CHAPTER 4 - STAGES OF RESEARCH

In this chapter I will attempt to outline the stages of research in the Kpelle mathematics project. There have been two phases in the work completed thus far, and these will be described in detail in this chapter. These two phases were devoted to preparation and research respectively. The methods followed were as nearly as possible those outlined in the previous chapter. I will give as much detail as seems necessary to support the conclusions which will be stated in Chapter 5. Further details can be found in the specific reports which were prepared at each stage of the study and which are appended to this paper. Complete details can be found in the records which were kept of the specific experiments, tests and elicitations.

a. Preparation

(1) Origin and statement of the problem

As I mentioned in the Introduction, I first encountered the difficulties of African students with mathematics when I taught first and second year mathematics courses at Cuttington College in 1959. I did not know the source of these difficulties at the time, and thus made a number of mistakes in attempting to overcome them. Different textbooks were used, but the choice of textbook did not seem to affect the difficulty students had with the courses. Whether it was a traditional college algebra book or a modern integrated approach based on the theory of sets, students seemed to be unable to grasp the subject by any approach other than simple memorization. The severity of the problem was indicated by one Cuttington student who demonstrated his ability, learned by memory, to differentiate the function $(x + 2)^2$ but who was unable to differentiate the almost identical

function $(2x + 3)^2$. He told me that he had not learned that one yet. I showed him how to do it, but he still was unable to make the generalization necessary to solve another similar problem. This example is typical of many such difficulties which arose. Moreover, such troubles were not confined to the poor students—even those who were most competent at memorizing the textbook had trouble applying what they learned to new situations.

After a number of false starts, I concluded that the best approach might be to improve mathematics teaching in the elementary and secondary schools. It was clear from the entrance and placement examinations (the California Reading and Mathematics tests) which Cuttington administers to entering students that the preparation of our students was inadequate. Consistently the average score, based on American standards, placed high school graduates at the 9th or 10th grade level. Some fell below this standard, while others at times made scores which would rank with American college freshmen. But such students have been all too rare. My own observations in schools indicated, moreover, that these poor results were to a great extent due to poor teaching and poor learning. Whereas at Cuttington, I saw students unable to take derivatives, because they could not perform the required algebraic operations, in the high schools I saw students unable to perform algebraic operations because their arithmetic skills were inadequate. And, furthermore, in the elementary schools, I saw students unable to do arithmetic, because they could not understand the teacher or the book. And in no case did I see teachers attempting in a creative way to overcome the difficulties. All the teachers, including myself, resorted to reliance upon memorization in the end.

All this led me in 1962 to leave college mathematics teaching in other hands, and turn instead to preparing teachers to teach mathematics in the elementary and

secondary schools. In 1962 I taught a course in the teaching of elementary mathematics, and in 1963 a course in the teaching of secondary mathematics. The former course was reasonably successful, but the latter course, unfortunately, did not achieve its purposes. Among the reasons for the failure was the fact that our Cuttington students did not themselves have the mathematical sophistication to deal on a mature level with the content and structure of secondary school mathematics. They knew how to perform most of the operations, but they did not understand their meaning.

The experience I had preparing elementary mathematics teachers led me into contact with the African Education Program of Educational Services Incorporated. I had previously been acquainted with Mr. E. M. R. Smith of the mathematics department at Fourah Bay College, and I had told him about my difficulties in teaching mathematics at Cuttington and my attempts to overcome them. I also mentioned my course in the teaching of elementary mathematics, and I asked him to keep me abreast of developments in this field. He then told me about the conference which had been held under the sponsorship of Educational Services Incorporated at Accra in December, 1961, and arranged to have me invited to their next conference at Ibadan in March, 1962. There I learned about the proposed writing conferences to be held at Entebbe, and I expressed my deep interest in the project. And when the first writing conference, which I was unable to attend, produced Primary 1 and Secondary 1 texts, I put them to use in experimental classes in Liberia, taught by Cuttington students and graduates.

My observations in these experimental classes led me to conjecture that there might be cultural factors which were interfering with mathematics learning. For this reason, I proposed to Educational Services Incorporated that they support a

research study of mathematical ideas in Liberian languages (see Appendix 1). The original proposal, made in November, 1962, although it was based more upon ignorance than it was on knowledge, interested a number of people, who then expressed their willingness to assist me. Professor H. A. Gleason of the Hartford Seminary Foundation in particular provided valuable support in the winter of 1962 by introducing me to the discipline of linguistics, and making sure that I understood the complexities and difficulties implied by my proposal. Educational Services Incorporated also showed interest and encouraged me to go ahead with my work while they sought to find adequate support for the project.

(2) Preparation for the investigation

Before going any farther with the actual study itself, it was necessary for me to extend my knowledge in a number of areas. In particular, I spent time studying linguistics and the Kpelle language. These two activities took up most of the time I had available for research during the year 1963, but have proved since then a valuable expenditure of time. I read several works suggested by Professor Gleason and by Mr. William Stewart of the Center for Applied Linguistics, and worked with Mr. John Wedar on Kpelle. It became clear during this time that the study needed to be restricted to Kpelle culture at first, because of complexities I had, in my innocence, not anticipated.

