

M A T H E M A T I C S

A M O N G T H E

K P E L L E T R I B E O F L I B E R I A

by

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Suacoco, Liberia

Sponsored by

African Education Program
Educational Services Incorporated
Watertown, Massachusetts, U.S.A.

Preliminary Report
1 May 1964

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INTRODUCTION

The instruments of thought which have been forged in western society are being used as tools throughout the inhabited world. Not unnaturally, there have arisen difficulties in making use of these tools, particularly where the user draws upon an experience vastly different from that of the tools' makers. This problem presents itself most acutely in the fields of mathematics and logic, disciplines which, on the one hand, seem to have universal applicability, and, on the other hand, seem to arouse formidable resistance from those who might profitably apply them. This resistance to logical and mathematical thought is widespread. It appears as the political and pseudo-scientific irrationalism of highly educated Germans during the Nazi era. It appears as the frustrating unconcern with time which marks many nations. It appears among small children everywhere, when they confront arithmetic in school and decide that they hate it.

This problem has come into a position of special importance for me in the situation where I have worked for the past five and a half years. One of my first assignments at Cuttington College, which is a liberal arts college on the American pattern, taking students at the end of secondary school and giving them four years of education leading either to the B. A. or the B. S., was to teach first and second year mathematics. I had been warned before I came to Liberia that the mathematical background of the college students was poor, but this warning was insufficient to prepare me for the tremendous difficulties my students were to have with their courses. Seemingly routine operations, which should have been learned in elementary school or early secondary school, proved to be major stumbling blocks.

And yet the difficulties were but intensifications of difficulties known

all over the world. There was nothing different in kind between the initial troubles with mathematics of a Liberian college student and those of an American college student. However, it soon became clear that the former consistently was unable to do that which the latter more and more frequently found to be within his abilities. I tried many approaches to this problem, but without notable success. There seemed to be a massive and unbreachable wall between the student and that logical and quantitative precision which should mark mathematical reasoning. It was clear that a problem of such serious and significant proportions required a serious and significant attempt at an answer.

The first step toward such an attempt must be to list all the possible sources of difficulty which hinder the proper use of those mathematical and logical instruments which western nations have found to be so devastatingly powerful. Those sources of difficulty can then direct an inquiry into ways of overcoming the difficulty, with the hope that eventually conclusions can be reached which have practical implications for classroom teaching, as well as for social amelioration.

The present study, which has grown out of such an approach to the problem, is specifically concerned with one group of people, not so much because their problems are exemplary of the problems for all non-western persons in the use of western intellectual tools, but because a full and detailed study of this group should suggest both tentative answers for the general problem as well as a procedure for verifying and modifying these answers to suit a wider range of peoples. The group chosen is the Kpelle tribe, a society of perhaps 500,000 persons in the hinterland of Liberia and the southeastern corner of Guinea. The Kpelle language is a member of the Mande language group, which is itself a subgroup of

the Niger-Congo branch of the Niger-Kordofanian language family. Thus Kpelle is related, albeit distantly, to languages ranging from Dakar to Dar-es-Salaam, and to that extent is at least not atypical of a large majority of the African languages.

Cuttington College is located on the edge of an old Kpelle town, and is very nearly at the center of Kpelle country. Although its students represent tribes and nations from Panama to Zanzibar, there are a few articulate Kpelle-speaking students at the college. In particular, Mr. John Wealar, who has acted as research associate and informant throughout the duration of the project, has helped me to make a careful study of the cultural patterns of this tribe.

This report, whose structure reflects the stages of research, will be in six chapters. The first deals with the general cultural background and reasons for the investigation. The second states the problem in as broad terms as possible. The third deals with the canons of research applied to the study, both those which are general requirements for a scientific study and those which were demanded by the specific project. The fourth details the progress of the research, both completed and projected. The fifth chapter suggests certain conclusions which can be drawn from the study, while the sixth offers both theoretical generalizations and practical recommendations.

