Rethinking Cultural Research

Kay Owens

Research in ethnomathematics is needed to preserve what might be considered the cultural mathematics of a particular community. It is important to describe and analyse this mathematics before it is lost. Some of the current ethnomathematical knowledge such as the counting system records and analyses in Papua New Guinea (PNG) are at the description or content analysis level. This is an essential aspect of ethnomathematical research. However, ethnomathematics research needs to consider other aspects of ethnomathematics besides content analysis. The current knowledge resides with those who may be elderly while the researchers are normally younger members of the community. The relationship between people and the place of the ethnomathematical knowledge in the cultural practices and relationships needs to be recognised. The values embedded in the way the mathematics is presented and learnt is as important in the realm of ethnomathematics as it is in school mathematics. Challenges for the young researcher are to be critical and reflexive and to know not only the right questions to ask but also when to ask, whom to ask and what not to ask. The cultural expectations on the researcher need to be recognised as a result of the collection of data.

Introduction

> The objects of ethnomathematical study will always be mathematically unfamiliar – that is why we are interested in them. We wish to explore concepts and practices which are, in some sense mathematical, but which are not part of our familiar world of mathematics. (Alangui & Barton, 2002).

Cultural research in many developing countries and more so in developed countries involves strengthening practices and ideas that belong to past generations. In many cases, the people of knowledge are elderly and may not have experience of modern school education. The educated researchers of the same community will often have certain beliefs, attitudes and language skills that are like remnant rainforest. There may only be pockets of forest left that are unsustainable if further encroachment occurs. The forest needs to regenerate. The remaining forest needs to be explored, classified, and described. Seeds need to be found and propagated before they are lost. The right environment, free from overpowering weeds, needs to be fostered. Rejection and misunderstanding will strain the revitalising of cultural mathematical knowledge. The young researcher needs to communicate with those who know more in a way that their seeds of knowledge can be stimulated and enlarged, watered and fed so they grow into a plant with all its features, structure and branches. Other ways of seeing mathematics besides the commonly held Western or school mathematics must be accepted as legitimate (Barton, 1996). Interpreting the phenomena only in terms of Western mathematics and without the possibility of accepting a different mathematics is like weeds that throttle understanding of the mathematics embedded in the culture. If governments, curriculum officers, teachers, teacher educators, and mathematicians reject the legitimacy of ethnomathematics then the rejection and misunderstanding will prevent revitalising the mathematics of that culture.

This paper will consider some of the current research on ethnomathematics in Papua New Guinea (PNG). It will consider the research on number systems and then the plans for researching measurement systems. Following these sections, the plans for research on

measurement will be critiqued in terms of the intertwining relationships between the researcher and the researched and of the role of knowledge of measurement. Other systematic processes may also emerge from the research which cannot be described by our Western view of measurement.

Describing Mathematical Concepts: Content Analysis

When researchers aim to record the mathematics of a cultural group, the first challenge is to describe the mathematics of the group. Description can be used to make comparisons about an aspect of mathematics developed by related cultural groups. Description is an apt word for much of the research on PNG ethnomathematics especially the work on counting systems (Lean, 1993; Owens, 2001). From a linguistic perspective, counting systems of the various language groups were recorded and morphemes were used to analyse them to provide a simple description. It was possible to discuss the cycles of the counting systems, the words that formed the frame for counting and the operative patterns by which the words were combined to represent larger numbers. For example, in some languages the counting system could be described as a cycle of 10 with the numbers between 7 and 10 being represented as pairs or pairs plus one. That is 8=2x4 and 9=2x4+1. In other languages, the numbers for 7 to 10 are the numbers 3 before 10, 2 before 10, 1 before 10, 10. Morpheme study also included noting how body parts are used in ascertaining counting words and their order and how the composite groups or cycles were formed. For example, in digit-tally systems the fingers of one hand are followed by fingers of the other hand so that 6 is “a hand plus one”. After two hands, the digits of the feet are systematically included up to two hands and two feet or a man. Digit tally systems, especially if limited records were available (e.g., linguistic surveys giving 1-5, 10), may be distinguished from a body-part tally system if the hand morpheme was used rather than a thumb morpheme in conjunction with other morphemes such as man for twenty.