I also continued to observe mathematics classes in action, particularly those which were using the texts prepared at the 1962 Entebbe mathematics workshop. In this connection, I worked closely with primary school children in the nearby town of Sinyee, and had the opportunity to teach first graders for several weeks. This work helped me understand some difficulties of primary school children, and gave me a number of valuable hints for further work in the project.

I participated as an observer in the 1963 Congress of West African Languages, held at Fourah Bay College at the end of March. At this time I had the chance to discuss my problem with several linguists interested in the subject, particularly with Mr. Gilbert Ansre of the University of Ghana. I also observed with interest the fundamental similarities in syntactic structure among a large variety of languages.

I also participated in the 1963 Entebbe mathematics workshop, where I helped to prepare the book Basic Concepts of Mathematics, which is intended as an introductory course for teachers in teacher-training colleges. During this workshop, I had many conversations which proved useful, particularly conversations with Professors Gleason and Ansre on linguistics, as well as conversations with Professor Alfred Putnam of the University of Chicago on the relation between logic and mathematics.

Finally, in my Cuttington course in the history of philosophy, I laid special emphasis upon theories of knowledge in western philosophy. This study proved useful in helping me sharpen my ideas concerning the relation between mathematics, logic and philosophy. In this way, I came to understand the close tie between epistemology and the particular research project I had proposed. The range of possible implications of the project thus was expanded to include conclusions relevant to the theory of knowledge.

b. Data Gathering and Forming Hypotheses

(1) Order of events

A simple chronological account of the activities in this data-gathering and hypothesis-forming stage is useful, but should not be allowed to confuse the logical structure of the inquiry. Thus in the following sections, I will speak of

these activities in structural rather than temporal order. I will not take into account the fact that one step was taken before another step, unless that fact is actually relevant to the main purpose of the project. At times, in any research project, data gathered at an early point in time is not used until late in the proceedings. Moreover, conjectures which are important to the logical flow of ideas are at times not verified by data until after they have been used.

However, for the sake of the record, I will state the order of events for this period of data gathering and formation of hypotheses, which period lasted from roughly December, 1963, to April, 1964. All field work was done in the rural village of Gbanzu (see Figure 1), a typical Kpelle town of approximately 60 huts and 350 people, located a four-hour walk from the nearest motor road and an eight-hour walk from Cuttington College. The town has an air-strip originally constructed by the Lutheran church for the use of a pastor and school teacher supplied by the church. On most of our trips, we flew in with Mr. Esston Wilkins, a Lutheran missionary pilot (see Figure 2), although our initial visits were on foot. The arrival of the plane was a great event, of course, and the whole town would turn out for it (see Figure 3). The school, which we used for a house (see Figure 4), was closed a few years ago, and no pastor is presently in residence. Thus the town is quite isolated from western culture, although not absolutely so. Since the school was in operation for only a few years, and reached only a small number of children, its total impact on the town was quite small, and the residual impact is at present almost negligible. A number of the men of the town have worked for varying, usually short, periods in such places as the Firestone Plantation or Monrovia, and, as a result, have some slight command of English. But only the town chief, Benjamin Mulbah (see Figure 5), has had any formal schooling, and his schooling did not go beyond the third or fourth grade. There are, to be sure, several persons, originally

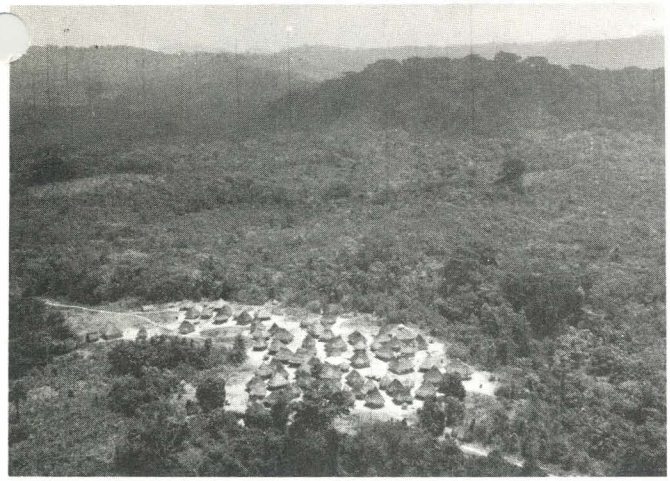

Figure 1.
The village of Gbanzu.

Figure 2.
Mr. Cole, psychologist and consultant; and Mr. Wilkins, pilot for Lutheran mission in Liberia.

Figure 3.
People of Gbanzu at the air-strip greeting the plane's arrival.

Figure 4.
Former village school in Gbanzu,
now used for a guest house.