This report is a first draft, a preliminary version, of what will eventually be a more complete statement of the nature and implications of pre-logical and pre-mathematical thought in Kpelle culture. It is presented in this preliminary form primarily for the benefit of those who are to participate in the third Entebbe mathematics workshop, and should be judged strictly as a working paper. It is hoped that the final report will be completed after approximately another year of study.

My first thanks go to Professor Jerome Schneewind of the University of Pittsburgh for suggesting to me many years ago a study of philosophy in African culture, and who first made me see that philosophy has to do with human rationality in action. I am grateful also to Educational Services Incorporated, and particularly to Mr. Stanley Weinstein, for providing the financial support and administrative help which has made the first stages of this project possible. I am grateful, moreover, to the consultants who have given generously of their time, their ideas and their ingenuity, in setting me on the right track, particularly Professors H. A. Gleason of Hartford Seminary Foundation, Gilbert Ansre of the University of Accra, David Crabb of Princeton University, Paul Johnson of UCLA, William Welmers of UCLA, Michael Cole of Stanford University, and William Stewart of the Center for Applied Linguistics, The administration and staff of Cuttington College deserve my thanks for their willingness to make time, ideas and resources available to me in my work. The chief and people of Gbanzu deserve our thanks for their patience with crazy foreigners. I must emphasize my debt to John Wealar, who has struggled with me as I learned what little Kpelle I know, and has acted as a sensitive, articulate and informed intermediary between me and the Kpelle culture within which he grew up. And, finally, I wish to thank my wife for bearing with me, supporting me with good food and good ideas, and generally making this project possible.

CHAPTER 1—GENERAL BACKGROUND

The difficulties which students have in learning mathematics are, of course, related to the difficulties which they experience in other subjects. In some ways, mathematics is unique, but that uniqueness does not lie in the types of problems encountered. Rather it lies in the particular ways those problems manifest themselves. I will explore in this first chapter certain general problems which have implications not only for mathematics, but also for other subjects. And then I will attempt to make clear some of these implications as they specifically relate to mathematics and logic.

a. General Cultural Background

The major areas within which difficulties are found are linguistic, anthropological, psychological and educational. It is true that individual students may be hindered in school by problems of a physiological nature, but such problems are not germane to this inquiry, however relevant their implications might be for general learning theory. Human knowing can, in most general terms, be divided into its physiological, linguistic and psychological aspects. I will not discuss the first aspect here, but will focus upon the second and third, bringing to bear upon them as well whatever insights might be provided by anthropological and educational considerations.

(1) Linguistic

Language is the universal human medium of gaining and expressing knowledge. Obviously, therefore, the structure of language must have a decisive effect upon the learning and knowing processes. Yet all too little is known about this effect, particularly in the case of non-western languages. It is fortunate that

the Kpelle language has been thoroughly analyzed by Professor Welmers and other linguists—this makes the immediate problem simpler. But in many other cases, non-western languages have been neglected or treated as crude, primitive substitutes for supposedly sophisticated western languages. The opposite is of course the case. Each language that man has devised for his use is a subtle, sophisticated instrument of communication. These languages differ in important ways, yet all accomplish with remarkable efficiency the business of communication.

There are three ways in which language may act to confuse the learning process. First, the vocabulary of ordinary language may not be adequate for the expression of concepts in the discipline being studied. As a result of this problem, technical terminologies are developed in each field. Where these terminologies become sufficiently specialized, they give rise to what are almost new languages. The technical language of law is a good example, since the educated layman often fails totally to understand a legal brief. Another, somewhat different, complication which may arise is the redefinition of terms which have an everyday use in ordinary language. Mathematics is constantly redefining, with the hope of making more precise, terms from ordinary language. An example is the term "group", which has a precise technical meaning in mathematical language, a meaning which limits and specifies the ordinary meaning.