Where possible, Lean (1993) provided some context from anthropological data. This data gave an indication of how counting was used in the community and what role counting played. For example, it may have been used to count pigs and sweet potato in an exchange ceremony but in other communities amounts were determined by displaying food in a spatial way, or by exchanging fathoms of shell money. Lean (1993) was also able to develop his thesis about how different counting systems had developed and spread within the Melanesian region. His linguistic records indicated how a set of counting words within the one language varied from village to village, how they compared to neighbouring languages, and how the words may have changed over time. Sometimes, he could do no more than summarise his extensive data from different sources (many students and written records) and some of the differences are not included in his published data sets.

Sometimes, Lean was constrained by the limited number of words from some languages available to him from written records (e.g. linguist survey word lists) and responses to his counting system questionnaire. His methods of analyses were systematic and described within the language of cycles, frame words, operative patterns and in some cases classifiers (generally denoted by the use of suffixes for counting different classes of objects). He was able to show how counting words were constructed and to some extent how they constructed and reflected reality. He was aware that language was not transparent or value-free but was embedded in contexts. When he learnt a language extensively, he made field trips or there was more extensive anthropological data, he provided extensive records on the counting system, its structure and its uses.

A New Area for Research

Measurement is one aspect of PNG societies that has not been systematically researched. There is some oral data from the Southern Highlands (Kewa language) that mounds of sweet

potato were made equal by using a rope for the circumference of the base and a stick of a fixed size for the height. There is information from a number of districts that lengths were paced out for garden measures (usually a semi-perimeter was measured) and in the New Guinea islands fathoms (arm spans) were used for lengths of shell money. Lengths were also estimated when selecting trees and saplings for building bridges and houses. House builders had a good idea of how much bush rope, bamboo and palm fronds would be needed for a particular house.

For measurement, the study may begin with exploring the attributes of objects that a society compared and measured. Measurement is likely to be a mathematical activity essential for building, designing and other survival activities. One way of ascertaining aspects of mathematics is to be aware of mathematical activity (Bishop, 1988). The mathematical concept may be used in a variety of activities. The researcher needs to determine how extensive the idea of length, for example, was used across a range of activities and how length formed part of a wider cultural context and if there were systematic approaches that would bring measurement into the realm of mathematics.

People may have developed various methods of measuring. The degree of accuracy, like the extensiveness of some counting systems, may depend on the importance placed on measurement. Measurement may have involved an instrument such as a pace, a length of rope, a stick or a bamboo container. The cultural group may or may not have combined units into composite units (cf, centimetres into metres). A comparable notion would be that of cycles in the counting systems in which, for example, 5 and 20 were composite units in digit tally systems. Notions of ratio may also be prominent when two kinds of measures are used. Matang (personal communication) reports that people in his village knew how much garden area could be watered by two or three lengths of bamboo of different thicknesses. They were able to develop large bamboo music bands to play different notes in tune. In order to determine how measures may be combined, the linguistic dimensions of comparison and combination need to be investigated. Again, the research may begin with content analysis with a systematic way of recording processes, units and their structure. This in itself may be as complex across languages and across villages within languages as Lean found of the number systems.

Critical and Reflexive Research

In our current research, we intend to move beyond the content analysis of mathematics to a systematic and explicit analysis of ways of thinking and speaking about aspects of reality (Cheek, 2000; van Dijk, 1997). An approach to this kind of research is outlined in this paper. In order to explore, for example, mathematics that we might currently call measurement in a cultural context, we need to consider cultural expectations of the researched phenomena, the researchers and the research (Foucault, 1971).