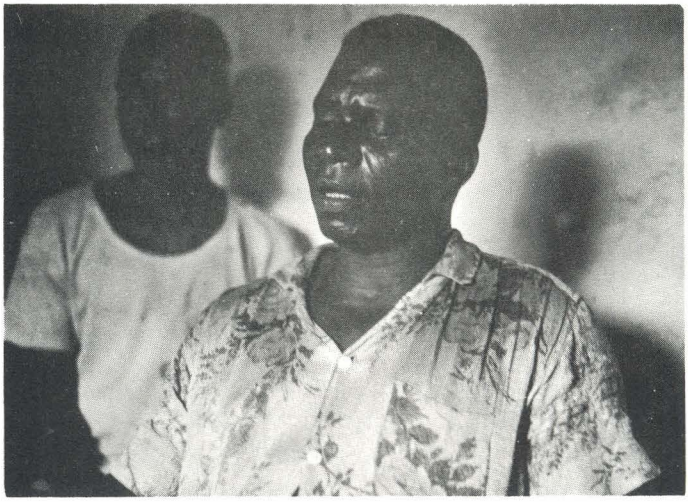

Figure 5.
Gbanzu chief Benjamin Mulbah.

resident in Gbanzu, who have gone to school and remained in the outside world, only returning to Gbanzu at rare intervals to visit their family and friends. The three most important individuals in town appear to be the chief, Benjamin, the evangelist, Veseli (see Figure 6), and the leader of the bush school (see Figure 7), with whom I did not become well-acquainted. The first two represent the progressive element, even though the evangelist is illiterate in his own language and can speak no English. The head of the bush school, of course, represents the conservative element. Fortunately for my work, the progressive group was able to convince the townspeople of the value of the project, and the conservative group did not cause any active trouble, even though it remained suspicious.

From 16 December, 1963, to 18 December, 1963, Mr. John Wealar and I worked in Gbanzu conducting preliminary interviews with the tape recorder. We set up test situations and discussed them with a number of citizens of the town. Then on 20 December, Mr. David Crabb and Mr. Paul Johnson arrived as consultants to the project. We discussed procedural, linguistic and mathematical questions until 30 December, Mr. Johnson having left on 26 December. Then from 30 December, 1963, to 3 January, 1964, Mr. Crabb, Mr. Wealar and I worked in Gbanzu, gathering data and discussing linguistic and mathematical concepts. There were further conversations on these matters at Cuttington College from 3 January to 7 January, during which time Mr. Crabb and Mr. Wealar wrote their paper on field research (see Appendix 2), and after which Mr. Crabb left.

Mr. Wealar and I worked on related matters until 18 January, when Mr. William Welmers arrived as the third consultant. His visit had three phases, a preliminary period of discussions at Cuttington College from 19 January to 27 January on linguistic and anthropological matters being the first. We then worked in Gbanzu from

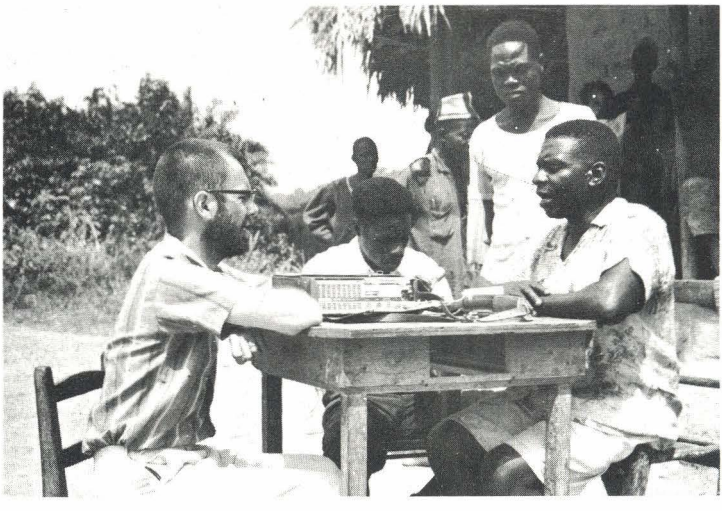

Figure 6.
Mr. Wealar, Kpelle informant; Veseli, Gbanzu evangelist; Benjamin, Gbanzu chief; and the author.

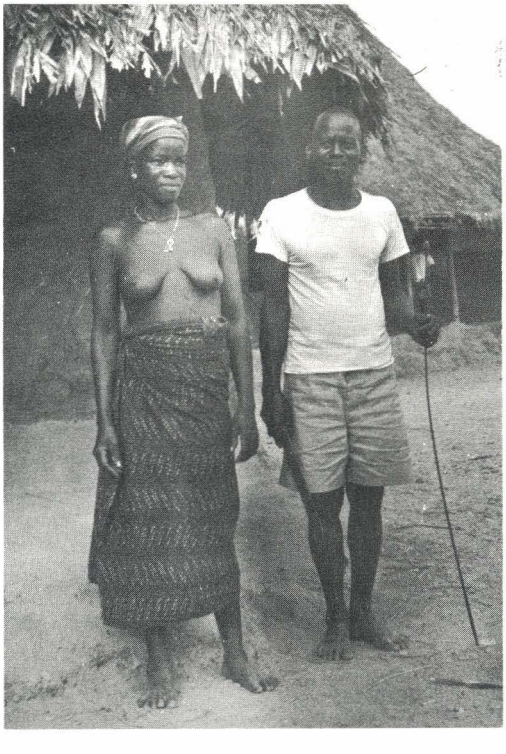

Figure 7.
Leader of the Gbanzu bush school and his wife.

