analysis.

Scientific work done at the observational level must eventually be related to the work done at the conceptual level and *vice versa.* A more basic question is not at which level should we "start" or "end" our scientific work, but how to link the two levels, though it is customary to start at the conceptual–theoretical level first. Moreover, it is reasonable to start work at the conceptual level since that which is conceptually unimportant is not worth analyzing. Those who start at the empirical level first are taking a chance in science. However, what is not yet regarded as conceptually important is not likely to stay that way for very long, as the history of science testifies. There is nothing inferior or superior about one level or approach as opposed to the other in science. What is conceptual must pass the empirical test (not necessarily the test of operationalization, but at least some utility in analyzing) and *vice versa.* Usually deductive approach is associated with the former process and inductive approach with the latter. Both are not simple, mechanistic processes, since concepts do not impose their operational definitions any more than operations impose their concepts on us, but both involve creative struggle by mind.

Facts are low level empirical generalizations from raw sensations. Facts are not imposed upon us by our sensations. There are no self--evident facts. They are a product of conceptualization, however simple the conceptualization might be. When we experience a sensation, we still have the problem of coding it, though we are not aware of such a process in our everyday life. It is only when we experience something "strange", do we become conscious of the problem of coding our experience. For example, a person who tastes or sees or hears something "strange" is faced with the difficulty of coding that experience.

Highly discriminative findings (facts) can not emerge aparat from conceptual tools with high discriminatory power. Our findings are no better than our conceptual tools. The creation of more sophisticated data in science such as arithmetic mean, standard deviation, standard error, *etc.*, make the point that factualization is a product of conceptualization quite clear.

Different "findings" are created by different conceptualizations. For example, according to the concept of absolute standards, most of the developing countries have recently improved their lot a great deal. But by a relative standard (*i.e.* in relation to the comparable growth experienced by the developed countries), they have lost further grounds in their struggle to catch up with the developed countries. What we need in science is not just "findings" regardless of how reliable or refined they are, but "pertinent" (*i.e.* pertinent to the problem under consideration) findings. Since several findings can be created from the same "raw" data, the question as to which conceptualization to use becomes a crucial one in science. In other words, whether to use standard deviation or some other measure of dispersion should be determined by the nature of the problem under consideration.

Once findings are created, they do not speak for themselves any more than the original "raw" data themselves did. To take another example from social science, modern increase in divorce rate has been interpreted as a sign of social disintegration on the one hand and as a sign of evolution on the other. In science we can not stop at collecting pertinent facts, but have to go beyond to "interpret" them. It is in our attempt to interpret our findings in one area, do we bring findings and assumptions from related areas to bear upon the problem. In other words, a finding becomes meaningful (*i.e.* intellectually understandable) only by being related to other facts with the help of explanatory concepts. For example, modern increase in divorce rate can not be understood apart from relating it to other facts such as modern increase in industrialization, urbanization and education. It is a sign of good explanatory system (theory) that it is able to relate seemingly unrelated phenomena. A theory is basically an *in*sight into a problem, a *dis*covery of a network of relationship.

It should not be understood that there is only a one-way influence between experience and concepts. An experience which does not fit into the old conceptual categories points to the need for new conceptualization. History of science is full of examples of influence of experience and concepts on each other. Darwin's findings of prehistoric animal life did revolutionize not only our concept of animals, but also of man and universe, for example.

VARIOUS DIMENSIONS AND LEVELS OF CONCEPTUALIZATION

Concepts are not photographs of reality. They are abstract mental constructs designed as tools to understand (comprehend) reality, though the dimension of ideality varies from concept to concept. To argue that a particular model or conceptualization does not fit reality, is to argue for the fallacy of misplaced concreteness. It is extremely important for the development of science to realize that our concepts are basically mental tools. Repeated conceptualization of a phenomenon in the same manner is likely to reinforce our confusion between ideal and real dimensions of the phenomenon. For example, often in the West, one gets the impression that social class is a three-layer (upper, middle and lower) phenomenon. We would not be able to develop interdisciplinary conceptual models until we realize that the boundaries we have drawn for each discipline are arbitrary to a great extent and that they do not correspond to definite demarcation in reality. The great scientists in history who became interdisciplinary in their approach were the ones who had recognized the arbitrariness involved in conceptualizations. In a sense, great scientists in any field are "nonconformists" within it as in the case of great men in a society.