Cultural Expectations of the Researched Phenomena

There will be an historical background influencing the research. This will include colonial history and the direct impact on practices involving measurement. For example, the tape measure may have impacted on the building of houses in traditional societies. There will also be an impact on the role of measurement in society. This will include the degree to which measurement is significant and how it is significant. Measurement may be important in providing status. For example, measuring fathoms of shell money is an important aspect of Tolai society. Size of sweet potato mounds may be carefully controlled in order for the number of mounds to be significant during an exchange ceremony. Houses may be divided up into areas for sleeping and the allocated space as well as position in the space may be

significant to status or relationships. The impact of changing the overall size of the house may create proportional change but it may not. Accuracy will be influenced not only by the need for stability but also by the importance placed on accuracy for determining status differences. Measurement is also closely linked to embodiment, the use of body parts and the feelings and values associated with people's bodies and the role these may play in a particular place. For example, when counting pigs for an exchange, men will stride down the lines, one counting to 10 while another keeps track of the groups of 10. Fingers and gestures are used significantly. Gathering materials for a house, working with the materials, and working together to build a house are significant interpersonal and bodily activities.

Bishop (1988) says studies that deal with aspects of the material environment which interact with visualisation are interesting and informative. For example, Mitchelmore (1984) interpreted his findings of relatively weak spatial visualising skills among his learners in Jamaica in this way: "Many homes in Jamaica lack special play equipment for children. They have fewer toys … The effect of such a home environment is dramatized by the exceptions that come to light … such as the grade 4 son of a mechanic with a workshop at his house and the grade 6 boy who often helped his mason father; both boys did outstanding work on symmetry in rural classes consisting mostly of farmers' children" (Mitchelmore, 1984, p. 139).

Another example from another culture also illustrates the role of activity as a source of mathematical thinking and the role of the physical in the process. There were many different practices used by 12 brick layers, building carpenters and building foremen when making a right angle according to Fioriti and Gorgorió (2001) in their study. Besides Pythagoras' rule expressed as "60, 80 and 1 metre" lengths or double these lengths, the builders used parallel lines and perpendiculars obtained by using their tools such as the plumb line and spirit level to obtain right angles. They used diagonals of a rectangle to form an isosceles triangle and hence obtain the perpendicular height. At least one man was able to move from one construction process to another. The metal right angle tended to be used only as a check. Fioriti and Gorgorió asked the builders questions about how they did things rather than mathematical content questions. They also posed some important follow-up questions such as at what point can the informal solution to a particular situation provide an effective foundation for more formal mathematical reasoning, what are the limits and how can situated learning move students from using mathematics as a tool (e.g. following a set algorithm) to working with the mathematics as an object (mental schema).

Power and governance (Foucault, 1971) come into play in the research situation. The researched concepts may have a role in power relationships but may also be involved in other relationships within the society. The society may function with emphasis or little emphasis on the researched concepts. To give a comparison, in our society, we may be willing to spend a considerable amount of money on weddings or a house or a car but we give little thought to comparing those amounts with the weekly shopping bill. Similarly, amounts of food and pigs used in exchange ceremonies are not necessarily linked to amounts used in daily food consumption.

In PNG society, for example, the size of the mound of sweet potato or a unit of nuts and other food items may be significant in an exchange but the distribution of the mounds or bundles is also significant. The way in which the whole is subdivided is likely not to be into equal parts and this may impact on the notion of equal parts and measures. The maintenance of the society (governance) through the use of measurement may be less significant than other aspects of the exchange such as type of gift, part of pig or who gives to whom in maintaining relationships (Brown, 1978).

The concepts being researched such as attributes that can be measured may not be readily described in English mathematical terms. Tacit knowledge in particular is difficult to explain in any language (Frade, 2005). The questioning and observing may not result in valid and explicit data. It is only possible to explore each issue in the language of the community, gaining information from different people and triangulating the data by observation where possible. Nevertheless, observation may yield data that are not available from interview. An issue with the research will be the time available for research. It may not be possible for the researchers to remain in the village long enough to glean sufficient information about the researched phenomena. However, it is expected that researchers who are members of the community will be more able to assess significance, power, governance and details and to make sense of their observations and discussions. They will also be able to know when to pay attention to activities and conversations from their experiences.