27 January to 30 January, during which time discussions were held, papers on Kpelle structure written, and interviews on logic held. After we returned from Gbanzu, Mr. Michael Cole and Mr. William Stewart arrived for three weeks of consultation lasting from 1 February to 22 February. Mr. Welmers, Mr. Wealar, Mr. Cole, Mr. Stewart and I spent a few days in general discussion and orientation, after which time we formed several working subgroups. Mr. Welmers completed papers on Kpelle structure. Mr. Cole began psychological experiments with local schoolboys. Mr. Stewart began an analysis of Liberian English. Mr. Wealar and I continued work begun at a previous time. Then after Mr. Welmers left on 9 February, Mr. Cole, Mr. Wealar and I developed tests which we conducted in a Gbanzu trip which extended from 13 February to 17 February. During that time Mr. Stewart continued to work on Liberian English, a project which occupied him until he left. After returning to Guttington, Mr. Cole and I summarized and began to analyze our data, and made a number of recommendations for future work.

My work since the consultants left has been to organize and summarize the data, hazard certain conclusions, and write the present report, which is being submitted to Educational Services Incorporated on 1 May, 1964. Mr. Wealar returned to his studies at Cuttington, and his role as my Kpelle teacher.

(2) Preliminary analysis of important mathematical concepts

Mr. Johnson, Mr. Crabb, Mr. Wealar and I held an important series of discussions on this matter. Mr. Johnson was asked by the rest of us to state what he felt were the topics in mathematics we should consider in our project. He led the discussion for most of two days, and helped us organize a rough general outline, dividing the subject into arithmetic, geometry, logic and applied mathematics. On the basis of this discussion, Mr. Crabb and I tried to organize a general outline

of tests which we wished to carry out in the field. We tried to isolate the most basic of the concepts and to suggest approaches to obtaining information concerning them.

(3) Preliminary analysis of pre-mathematical thought in western culture

At various points in the discussion it became clear that we needed to know more about the role of pre-mathematical thought in western culture as well as in Kpelle culture. There was more discussion than achievement in the areas of anthropology, psychology and education, but a serious attempt was made to analyze the linguistic situation. This study of the linguistic aspect of pre-mathematical and pre-logical thought in western culture grew out of conversations between Mr. Crabb and myself in Gbanzu. We conjectured, on the basis of our discussions with Mr. Johnson, that any description of that to which we attend has a mathematical element at least implicit in it. We explored this idea at some length, Mr. Crabb acting as an informant for everyday English usage, while I attempted to elicit from him those aspects of the speech he used in reporting the contents of his experience which could be called mathematical or pre-mathematical. On the basis of these discussions, I wrote two papers, which were revised and enlarged several times, analyzing the description of fields of attention and the organization of propositions (see Appendices 3-4). The ideas expressed in these papers proved extremely useful in organizing the later stages of the project.

Some preliminary discussions were held concerning the anthropological, psychological and educational aspects of pre-mathematical thought in western culture, but the ideas suggested in these discussions were not treated in rigorous fashion. This is an aspect of the subject which must be considered in more detail at a later stage. A number of suggestions have been made in connection with work done in

Gbanzu for extending psychological testing. In particular, we plan to conduct experiments similar to those conducted in Gbanzu among groups of non-tribal Liberians as well as Americans, both literate and illiterate. In this way, quantitative comparisons can be made among the different cultures involved in the tests.

The data already exists for a comparison of educational methods in schools within western society and within the Kpelle culture-area. There have been many extensive tests done in the United States to evaluate the use of the new mathematical materials. The only problem is to find situations which are comparable to those in Liberia. This problem should be referred to the groups who are observing classroom reactions to new mathematics texts and curricula in the United States.

The problem of the place of pre-mathematical and pre-logical thought in the culture of western nations has not sufficiently been analyzed. Some attempt should be made to survey the literature to find if any studies of this type have been made. The question to ask is this: what is the role of reasoning of a mathematical and logical type in the everyday life of an ordinary American? We are attempting to ask this question in the Kpelle context, and thus it is important to have comparative data. Some data will be provided by psychological testing, but we must attempt to investigate the problem in the larger cultural setting.

(4) Work with an educated Kpelle informant

Once the proper questions are asked and set within the context of the invading western culture, the next step is to get a general picture of behavior in the Kpelle culture which might be analogous to that observed among those within the invading culture. To this end, my consultants and I worked closely with Mr. Wealar, since he has meaningful ties with both cultures. He was born and raised in the Kpelle village of Kpaiye, which is near the Guinea border in the north central part

of Kpelle country. His parents were illiterate tribal people, but he had the opportunity to go to school under the auspices of the Lutheran church. He went to Lutheran elementary and secondary schools, and then came to Cuttington College to prepare himself to be a secondary school teacher. He is at present a senior at Cuttington, and will receive his B. S. in education in December, 1964. He has taken courses at Cuttington in mathematics (based on the theory of sets, and thus quite useful from the point of view of Entebbe mathematics), linguistics, anthropology, psychology, philosophy and educational method. Thus his background is most useful for the work we are doing on this project.