The fact that a concept is a tool does not mean that one has unlimited freedom in conceptualization. Such conceptual nominalism is unreal in the light of history of science. As an ongoing historical process, science needs to keep a basic sense of historical continuity, a factor which can not be accomplished by a constant shifting of concepts. Once we call a psychic phenomenon "anger", we can not call it something else without creating conceptual confusion. In other words, each conceptualization while it brings new freedom of thinking, it also brings new limitations on the next conceptualization.

It is not enough to say that concepts are tools. Concepts always do not lack a reality-dimension. Most of the concepts do have a reality-dimension, though it varies from concept to concept. Some concepts are abstractions from reality and as such they represent certain aspects of the reality. It is because of the reality-dimension involved in concepts, some of them tend to be misleading whereas some others are not so. To call a social phenomenon "education" is to imply a different picture of the situation than the concept "indoctrination" would do. It is in this sense that Rapaport feels that a good many of the mathematical models in social science give the impression that human beings are well-programmed computers. [5]

[5] A. Rapaport, *Uses and Limitations of Mathematical Models in Social Science*, in: L. Gross (ed.), *Symposium on Sociological Theory*, Row, Peterson, New York, 1959, pp. 348–372.

Similarly "average income" of a country can be very misleading though it is an "accurate" figure. Some concepts are used to portray a picture of reality. It is in doing this function that a concept's reality-dimension becomes extremely important. A peculiar dilemma of social science is how to portray the dynamics of social situations without being "moralistic" (judgemental) about or indifferent towards what is happening. Conceptualization in social science at its worst becomes "name calling".

The advantage of conceptualization at higher levels of abstraction is the greater degree of freedom involved. Manipulation of symbols is easier than manipulation of objects. This is why advancement in mathematical sciences often preceded great many discoveries in most fields. In science conceptualization is experiment with ideas. The impact of mathematical sciences on other sciences is comparable to the impact of the development of currency on trade and commerce. Yet, it is an irony of history of science that mathematics, which developed as experiment with abstract ideas, has become a symbol of conceptual rigidity to a great extent.

The danger of conceptualization at higher levels of abstraction is its tendency to lose touch with reality. Such misguided conceptualizations become an end in themselves rather than tools in understanding real situations. Moreover, since each conceptualization has its own limitation as to what kind of problems and data it could handle, it is important to bear in mind that some of the major problems in a field are not left out by untimely conceptualizations. In other words, concepts, apart from being useful tools, determine in no small extent our general views, selection of problems and emphasis in our explanations as Dahrendorf has pointed out.[6] In general, conceptualization in a field must be related within limits to the stage of development of the field.

Different concepts may perform different functions in the same thought system or same concept may perform different functions in different thought systems. Some concepts are used to organize thoughts while some others to organize observations; some are used to describe reality while others to explain it. A coherent scientific system not only needs conceptual tools of all types and levels of abstraction, but also the ones which can unite various levels of abstractions.[7] It is a mark of a good concept that it is useful in different types of thought systems or theories. A concept which is capable of analyzing only one situation is not a good concept in science, regardless of how useful it is for that particular situation.

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[6] R. Dahrendorf, *Essays in the Sociology of Society*, Stanford University Press, Stanford, Calif., 1968, p. 125.

[7] W. R. Catton, Jr., *From Animistic to Naturalistic Sociology*, McGraw-Hill, New York, 1966, p. 46.

When we deal with multidimensional concepts, it is often theoretically fruitful to specify methodologically the component dimensions involved in it. History of science has plenty of examples of increasing specification of various dimensions of general concepts. However, conceptualization is not a one-way traffic. History of science has plenty of examples of the reverse process (conceptual generalization) too. While conceptual specification brings more clarity, conceptual generalization brings more systematization. It is a sign of mature science that it shows balanced growth in both types of conceptualizations.