Cultural Expectations of the Researchers

The research participants (village participants) and interviewers/observers (tertiary student or lecturer researchers) may be members of the same or different cultural groups. If they are members of the same cultural group, there may still be subcultural influences. There will be an existing relationship between the research participants and interviewers/observers. In many cases, these will be age differences but there may also be educational differences, differences in initiation experiences, differences in the ways each has been expected to play out his/her relationships within the community, and familial differences. For example, a younger member of the community may not have met the earlier cultural expectations of initiation and marriage relationships. They may, however, be expected to solve problems related to the new economy.

The ways in which phenomena are described may have a significant effect on the power relationships within the society. These descriptions may not be seen as mathematical and quantifiable and descriptions of quantity (size of unit of exchange food) may be of secondary or minimal importance.

In understanding the discourse on measurement or mathematical activity, consideration must be given to the interaction between interviewer/observer and the people of the community. This includes consideration of the relationship of the interviewer and the interviewee. When working within many traditional societies, the role of the elder needs to be recognised. The information may not be appropriately shared with a younger person. Knowledge and ways of knowing may reside in the thinking of the wise and experienced elder and there may not be a taken-as-shared understanding despite language similarities and kinship. Sharing of knowledge may be used to marginalise some people including members of the group or the researcher. Interesting comparisons may arise when a person from the language group and a person not from the language group investigate the situation.

Knowledge sharing may also come with other obligations on the part of the researcher. In particular, this may be associated with power. For example, a student may be seen as a person who has or will get money, co-researchers from another cultural group especially expatriates will be associated with money. However, money in its own right can cause problems because of how it is shared with others. It will be important to consider how obligations can be met in other ways. Alexander (2005) discussed this issue of obligation when working in Lao PDR as an expatriate.

Cultural Understandings of Research

There may be a dissonance between what is regarded as significant by the community and the purpose of the research. It may be difficult for members of a specific community to realise the benefits that generic research into phenomena can achieve. In layman's terms, this means that

in the eyes of the researched, the purpose for the research may or may not be of immediate benefit to the community or its school (Alexander, 2005). The community may regard their measurement concepts as outmoded or beyond resurrecting for today's societal needs. It is difficult to foresee where the data will lead in terms of theoretical understandings.

In the case of PNG, it is important that community knowledge known by their forefathers be recorded and maintained as far as possible. Clearly, the society may well have changed beyond the possibility of the community re-engaging in some mathematical activities. For example, when the Gogodala at Balimo decided to rebuild their communal house, a huge effort was required (Crawford, 1981). In many places the young manpower of the community is no longer in existence for construction or other work. In New Ireland, logging has destroyed the trees that were once used for making canoes. It is no longer possible to make these canoes so that these activities cannot be observed. Knowledge of measurement of lengths used in boat building and distances for travel by canoe will be affected as travel is now by dinghy with outboard motors.

Research is not unknown to villages. It is clear that experimental research has been used over time to develop, for example, gardening techniques, fishing and hunting techniques and new house designs. The keeping of data on which later decisions could be made when pursuing the activity was mental and not recorded. How the research was carried out and who was involved may vary from community to community and would have been embedded in action research paradigms of a natural kind. For example, a round house design with the centre pole cut so it did not reach the ground spread through Engan villages freeing up internal space (A. Kepako, personal communication).

Anthropological research was also known in most places. Many communities have had linguists at least recording some of their language. In many cases, the linguists stayed for many years, learnt the language fluently and recorded it and used it for translation and literacy. Many anthropologists stayed or visited regularly for many years. In other cases, the researcher visited for only a day or a week. However, this history of research may generate a feeling that they have been a commodity from whom knowledge would pass one way. In return, the communities received familiarisation with Western society, education and Christianity. Often this ultimately resulted in money from cash cropping or working as a village worker for a church or government. In many cases, these new ways did not sit well in the society, and respect, taboos and safeguards had less hold resulting in an upsurge of violence, disease, lack of identity, and less sharing of workload needed for subsistence living.