Thus in each of the four areas of particular concern in this project—linguistic, anthropological, psychological, and educational—we were able to question him, knowing that he had some understanding of what we were looking for. On the basis of his answers, we were able to make preliminary statements about the role of mathematics in Kpelle culture, statements which we would then at a later date be able to test in the field. Much of the time that the consultants and I had available at Cuttington, as well as some in Gbanzu, was spent with Mr. W$_e$alar in this enterprise.

In linguistic matters, we elicited from him terminology of a pre-mathematical character, in that it expressed the matter and structure of fields of attention in terms of content, form, aspect, measure and value. We started to develop an expanded content-centered dictionary of terms describing important fields of attention. We found many terms and phrases which were analogous to pre-mathematical terms in English, such as terms for set, measure and so forth. We also discussed proposition formation with him, and he wrote for us three papers on implication, equivalence, conjunction and disjunction in the Kpelle language. (see Appendices

5-7). Finally, we worked with him on the question of argumentation, attempting to discover how Kpelle persons organize arguments out of propositions. The results we obtained in this area were fragmentary compared with those obtained in the other two areas.

In the field of anthropology, we made a preliminary survey of culturally relevant materials and situations, for the purpose of carrying out tests in the villages. We talked about games, economic life, everyday village activities, the talking of palavers, village government, marriage and family customs, farming, and other important activities. From this we learned important terms as well as their meanings in terms of the people's lives.

We then discussed with Mr. Wealar psychological experiments which we proposed to use in the villages. We were unable, of course, to learn anything significant about the traditional Kpelle psychology from him, since his understanding and use of mathematical concepts is heavily dependent upon concepts drawn from western culture. However, he was most helpful in designing experiments and suggesting materials and situations for use in the field.

Finally we discussed with him briefly the place of education in the village situation. On this question his own background is relatively weak, since he left the tribal society before his own education, considered in traditional terms, was complete. His relationship with the Poro society, for instance, is minimal, and his understanding of that phase of education thus quite limited. However, he was able to make a number of useful suggestions for us to follow up. In particular, we gained some insight into the relations which exist between the various age-groups within a village.

(5) Statement of problems to be analyzed in the field

After working with Mr. Wealar in a given area, it was then necessary to make

tentative hypotheses concerning Kpelle mathematical behavior, hypotheses which required verification in the field. Many important aspects of the verification procedure are summarized in the paper written by Mr. Crabb and Mr. Wealar giving practical suggestions for field work in mathematics (see Appendix 2). This paper is primarily methodological, but it also suggests a number of specific, concrete problems to be studied in work with non-literate tribal informants. It suggests linguistic topics to be studied, and procedures for studying them, especially contrastive analysis, behavioral usage, elicitation frames, and componential analysis. In every case, of course, it is assumed that preliminary hypotheses are made with the help of an educated literate informant, and then verified in the field.

The linguistic problems to be studied in the field upon which we agreed concerned the descriptionof fields of attention, the formation of propositions, and the construction of arguments, in accordance with the discussion in Chapter 2. We were able to make this general problem specific and detailed, so that we knew at least in the first and second areas exactly what we were looking for. We wished to prepare the expanded dictionary giving terms descriptive of those fields of attention which we found to be culturally relevant. We wished to explore carefully the usage for certain important logical connectives, as well as other function words. And to do this, we required that elicitation frames be set up which allowed us to map semantic space, to use Mr. Crabb's phrase. We tested out a procedure for doing this, using local Kpelle primary school students as informants, and found the procedure adequate. We recommended that study be made of forms of argumentation, but we were unable at this stage to make the problem more specific than that.

Our understanding of the educational problem was weaker than our understanding of any of the other problems we faced. It was evident to us that children in the

culture learned from their elders and were able to take their place as full members when they grew to adulthood. However, we had no idea how this learning took place, and thus we approached the data-gathering phase without a specific program. We were aware of the bush school, but we knew that there are great difficulties in the way of a foreigner obtaining information about its operations. We could see children at play and work in the village, but we could not yet see how they learned, except perhaps by example. However, the fact that our formulation of the problem was so vague did not mean that it was not a problem to us. We intended therefore simply to keep our eyes open and hope to learn something from unprejudiced observation.

Basic to our educational problem is, of course, the problem of teaching children with no previous experience of western culture. For this reason, we suggested that it might be useful to put small children into a kindergarten situation, and attempt to create, reading, arithmetic and general language readiness in them. It would be most interesting to compare the results using such children with results obtained using children raised in western-type homes, with literate parents, books, and all the equipment such children have. However, we had to postpone this problem to a later date when we would be adequately prepared for it, with the proper staff and equipment.

(6) Field work on the problem

As indicated above, we spent time in Gbanzu on four separate occasions. I will not report these trips chronologically, but rather topically, reporting on the research done on each of the problems listed above. I will, moreover, not give a detailed report on the results obtained in each case, but at this point will only indicate the scope of the research, reserving the detailed report for the next chapter.