Second, the grammar and syntax of ordinary language may not express clearly the structural patterns important to a particular discipline. This is most apparent in the case of logic, where such structural concepts as equivalence, disjunction and so forth, do not find immediate parallels in the grammatical organization of common speech. For a specific example, the structure word "or" in English is ambiguous, since it is not clear, except from its context, whether

one of the two alternatives is necessarily excluded, or whether both may be included. In mathematics, ideas of negation and inverse do not find adequate expression in such English words as "opposite" or "reverse." This problem is closely related to the problem of inadequate vocabulary in the same way as form is related to content.

The third problem is really only an extension of the two problems stated above, namely, the mismatch between the languages of different persons. Two individuals who speak the same language may have different terms for the same thing or concept. The difficulty may arise between two dialect groups of the same language. That which an American calls the hood of his car the Englishman calls the bonnet. Moreover, the dialect difference may be cultural rather than geographical. Finally, the mismatch may be between two different languages. In this last case, the trouble is most acute, since different languages do not organize their pictures of the world in the same way. Thus, when a person is attempting to learn, even in his own language, a discipline whose leading structural and terminological ideas were formulated within an alien language group, he has trouble fitting the ideas to his own customary patterns. Of course, a perfect translation from the second into the first language would eliminate the difficulty, but such a perfect translation is almost inconceivable. Some difficulties can be avoided, as, for instance, the difficulty of translating the English 'hand' into the Kpelle /y^ée/, where the Kpelle word refers to the entire limb. But not all such troubles can be avoided, and thus inevitably translation is distortion.

This same problem arises most acutely when learning takes place in what is, for the learner, a second language. His mind is informed by his first language,

and he tends to make a rough identification of words and structures in the foreign language with those of his own. He "learns" the subject, at least to the extent of being able to parrot results, but often he fails to understand the subject, because of the underlying linguistic mismatch. His application of what he has learned is then wooden, mechanical and unoriginal. He follows a formal procedure which makes sense on his own terms, even though it may not express the central meaning of what was taught him.

A most interesting result of the interaction of languages is the development of the languages called pidgins and creoles. These are languages whose vocabulary is drawn from an imported, foreign language, yet whose structure is based on indigenous languages. Most often, the foreign language is the language of trade or conquest, such as English or French or Spanish. A pidgin is a language of this type which is learned by adults in order to compete in the complex world outside their tribal group. A creole is a pidgin which has acquired native speakers of its own, that is, individuals who were born into homes which spoke only the pidgin. The pidgin or creole, as the case may be, is a new and distinct language, even though its antecedents are clearly recognizable. And, as a language, it gives rise to the same problems of linguistic mismatch as in the other cases mentioned above. These problems are more subtle, and less easy to recognize, however, because of the surface similarity of the pidgin or creole to the foreign language.

In all these cases, therefore, the implications of linguistic confusion must be taken into account when attempting to improve teaching procedures. The differences in vocabulary and structure between the learner's everyday language and the technical language which he must learn must be explored thoroughly, and

bridges must be constructed which enable the learner to move from his accustomed usage to the usages of science. These differences are smallest where the learner's speech is close to the technical language being learned. They are greatest where the learner has grown up with a language of a completely different family, as different as English and Kpelle, for example. But they exist in every case, and should never be forgotten.

(2) Anthropological

Language and culture are, of course, closely intertwined. Language is the expression of culture and culture is the living-out of language. A formal study of the language is possible without a knowledge of the culture, but then the language becomes only a collection of organized sounds, in the literal sense "full of sound and fury, signifying nothing." In order for language to signify something, there must be something to signify, and that something is an element in the culture. Linguistics separates sharply the phonology of a language from the morphology. The former refers to the organization of sounds, and attempts as much as possible to avoid reference to meaning. The latter concerns itself with forms which have reference to content or to the organization of content. Our linguistic concern is obviously with content, since for us language is either an instrument for or hindrance to the process of learning. Thus we must consider language in relation to the living experience on which it is based. Thus, if we are to be concerned with the meaning of language, we must make use of the insights of anthropology.