In general, the communities are proud of their abilities and cultural heritages. They are therefore willing to share it but the power resulting from knowledge must remain with the elders and the community. It is on those grounds alone that data can be collected and research can be carried out. An interesting project is now underway in the Eastern Highlands of PNG where members of a community who have identified areas in agriculture with which they need assistance are able to employ members of another community with this knowledge. Sharing knowledge across communities is beginning to become a norm, albeit for money (Agricultural worker, personal communication).

There are no obvious gains in sharing their knowledge on measurement with village researchers or co-researchers except that it will help participants and researchers to value their culture and it will be useful in elementary school and possibly later school education. For schooling, it will mean that teachers and teacher educators can analyse the measurement systems and more appropriately share this knowledge with the students. The research can go back into mathematic textbooks and be incorporated into teacher education. This is the case

with counting system knowledge but without the research finding its way back to the community school teachers, the value of the research will not be as strong as it could be.

The implication from this discussion is the importance for the research to be interpreted in terms of the use that teachers can make of the research. The research needs to be taken back to the communities, primary schools and high schools that the village students attend.

Cultural Approaches to Obtaining the Data

Recent emergent theories of research and critical approaches to research encourage recognition of possible different ways of obtaining research data. While observation, record taking, and interview data are commonly analysed and even deconstructed, there are other ways of inquiry. Narrative writing, storytelling and writing as inquiry are espoused as alternative research methodologies. In these approaches, the person writes in order to use a flow of consciousness and reflection to provide data. The emphasis on this kind of approach may involve centring oneself in the body or in a particular place in order to allow the writing to develop. The narrative can then be represented skeletally by selecting key words which are connected like free-form poetry and represented as an image. This link to place is remarkably valuable in Indigenous community research (Sommerville, 2005). Much will be expressed by the telling of stories linked to place. This may prove a valuable tool in establishing a way of obtaining data that is otherwise tacitly known. Place-based research extends place-based pedagogies which are recognised as valuable in mathematics education (Bush, 2005). "The subjective dimension of thinking, as something accomplished by historically-situated and unique individuals, makes possible the overcoming of the actual and the expansion and modification of knowledge and culture" (Radford, 2005).

Interpreting the Data

One of the critical aspects of the collection of data is the acceptance of contradictory descriptions and explanations offered by participants. Pamphilon (1999) describes this acceptance as a recognition of the diversity of lenses and levels needed to make sense of the story. For example, it may be possible to interpret one's own behaviour and thinking in various ways determined by sociocultural aspects. In particular, the discourse may be in terms of the dominant cultural terminology (e.g. school mathematical terminology) or explanation that is embedded in cultural ways of thinking. Fluidity and change are particularly applicable to the discourse where colonial impact is recent and society is under global and inter-community pressures resulting from a more mobile society.

At the other extreme, the micro-level, there is the need to consider the linguistic aspects of the discourse. The morphology, contextual description, gestures and facial communication will hold significant data that needs to be analysed. The role of the community researcher will be critical in this aspect of the work. For example, the metaphors and juxtaposition of morphemes may explain the measurement concepts and measurement thinking rather than concrete objects.

Mathematical thinking may be intuitive and built on years of experience. It may not be easy for a person to describe this thinking or even necessarily to demonstrate it in a way where taken-as-shared knowledge is limited. Varying the lenses for understanding this tacit knowledge may be critical. It may be that some knowledge is commonly known while other aspects of knowledge reside with a few. Some knowledge may not be attainable without the wealth of experiences that the elder has experienced. However, sharing knowledge is a way of developing the community which is limited by only having basic schooling.

Brousseau (1984) identified three forms of functioning of knowledge corresponding to variations in the organisation of the milieu: (a) implicit use (action situation); (b) explicit use

(formulation situations) and (c) justification (validation situations). Applying this view to the PNG villager's mathematical activities implies that the context of the measurement application and the actions taken would need to be analysed, as well as the explanation and justification of why this approach is used and what factors are affecting the measurement.