We did not carry out a study of the ways of describing fields of attention in

a systematic way in Gbanzu, since we already had reliable information obtained by all of us from Mr. Wealar, as well as that obtained by Mr. Welmers from various informants on previous trips. We did some questioning of Gbanzu citizens on these field trips on certain scattered topics, as we required it, but it was not systematic or organized. However, we have a method for obtaining the required information in a systematic and organized way, and that method has been tested.

In the same way, we did not attempt to elicit information concerning structure words, and in particular the important logical connectives in a systematic way. The papers which were prepared by Mr. Welmers and Mr. Wealar give useful information on the subject, and, whereas that information requires checking at a later date in a controlled field test, that stage has not been reached yet (see Appendices 5-16).

Since we know less about the forms of argumentation, we attempted to construct situations in which people would use discursive reasoning. On one occasion, problems were given to a number of informants, using stones as concrete objects to be manipulated, and the answers were taken down on the tape recorder for analysis. Moreover, situation problems were invented and given to these same informants verbally, in order to record their reactions and solutions. On another occasion, games were observed, with the hope of reconstructing the reasoning process by which a player wins a game. And again, logical problems were prepared, using local materials as examples, and given to a number of informants to analyze and solve. Finally, traditional puzzles and riddles were presented to a group of men for discussion, and their comments recorded. It was hoped at some point to analyze the legal process by which an argument or controversy is resolved, but the opportunity to do this was not found on these trips.

In the matter of anthropology, we made close observation of village life, and made notes on the relevant aspects of that life. We made a list of commonly used materials, and situations which commonly arise. We also observed games and amusements, and tried to understand their place in the lives of both children and adults. At one point, we questioned several individuals, and recorded their answers, as to their behavior in situations which seemed to us to involve mathematical reasoning and activity. We also asked a group of men what they thought people in town used numbers for, and tried to get specific answers in terms of actual situations. These inquiries were largely impressionistic and unstructured, however, and are thus purely preliminary.

Our psychological work in the village was the best organized and structured of all the work we did. We had specific problems as well as carefully prepared tests which would enable us to get quantitative answers for these problems. We did five tests which involved drawing pictures in the sand, and asking informants to identify which of the two pictures we had in mind (see Figure 8). These tests required the informants to distinguish which of the following pairs of concepts we had in mind: straight line vs. curved line, circle vs. ellipse, right angle vs. non-right angle, triangle vs. circle, and triangle vs. rectangle. For half of the informants we favored one concept and for the other half we favored the other concept. We gave a maximum of 32 pairs of pictures to an informant for each test run, and we agreed that he understood the concept if he identified eight pairs in a row correctly. We then asked the informant to state in words what characterized the item in each pair that he chosen. Our next test was organized in the same way and involved identifying which of two piles of stones we had in mind (see Figure 9). Half the time it was the larger and half the smaller. We then gave the test in reverse order to each informant.

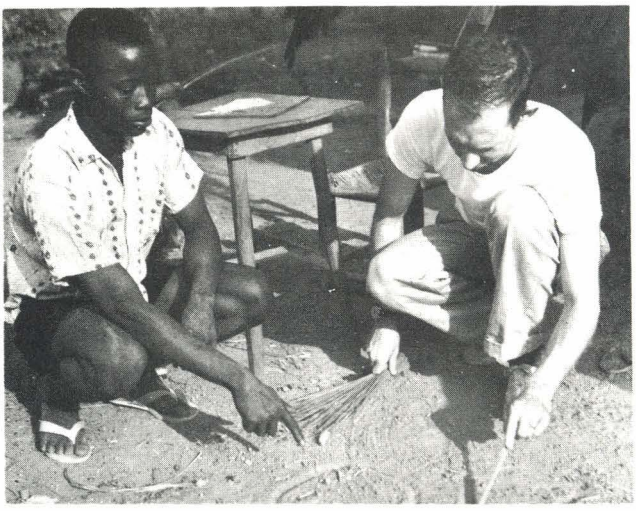

Figure 8.
Mr. Cole administering psychological test to Gbanzu resident.

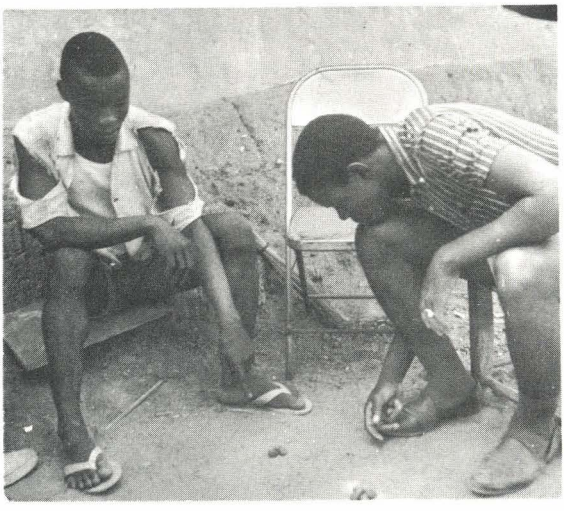

Figure 9
Mr. John Flumo, assistant for the project, and Gbanzu resident in psychological test.