Anthropology is, of course, not simply the study of curious habits on the part of dwellers on exotic tropical islands. It proposes as its subject the total culture of a society of human beings. Very commonly, it applies itself to

isolated and primitive peoples, but this limitation is not essential to the subject. Such emphasis on the isolated and the undeveloped societies is a matter of practical expediency, not only because it is simpler to study the total culture in these cases, but also because these cultures may disappear before too many years elapse. But there is no theoretical reason why anthropology should not study more complex, technologically developed societies.

The raw material for anthropological study comes from such disciplines as sociology, political science, economics, religion and art. These disciplines are as relevant to the developed as to the undeveloped society, although in most cases the specific disciplines have grown up in the context of the developed society. This has given rise to a misconception of the role, both of anthropology as a whole and of these special disciplines individually. Anthropology, since it has tended to look at exotic cultures, has come to be thought of as purely descriptive, taking the data of observation and generalizing therefrom to theoretical conclusions. Other human sciences, such as sociology, political science and economics, have been thought of as practical, suggesting means of altering and improving the culture within which the scientist himself lives. Yet, in both cases, the problems are the same. The student of so-called primitive societies must be concerned with description and theory, but he must also attempt to use his conclusions for social amelioration. He describes the culture, but he must also be willing to prescribe for the culture. In the same way, the political scientist must be as willing to give an objective, theory-centered description of the nation he studies, as he is to make recommendations for its development and growth. The human sciences are both descriptive and prescriptive, both theoretical and practical.

Specific problems arise for the teacher which are subject to analysis by the anthropologist who attempts to look at the total culture. Teaching involves the use of language, but the language used must make sense within the culture of the

learners. The Eskimo is perfectly capable of stating on an examination paper how to grow bananas, but the information is sterile and formal. Since we are concerned, not only with sound, but also with sense, we must consider what meaning the words and structures being taught have for the student. Bridges must be built, as was mentioned at the end of the previous section, from the learner's accustomed usage to the usage of science. And these bridges must be built using materials, both the language and that to which the language refers, provided by the learner's culture.

The principal difficulty which arises from an anthropological point of view results from a mismatch between the culture represented by the discipline to be learned and the culture of the learner. It is true, of course, that the learner must advance beyond the culture of his childhood, but he can only do so a step at a time. Thus the educational program must be so designed that it begins with the student's experience and moves systematically from that experience to comprehension of the discipline being taught.

To this end, therefore, it is necessary to study two cultures in relation to the subject matter under consideration. It is necessary to understand how the subject matter grows out of and is related to the culture of its initiators. And it is necessary to understand the culture of the learner in relation to the problems suggested by the subject matter. Only in this way can bridges be constructed adequate for moving from one culture to another.

In this connection, it is necessary to consider these cultures which are products of this state of transition from undeveloped to developed society. These cultures are the bearers of the pidgin and creole languages mentioned above, and they show many of the same marks as do the pidgins and creoles. Specifically, much of the content of living is drawn from the new culture into which the person is moving, whereas many of the formal ways of dealing with this content refer back to that

person's original culture. The reverse is also at times true, as when a person in the transition culture adopts certain of the forms of the foreign culture, filling them with a content drawn from his own original culture.

Most school children in developing countries are in this state of transition, but the transition is made doubly difficult for them because very few serious attempts have been made to build bridges for them from the old to the new. Once they become literate, they tend to be rejected by the old people. On the other hand, they have not yet acquired the veneer and polish which make it possible for them to move with ease in the sophisticated western society to which they aspire. They are caught in the middle, and, should they not complete their education, they remain in that intermediate state, drifting between cultures. And yet, in drifting between cultures, they are creating a new culture, a new culture to which we must pay serious attention. It is the culture of many whom we teach, particularly those young children who grow up in transition communities, having never known the traditional society.