Training Tertiary Student Researchers

The implications of the above discussion lie in the way in which the student researchers are prepared for their task of researching in their own communities.

One way of obtaining extensive information is by survey questionnaires. The questionnaires will be predetermined and given to all student researchers despite their different communities. However, the questions will be asked within a context. The context involves ethical considerations. First the student researchers need to be aware of the right of ownership and the right of relationship. In Western terms, this might be called privacy. They also need, as Stake (2005) suggested, to know when to ask and when not to ask. The researchers need to make participants aware of the purpose of the research. The research will not bring goods to the community. It may position the community as an exhibit, an issue which must at all costs be avoided by the researchers (national and expatriate, local and cross-cultural). The purpose of the research is to value the ways of mathematical thinking specific to that community. It is to preserve traditional knowledge. It is also to provide the richness of cross-cultural diversity to the education system of the country and to those from other countries.

Student researchers need to be well versed in the above discussion. They also need to know how to recognise and record tacit knowledge about concepts, procedures, attitudes and dispositions (Frade, 2005). The community researcher needs to be critically reflexive. A framework for this is presented in Figure 1 as a starting point for discussion.

One aspect of obtaining data in PNG villages is the likelihood of data being a story. The most well-known example of this was the data given to Margaret Mead (Goodman, 1983). My own personal experience indicates that data collected from village areas with some time between visits will result in different stories about the same objects such as burial sites. Since much of the data to be collected is likely to be fairly non-sensitive as it is about skills of measurement and related knowledge, it is anticipated that there will be little data provided that is prefabricated. The major concern is that practices are "dying out" and younger members of the community may "fill the gaps" in ways that are not as the older members of the community or those who have died would have said. It may be possible to glean some knowledge of these gaps from old linguistic records.

Ethics

The student researcher needs to know what might be the usual way of gaining consent from the community, significant people within the community and from those interviewed or observed. However, it is not necessarily appropriate for all members of the community to sign a consent form. It is generally more appropriate for a community meeting to be held and the purpose and value of the research to be outlined. The value of the research is best explained by examples. The PNG counting system project, the Maori mathematics project (Barton, Fairhall, & Trinick, 1998) and the Inuit mathematics project (Lipka, 2004) are appropriate examples. Those who are to be interviewed or observed should be identified by the community. The community should also select the person who is to sign on their behalf. An example letter is attached. It may be necessary to explain that no more than 10 people can be satisfactorily interviewed. It is important that this include female members of the community. For this reason, both male and female researchers should be involved and where necessary the team of researchers expanded to four by using local teachers or other English speaking

members of the community. Discussions about the use of the data should be held. For example, can information gained from male or female members of the community be later shared with members of the opposite sex or how may it be shared? Similarly, use of data from initiated or non-initiated members of the community should be checked. In addition, the community needs to be aware that the researchers will be summarising this material for other teachers in other communities and with those in other countries.

The community should be informed that community members may withdraw from interview if they wish. They will be given an opportunity to check the summarised data. They should also mention that the research has been approved by the Universities involved.

The use of videotape and digital tape should be explained and they should be used as much as possible. The members of the community generally like to see themselves on the camera's replay. Any benefit to the schools should be discussed with the teachers.