Our other psychological tests involved the use of puzzles of various types. We gave the six-piece puzzles described above, and timed each of the subjects (see Figure 10). For half we gave the colored puzzle first and for half the plain puzzle first. We also did the same with the shape vs. color puzzles we had prepared (see Figure 11). We also had a test in which the subject was to indicate when two objects were the same or different, using various colored shapes. In half the tests the pieces with the same color were considered the same, and in half the pieces with the same shape were considered the same.

We had approximately 20 subjects for each of the tests except the last, for which we had fewer subjects because of lack of time. Detailed results are given in the next chapter. We agreed that more such tests were necessary, using the same as well as different concepts, but there was no time on this particular trip to Gbanzu.

Since we did not have a clear understanding of what we wished to do with the educational problem in field studies, we limited ourselves to two activities in Gbanzu. We did some general observation of children and adults, with the hope of finding relevant information about the way children learn. And we had a long discussion with the chief and the evangelist to learn what they could tell us about the subject (see Figure 12). The discussion was tape-recorded and transcribed at a later date.

(7) Analysis of the data and preliminary report writing

In most areas analysis of field data has thus far been minimal, for the reasons that time has been limited and the field data scanty. This is a task which must be done in the future, as more data and time are available. Thus most of our analysis has been based on data obtained from Mr. Wealar and other educated informants, as

Figure 10.
Timed assembly of jig-saw puzzle in Gbanzu

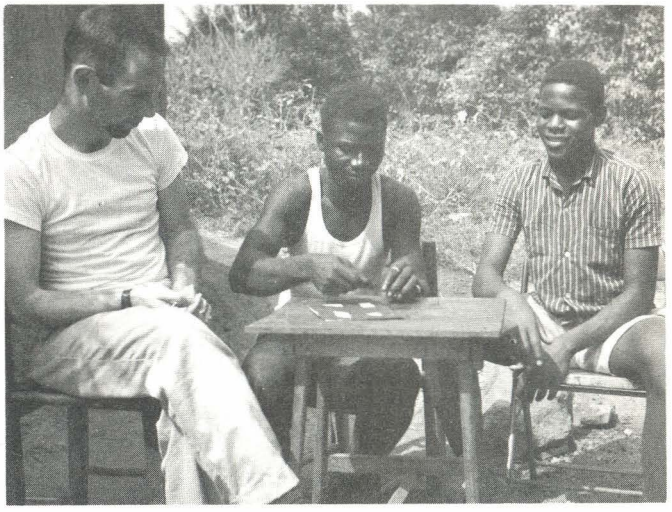

Figure 11.
Mr. Cole administering puzzle test to Gbanzu with Mr. Flumo observing.

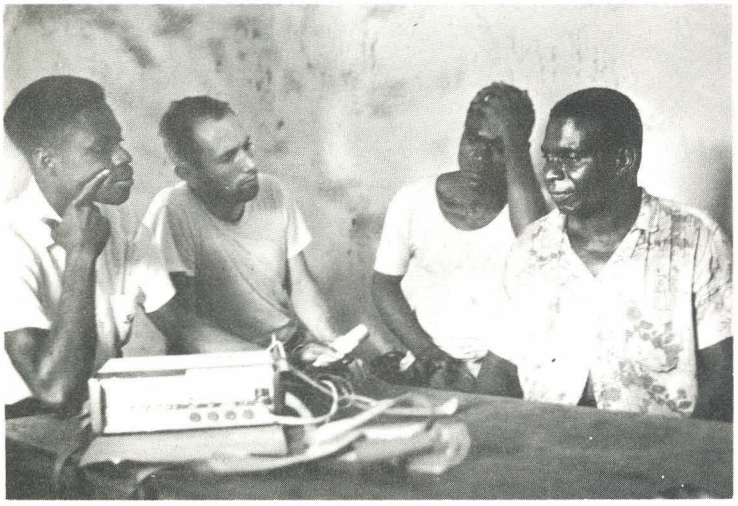

Figure 12.
Mr. Wealar, Mr. Cole, Veseli and Benjamin discussing education in Gbanzu.

well as from Mr. Welmers' previous informants.

In the linguistic area, some preliminary attempts to organize the expanded dictionary of terms descriptive of culturally relevant fields of attention have been made. However, these are still isolated and sketchy. The papers written on syntax, logical connectives and structure words are, of course, based on data obtained from previous informants, but these results will be checked independently at a later date. Very little analysis of argument formation has been done yet. This report represents an interim summary and generalization from all data obtained thus far.

The same facts hold true in the case of the anthropological studies. Some isolated facts have been learned, and some attempt has been made to put these facts into a larger context. Once again, this report represents the first occasion to summarize these results and draw general conclusions.

The psychological data have been subjected to more detailed analysis. Average learning times and solution times have been computed for the various tests. And on the basis of these averages, concepts have been ranked according to their difficulty and generality within the culture. These conclusions are, of course, tentative, and will require more data to supplement and complete them. These preliminary conclusions are reported in the next chapter of this report.