Thus we must attempt a descriptive analysis of cultures. This must not be simply a general analysis, however, but rather an analysis related to our problem. In the case of mathematics and logic, we must know how the insights of these disciplines fit into the two cultures, the culture of the learner and the culture of which the disciplines grew.

(3) Psychological

The language and the culture into which the new learning comes, condition and are conditioned by the psychology of the individuals who speak the language and make up the culture. This psychology, which can perhaps be defined as the nature of the mental response an individual makes to a stimulus, has three aspects: the psychology which is characteristic of the human being as such; the psychology

which is characteristic of a given social group; and the psychology which is characteristic uniquely of a particular individual. All three of these psychologies are important to the learning process, wherein an idea externally presented is made internally meaningful and real. We are here, however, concerned primarily with the second psychology, that of the behavior of members of a particular social group. The same types of facts and arguments which are set forth here concerning social groups are, of course, applicable to the whole human race and to particular individuals. But the problem which confronts us here is the problem of cross-cultural contact, and thus we limit ourselves to that which members of a given social group have in common.

Just as we must know the language of the learner, and the culture within which language has meaning for him, we must know his responses to statements and to material situations within that culture. We must know how he attends to things, and what things he attends to. We must know how he adds to his store of experience, as well as to his store of generalizations from experience. We must know of his emotional reactions to that which comes to him from the outside and the value judgments he makes on these experiences. We must know what he desires and fears. To a large extent, these things are culturally conditioned, and thus we must expect to find within his culture both blocks and aids to learning.

However, such studies have been few in number outside of the technologically developed areas. We have very limited knowledge of the ways in which peoples of undeveloped and developing societies react, and thus much research is needed in this area. In particular, this research must be of a comparative nature, and must be sufficiently precise and yet extensive, that a clear and distinct picture emerges of the psychology of the group. Experiments must be performed which test

specific reactions to specific situations within the cultures concerned, so that contrasts, as nearly rigorously quantitative as possible, can be drawn between different groups. Thus, for example, in the cases of mathematics and logic in which we are interested, the tests must be so designed that they show individual and group behavior relevant to these subjects. The language and cultural experience of the individual is in this way both used and tested.

The hope then is that these experiments will bring to light blocks to the learning of specific concepts and procedures imported from alien cultures and languages. These blocks must be contrasted with those found in other cultures, and ways of overcoming these blocks must be recommended. The problem is the same as in the cases of linguistic difficulties and anthropological difficulties--the mental reactions of those learning and those preparing the material to be learned are different, thus making learning difficult. Whether the differences are cultural or individual--but especially where they are cultural--we can study these differences, and on the basis of this study make recommendations designed to overcome the difficulties.

(4) Educational

We have been speaking throughout of the difficulties encountered in teaching in a foreign language, within an alien society, to an individual whose reactions are peculiar to him and to his culture. We have spoken of areas of needed research, and we have suggested ways of attempting to do this research. But all these ideas and hopes are of little value unless they are actually incorporated into the schools. Thus we must look at some of the problems which arise in the classroom, in addition to the general linguistic, anthropological and psychological problems.

In the first place, there are the practical difficulties encountered in de-

veloping a workable system of education. Textbooks must be prepared which speak to individuals within a given culture and language. But these books must also speak to other cultures and languages equally well, since it would be prohibitive financially and undesirable socially to have universal education available in every language. It may, of course, prove necessary to make education available for the first few years of school in many of the local languages, but after a certain point it is clear that a few standard languages must be chosen. In the African situation, it is likely that these languages will be both the dominant European languages and those few African languages which are spoken by large and articulate groups. Thus the results of this present inquiry into Kpelle culture and language must be integrated with the results of similar inquiries in other societies, with the hope of reaching general conclusions and recommendations which can be applied on a large scale.

Of course, it will be important always to adapt the curricula and texts to the local scene as much as possible, and it is assumed that curricula and texts will be prepared with this adaptation in mind. A fruitful compromise between flexibility and universality is that toward which the whole project must aim. If necessary, alternative approaches may be suggested for a particular topic, and the teacher allowed discretion in choosing which to use.