In the final analysis a concept can not be evaluated apart from the particular function(s) it is supposed to perform. In other words, the particular level of abstraction or clarity or organization of a concept would depend upon the kind of problem, it (concept) is intended to tackle, though still general evaluations of any concept can be made to some extent.

MAJOR PRINCIPLES OF CONCEPTUALIZATION

Scientific conceptualization as a formal process is guided by several principles. As in the case of all creative activities these principles apply more to the finished products than to the process itself. There are no recipes for creativity, yet it can be evaluated. So in the strict sense, these principles are guides for evaluation of finished products, not road maps for a destination. Some of the principles are:

(1) Principle of orientation: A concept is an arrow which helps us to direct our attention towards a particular aspect of reality. It is a sensitizing device. Focussing on certain aspect(s) of reality is to ignore certain other aspects. Experience or reality is too complex to be comprehended in its totality. Experiments in science underline the meaning of focussing. Some concepts orientate one to the general field, while still others to the specific problem. It should be realized that aspects of reality are not "out there" in the open as if they are so vivid to any one that they are simply waiting to be focussed on.

A new focus is a "new" area for research. Freudian concepts such as "unconscious", and "psycho-somatic disease" opened up new areas for analysing in social science. Aspects of reality worth-focussing are the ones which are capable of shedding some light on the problem of understanding it.

(2) Principle of reduction: Every individual case in nature is unique. Science can not deny the uniqueness of any individual. But a science can not be built by emphasizing the uniqueness of individuals. It is inherently part of scientific thinking to treat an individual as a "case" which falls under a general category, a treatment which causes considerable difficulty for social scientists in their relationship with the

rest of society. To treat a person as a "case" is to dehumanize him to some extent. Consequently, social scientists must be acutely aware of the problems which such dehumanization creates and show insight to keep it within justifiable limits.

Conceptualization is a reduction of experience. The complexity of experience must be brought within manageable limits. As in all reductions, we lose a great deal of information as a result of conceptualization. The problem in conceptualization is not how to keep the maximum amount of information (details) but how to keep the pertinent details in and the trivial ones out. What is pertinent and what is not are decided by the nature of the theory (problem). In every conceptualization it is as equally important to keep in mind the kind of details left out as it is to keep in mind the kind of details left in. Scientific humility is partly based on the realization of reduction of information involved in conceptualizations.

(3) Principle of clarity: Operationalization of a concept is to underline the necessity of clarity in scientific conceptualizations, though operationalization is not the only way to bring greater clarity to a concept. The major difficulty for science with analogical and mystical concepts is their lack of clarity. A developed field has concepts to distinguish very closely related phenomena it deals with. One is often tempted to leave high-sounding concepts and theories unclarified for prestige reasons. It is not only misleading, but also presumptuous to call an expected relationship between two variables a "law" while in reality it is only a hypothesis at best. To point out the limited applicability of a theory or concept is to reflect not only intellectual courtesy, but also intellectual humility. It is interesting to note in the history of science that theories developed in the early stages of a field tend to be all-encompassing ones compared to the ones developed later in it. One of the reasons for explicating the underlying assumptions in a conceptualization is to bring greater clarity to it.

(4) Principle of systematization: Scientific conceptualization is not a random shooting at reality. It is a systematic effort. Some concepts organize our thoughts while some others our observations. In general, the former are orientating concepts. Consequently they do not need to be operationalized. Only the concepts which are important and directly involved with observation need to be operationalized. Principle of systematization is not so crucial in exploratory studies unlike in the case of more focussed studies.

It is important not to confuse systematization of thought with rigidity of thought. The former is inherently part of science whereas the latter should not have any place in science. Often in the history of science some concepts and theories become "sanctified". Thus scientists commit what Francis Bacon called "the idol of theatre". An historical dilemma of scientific conceptualization is how to achieve systematization of thought without losing its flexibility.