In the area of education, few conclusions have been possible, because the data are so sketchy. At most we can report some superficial observations of village life, and comment on the relevance of the remarks of the older men concerning the ways the children in the village learn. These comments are included in the next chapter of this report.

c. Projected Work

(1) Comparison with non-Kpelle culture

At the beginning of this project, a serious attempt was made to analyze the way in which fields of attention are described and propositions formed in English. The two papers produced as a result of this analysis must be confirmed and extended on the basis of further linguistic work with English informants. The work should parallel that being done among Kpelle people, and should be so reported that all results can be compared easily and accurately. The study of the way in which arguments are constructed is, of course, subject of much current research in western countries, and it is hoped that such studies will prove useful to our project.

Linguistic studies of other Liberian languages should be initiated as soon as the procedure outlined in this report is put in systematic form. A useful and related study in the Loma language has been proposed by Miss Margaret Miller. Persons working in other languages have expressed their interest in this work. Mr. William Stewart has undertaken a research project in Liberian English, and this too should contribute to our understanding of the problem. He first analyzed the phonology of the language, and then began studies of the morphology and grammar of the language. The latter two analyses will fit directly into the structure of this project, and it is hoped that they will be available soon.

Little has been done yet to show the place of mathematics among ordinary persons in western cultures or in transition cultures, where western and tribal cultures interact. We plan an analysis of this problem here in Liberia, in those Kpelle communities where the money economy and English language have made the old ways impossible. It would be useful if an attempt were also made to understand what part mathematics plays in the life of the ordinary American. It should prove useful not only to this project to provide a standard for comparison but also to

persons attempting to improve mathematics teaching in the United States. Such a study, whether in Liberia or elsewhere, should concentrate on those materials and situations which are culturally common and useful, and which have mathematical or pre-mathematical implications. Likewise, the role of logic and argument in these cultures should be studied, particularly to find what kinds of arguments and evidence are considered acceptable to persons within the culture.

Both the psychological experiments carried out in Gbanzu and others yet to be designed will be administered to persons in a variety of groups, according to present plans. All tests will be carried out with at least 20 persons in each group, and the groups will be the following: Kpelle children, Kpelle adults, up-country Liberian school children, Monrovia school children, American illiterate children, American illiterate adults, and American school children. These tests will be carried out during the next several months, and the results studied and compared at the beginning of 1965.

The question of how children learn in other cultures is once again a question of great difficulty as well as great importance, not only to this project, but to the understanding of the whole educational enterprise. Many studies have been made of the subject, and it is hoped that some of these will prove useful. However, little has been done thus far to incorporate their results with conclusions obtained by this project, partially because of lack of time, and partially because we ourselves have done so little work on the topic. It is a subject to which much more study must be given. The only culture in Liberia to which much attention has been paid so far is the transition culture. Elementary classes have been observed in connection with the Entebbe mathematics project, and comparisons should be possible between teaching and learning methods in these classes and those within the traditional tribal Kpelle culture.

(2) Statement and testing of general conclusions

After all the preceding stages are complete, it will be time to attempt generalizations on the role of mathematics in tribal culture, in the transition culture, and in the fully westernized culture. These generalizations will synthesize the general conclusions from linguistics, anthropology, psychology and education. We have not reached this stage yet, of course, and so any generalizations made here will be strictly tentative, and subject to modification.

However, in principle, this final stage of reaching general conclusions is not different in kind and pattern from each intermediate stage of generalization. Statements are made on the basis of evidence gathered in controlled experiments, and are tested in further controlled experiments. Only when the further experiments satisfy two conditions, namely, that they give reasonable coverage of relevant situations and that they do not significantly modify the generalizations they are designed to test, will the project be considered complete. It may be that the conclusions reached in tentative form in the final chapters of this report will be those conclusions which the project considers definitive at the end. It is likely, however, that there will be some modifications, even though the basic outline will remain the same. The important point is that there must always be controlled tests to validate conclusions and answer the initial questions satisfactorily. And these tests must be conducted in new situations which have not previously been used for testing. Thus, at the final stage of this project, a new rural town must be found, and carefully chosen tests made among the people of this town to test the conclusions drawn. And, if the project has become sufficiently broad to include other cultures, it may be that tests made in an entirely new culture will not materially modify the broad outlines of our solution to the original problem. That problem,

in summary, concerns the impact of western culture on non-western society in the areas of mathematics and logic, and the best way to teach these subjects so that the culture-contact is most fruitful for all involved.

(3) Preparation of a final report

The final report will be only a modification and extension of this preliminary report. It must begin in the same way with a statement of the background, and a careful statement of the problem. It must continue with a study of scientific method so modified as to be most suitable for this project. It must then state the stages of research, as they were actually conducted. And finally, it must draw conclusions which not only answer the initial questions, but which state other significant implications. It must then suggest further areas of study, suggesting how these are related to the present project, and how they might be attacked.

The implications to be drawn in the final report must include implications for effective teaching of mathematics and science, for the best way to develop the transition culture, and for the understanding of the way people learn and know. These implications should be stated as concretely as possible, and should include suggestions for their implementation.