But this raises the very serious problem of training the teachers. In some cases, the teachers come from the same social group as those they teach. In this case, it is easy for them to communicate with their students, but, on the other hand, they often experience the same difficulties with the foreign material as do their students. And thus the teaching as well as the learning become wooden, mechanical and purely formal. The teachers in other cases are of a different

language and culture group from those they teach. The group to which they belong may be that foreign culture out of which the subject matter came, in which case the same problem arises of bridging the gap. Or they may come from still a third group, in which case the difficulty is even further compounded.

Thus in every case special attention must be paid to preparing the teacher to bridge the gap between the learner and that which he learns. If the teacher's background in the discipline is sketchy and his understanding of the foreign culture poor, he must receive special additional training in his subject matter and the ways to make it alive to his own people. If, on the other hand, the teacher understands the foreign culture, but has a poor understanding of his pupils and their language and culture, he must receive special training in that culture and language. If the teacher is foreign to both cultures, he is in particular trouble, and needs correspondingly more training.

Finally, it must be borne in mind that there has been a revolution in content and methods of education in those western countries where our modern world has been shaped. This revolution has in many cases been based precisely on that necessity for building bridges between the everyday language and culture of the student and the technical language and intricate culture which he is to learn. It is not necessary that the developing countries repeat all the stages of development of western educational method. If there have been improvements in technique for presentation of ideas, let them be used now rather than twenty years from now. But, unfortunately, all too often the texts and methods used in developing areas are those which technically developed countries have outgrown and bypassed. Old methods and curricula and texts which have proved inadequate to communicate to children in western cultures should not continue to be exported to developing areas. Where new insights into language, culture and psychology

have made teaching more effective in the west, it may be expected that, if these insights are sufficiently general, they should prove useful in other culture areas.

Thus it is necessary to develop a practical program for devising curricula and texts and for preparing teachers, suitable for large areas within the less developed parts of the world. This program must make use of the best insights into language, culture and psychology, and must not continue to use the leftover and discarded methods of western education. Thus the new countries must be at the forefront of research and development in educational theory and practice, so that they can not only help themselves but also be suggestive to others.

b. Specific Mathematical and Logical Background

I have spoken thus far about the general problems lying behind this study of Kpelle pre-mathematical and pre-logical thought. I have discussed the linguistic, anthropological, psychological and educational reasons for the study, and I have attempted to suggest some ways to approach the study within each of these areas. I must now turn to the specific mathematical and logical reasons for the study. These can be divided into reasons which are narrowly mathematical and reasons which are broadly epistemological, and they will be studied in that order.

(1) Mathematical

The special goal of this project is to learn more about the role of mathematics in non-western culture, particularly within the Kpelle culture. To this end, we must concentrate on the linguistic, anthropological, psychological and educational aspects of the problem. Little is known at present about the place of mathematics within a culture such as that of the Kpelle tribe. The general picture of the culture—its language, its institutions, its beliefs, its fears, its customs—is important to any investigation of this type. Within that frame-

work, we must find the place of mathematics. We must know in what ways mathematical terminology and structure appear in the language, and how they are used. We must know in what ways quantitative methods are applied to the things and concepts of ordinary life. We must know how mathematical behavior is learned. All this is necessary not only to gain a complete picture of the social pattern, but also to guide us in our mathematics teaching.

There is another problem of parallel importance, and that is the general problem of the role of pre-mathematical and pre-logical thought in learning. In every society children are exposed to thought and activity which suggest a mathematical or logical formalization. In every society, for instance, children learn to count up to small whole numbers at quite an early age, simply as part of their general development. Moreover, in every society, children learn to argue according to a pattern approved by the culture, if only to get their desires satisfied.