Systematization involved in conceptualization is multidimensional in nature. Within limits, on one hand, concepts through their operational definitions relate theory with the empirical world of observations while on the other, they link a particular theory with a general theory, related fields, and finally with a general philosophy of science. For example, ideally a sociological theory of crime should be related to a general theory of human behaviour, other related fields such as psychology and anthropology, and to a philosophy of science through a philosophy of social science. The actual magnitude of systematization attainable or desirable for a particular theory depends upon the stage of conceptual development in the field and upon the nature of the problem under consideration. A good concept is capable of integrating seemingly unrelated fields, contents, and problems. Continued existence of conflicting findings and interpretations in any field point out the need for conceptual systematization in it.[8] Systematization of thoughts and findings becomes a greater necessity with increasing development and proliferation of scientific activities.

(5) Principle of parsimony: Conceptualization is a way of economizing or simplifying our thoughts and findings. There is no sense in replacing reality-complexity with a conceptual one. Often scientists from an elitistic point of view develop unnecessary jargon, since it would form a defense for their privileged positions against "intruders". One who is not exposed to scientific jargon at an early age is likely to find it difficult, if not impossible, to enter the scientific community at a later stage in life. Science, which originally started as a "frontier" for aspiring minds, has become an upper class-oriented conservative force to a great extent.

That which can be explained in simple terms should not be explained in complex ones. More complex models are justified only to the extent they bring greater understanding of the problem under consideration. The question whether or not the degree of greater understanding brought about by a more complex model justifies the adoption of the new model is a practical one.

(6) Principle of heuristic validation: The initial goal of scientific conceptualization is to stimulate one's intellect and create an experience of creative freedom in the individual. In social science, concepts such as "instinct", "drive", and "basic human nature", can not be highly heuristic, since they are tautological or circular in explaining human behaviour. Most of the classical concepts in metaphysics such as "prim-

[8] P. M. George, E. T. Pryor, Jr., "Theoretical and Methodological Significance of Reconceptualization of Nucleation of Family", *International Journal of Sociology*, 1971.

ary property of matter", "basic categories of thought" and "nature of things" do imply a cognitive rigidity. Like Aristotalian logic, they imply a "closed" system of thought. That is why Einstein's theory of relativity has opened up new avenues for conceptualization in science.

The final test of a concept is its utility (direct or indirect) in understanding the empirical world. Regardless of how poetic, philosophical, logical or easily operationalizable a concept might be, it has very little use in science unless it is helpful in understanding reality. Some of Toynbee's concepts are being criticized as highly poetic, but not useful in understanding history. [9] All the principles mentioned earlier are secondary to the principle of heuristic validation. In fact, they are instrumental to the latter one. The final empirical test of a concept is what separates scientific conceptualization from all other types of conceptualizations such as in religion, philosophy and art.

SUMMARY AND CONCLUSIONS

Conceptualization in science is basically an insight in organizing our thoughts and observations, which provides an understanding of reality. A good concept is expected not only to focus our attention on new areas of research, organize seemingly unrelated contents, problems and thoughts, but also to raise new questions and provide new answers which are not open to the laymen. The double dilemma of scientific conceptualization is how to move from observations to higher levels of abstraction without losing pertinent details and to do the reverse without losing the necessary level of abstraction. A paradox of history of science is how to accomplish continuity and systematization of thoughts and findings without being rigid in thinking. It is a sign of mature science that it reflects not only sophistication of conceptual tools, but also humility in spirit. Scientific humility and sense of community are based on the realization that conceptualization involves a reduction of experience, experience can be conceptualized in many ways, and that conceptualization is a product of socio-historical forces. Scientific sense of community is materialized by conceptualizations at higher levels of abstraction. The quality of science in the final analysis depends upon the quality of its conceptualizations.

[9] This criticism is reported by M. W. Vine in her *An Introduction to Sociological Theory,* David McKay Co., New York, 1959, p. 312.