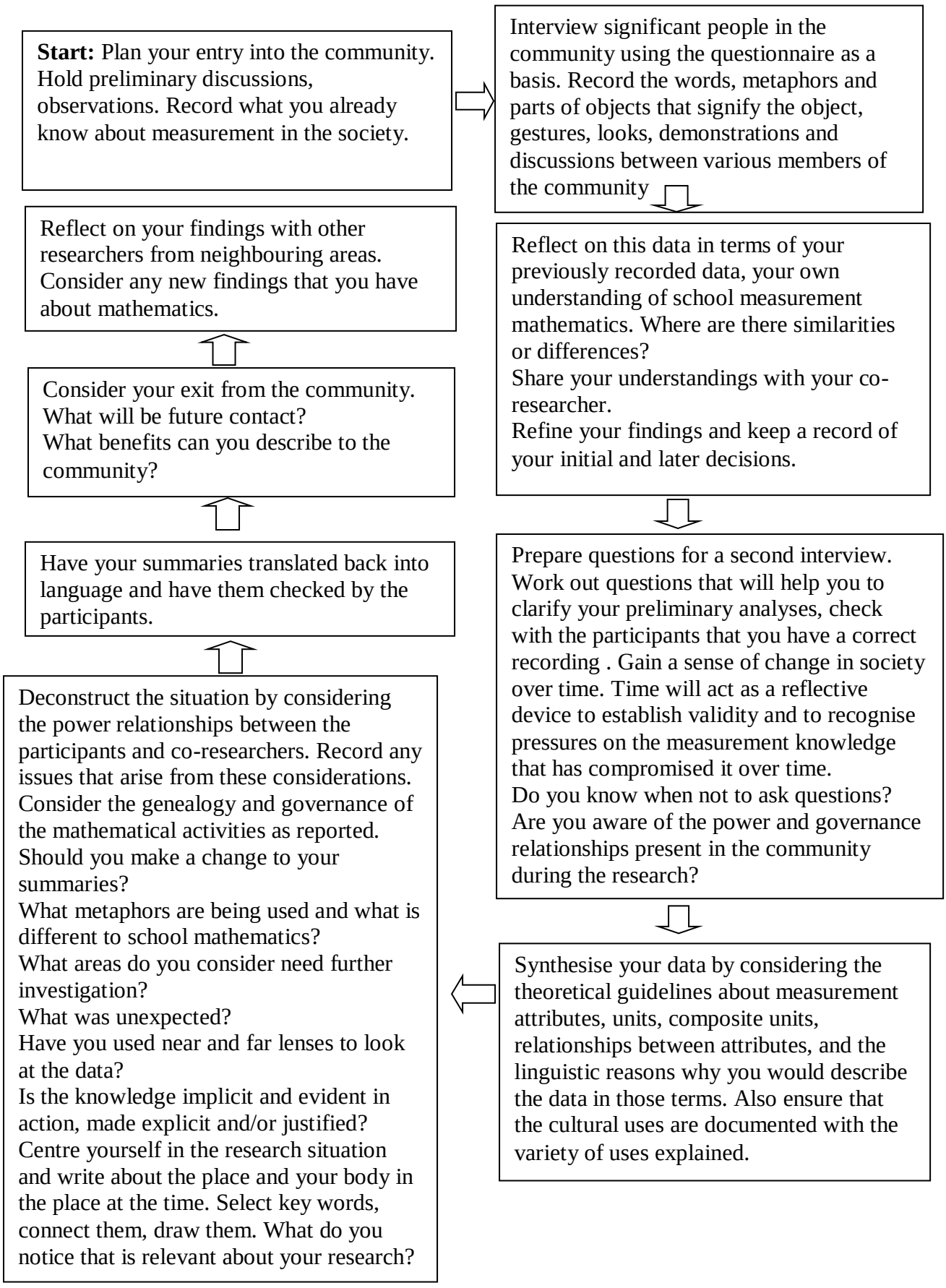

Figure 1. Reflective practice in ethnomathematics research.

The researchers will need to work on the data collected each day in order to transcribe it and to reflect together on the findings. This reflexivity is an important part of understanding the data. There should be a check on the summaries and on the records of the language before the researchers leave the village.

At the University of Goroka, student teachers from neighbouring areas will form discussion groups in order to make comparisons and reflect on their work.