But we do not know how such pre-mathematical and pre-logical thought helps in learning mathematical concepts. It will thus be necessary to study the foundations of mathematics in ordinary language, everyday activities, and normal mental reactions, as well as in the educational process. That there are such foundations is evident, since mathematics did not arise historically from nothing. It grew out of the ideas, activities and needs of particular peoples. The earliest records we have of mathematical activities are from the ancient Egyptians, who apparently used a rudimentary form of geometry in their building of the pyramids and in their control of the annual Nile flood. Even the most sophisticated of modern mathematical concepts can be traced back to their foundations in the daily life within western culture, and eventually find their applications in the further development of that culture.

We must thus investigate the place of mathematics in non-western societies, how it is learned and how it is used. The study of the development of mathematics, moreover, includes both the study of how children learn mathematics and the study of how the society adapts its behavior to new problems of a mathematical nature.

A further reason for this study is the recent revolution in the methods of mathematics teaching in the United States. This revolution is part of the general revolution in teaching methods, and we must find ways to use it in developing areas. We must thus first observe how these new methods are succeeding in western countries, and then modify them on the basis both of the success or failure we observe and of our knowledge of the circumstances peculiar to the areas in which we work. The new curricula being developed in Africa must be observed closely, and modified to take into account new developments in other areas, as well as new insights into the role mathematics plays in the language, culture, psychology, and patterns of learning of the developing areas.

(2) Epistemological

A further reason for this study is the possibility of illuminating the larger subjects of the theory of knowledge and the theory of learning. Up to the present, most studies within these fields have been conducted using literate European or American subjects, and thus are limited in their generality and applicability. Many of the remarks made about scientific method and educational theory, even in this paper, are dependent upon insights based on experience with a limited group of people. It is hoped, therefore, that this study will enlarge our understanding of knowing and learning, by suggesting new generalizations, verifying previous generalizations, and rejecting as faulty hypotheses too narrowly limited to western society.

The study of pre-mathematical and pre-logical behavior on the part of non-western as well as western social groups should suggest ways to approach the comparative study of the foundations of thought. When a truly descriptive linguistic philosophy is formulated, it will base its generalizations on the experience of widely differing language groups. A proper appreciation of the role of knowing and learning in the social life of man will depend on observation of these activities in representative societies. The psychology of learning and reacting must take into account cross-cultural similarities and differences. And an educational theory of wide generality must be built on ways of learning known to various traditions as well as on the fruits of contemporary research.

All this suggests the need for a general epistemology, applicable, with modifications, to all human groups. An epistemology, after all, is only a description of ways of expressing knowledge and widening the range of that knowledge. The formal disciplines involved in this activity are logic and scientific method, which are fundamental to the present study into the linguistic, anthropological, psychological and educational aspects of pre-mathematical thought in non-western cultures. The comparative study of logic and scientific method, as actually practised in various cultures, would, if considered in this way, help us to develop a more general and powerful theory of knowing and learning.

a. Conclusion

In summary, the reasons lying behind this study are two-fold, including both general cultural reasons and specific mathematical and logical reasons. The former include problems which can be characterized as linguistic, anthropological, psychological and educational. The latter include problems which are, on the one hand, specifically mathematical, and, on the other hand, broadly epistemological.

In each case, the problem is one of bridging the gap between knowledge which has been developed in one culture and a student who grew up in another culture. The cultural difference may be as narrow as that between a child and an adult in an American academic community, or it may be as broad as that between a literate American and an illiterate Papuan. The width of the gap is only a matter of degree, however. The important thing, no matter what situation is considered, is to find ways of building bridges from what the learner knows to what he wishes to know. To this end, it is necessary to institute a comparative study in each of the areas mentioned above.

The result hoped for is also two-fold. First, there will be better teaching and learning. Much mechanical rote learning, without interior significance, will be eliminated, if this study is successful. Second, we will understand better the foundations of thought itself, through the use of the research techniques and results obtained in the study. To these ends, then, we must address ourselves.