Language

Data will be obtained in the vernacular but will need to be available in Tok Pisin or English. Ultimately the summaries must be provided in English. Tok Pisin is a language that allows for new phenomena to be described in basic words with circuitous description if necessary. This then may need to be carefully translated into English. Where possible the translation will be back translated to the original language and checked by another speaker of that language. This will involve two other speakers of the language but they are unlikely to be available once the community has been left. For this reason, student researchers from neighbouring communities will consider the information and discuss how likely the information is. In some places, the languages are spoken across a wide variety of clans and villages many kilometres apart (e.g., Enga and Hagen languages). In this case, variation should be noted and not necessarily be questioned. For example, oral histories on marriage across different villages in Enga Province illustrated considerable differences.

Nevertheless, the final records should be carefully held in the vernacular, Tok Pisin and English. One reason for this is that the elementary schools teach in the vernacular. Tok Pisin is often used as a bridge to English. English is the main language of education, journal papers and records to be made available electronically.

Conclusion

Ethnomathematics in PNG requires research that records practices before they are lost. The communities are rapidly changing and it is important that this research is begun as soon as possible. The colonial history of research and contact has been that of obtaining data as "exhibit" and for communication between the colonisers and the Indigenous communities. It is very important that the research today is collaborative with community researchers and university researchers who are willing and able to draw together the diversity of cultural measurement knowledge. It is the intention of the researchers to empower the communities and to encourage them and future generations to value their cultural approaches to measurement. In order to do this appropriately, the cultural context and the tacit knowledge needs to be recorded as best as it is possible. Empowerment will be provided by developing cultural identity (ethnicity) and by enabling schooling to better take account of cultural knowledge.

The research needs to be rigorous in the way the data are gathered by native speakers of the language and with checks and reflexivity at each stage of the development of the research summaries. While measurement in school mathematics identifies the attributes to be measured, the structure of the measuring process, the units and composite units to be measured, and the interrelationship where relevant between attributes for certain objects (e.g. between lengths and areas of rectangles), this knowledge may be only partially reflected in the richness of traditional measurement systems in a cultural context. While student researchers will reflect on how the cultural measurement matches school mathematics, there will also be room for recognising the unexpected as often noted in Papua New Guinea, "The Land of the Unexpected".

However, if the research is to draw out alternative areas of mathematics, then alternative approaches to gathering data and analysing the data are required. The links between tacit knowledge, place, relationships, language and mathematical activity need to be unravelled if real knowledge is to emerge.

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Investigating Measurement in PNG

To: Village Community (read/given in a language that is understood by the community)

Greetings from (researchers' names). We are teachers at the University of Goroka and an Australian university. We are gathering together information on how different communities traditionally compared the size of objects, areas, distances or time. We think some of these cultural practices will be forgotten and we need to explain the approaches to students who are going to be teachers. We also expect the information will be important to teachers overseas who are teaching mathematics. The information will be used to improve education in PNG and we will write papers and talk about what we find out for teachers overseas and make it available on the computers.

We know that similar work in PNG on how people count has greatly benefited school teaching in PNG and overseas. We also know that similar work among Inuits in Alaska in North America has also helped their children to learn. The Maori in New Zealand have also used their traditional language and knowledge to help students to learn.

Our University students have learnt about observing and asking questions about traditional practices. We hope you can select people from the community to help them record this information from your village.

The student may want to make a tape or take pictures to help.

You can decide whether you want to take part or to continue with the work.

We would like you to discuss this work and select a person to sign the agreement form.

The information that we record at the University and make generally available to other people will include the name of your language and your village. It will not include the names of informants but the University student will record this and these original records will be kept locked at the university.

There are committees at our Universities who have approved this research. If you have any concerns please contact us by letter or phone.

Researcher details.

Thank you for your assistance

Signed: _____ Date: _____

Please cut off and give to the student researcher.

Agreement Form

The community agrees to the project on investigating measurement systems. We have listened to the information on the project and discussed the project and we have asked any questions we wished to ask about the project. The student can ask questions about how we measure and watch when we measure. The student can use a tape recorder or camera. We are happy for this data to be analysed and shared with other teachers in PNG and others around the world. The community has agreed that I should sign this form on their behalf.

Name: _____ Village: _____

District: _____ Date: _____