Enriching Students' Learning Through Ethnomathematics in Kuruti Elementary Schools in Papua New Guinea

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Abstract

Education system in Papua New Guinea has undergone iterations of national reform in the past few years. The varied reform has been driven by presumed national priorities with the need for universal education for all. High among the current educational reform is the introduction of the counting and calculating systems in different languages at elementary level. This paper examines the 'Kuruti' cognitive patterns used in weaving and the 'Kuruti' counting and calculating system and their relations to modern mathematics. It attempts to look at teaching mathematics through cultural relevance to help learners know more about reality, culture, society and themselves. It is anticipated that teaching mathematics through cultural relevance will enable learners to become more critical and appreciative, and more confident in learning mathematics. It will help them build new perspectives and syntheses, and seek new alternatives. It is further anticipated that learning mathematics through cultural relevance will enable learners to transform some existing structures and relations to comprehend their understanding of mathematics.

Introduction

This paper discusses the Kuruti number system and the cognitive patterns used in weaving, and examines how they can be utilized to enrich students learning of mathematics at pre-school and elementary level. It is anticipated that teaching mathematics through cultural relevance will enable learners to become more aware and more appreciative in learning mathematics.

Mathematics as defined by the American Mathematical Society is the "study of measurements, forms, patterns, and change which evolved from the efforts to describe and understand the natural world" [1]. This definition can be equally applied to ethnomathematics as bounded by the concept of natural world and the notion that mathematics culturally demonstrate the analytical power in identifying, counting, and the application of systematic generative process used in 'social statistics' to describe and classify objects, animals, and plant species. Ethnomathematics can also demonstrate the analytical power in identifying cognitive patterns used in paintings and various structural designs such as decorative walls, beds, baskets, mats, and decorative armbands, headbands, and other products weaved from plants and animal parts. The symmetrical nature and the structural design of these patterns are analogous to Cartesian coordinates system with its x and y axes.

The current trend in teaching elementary mathematics in Papua New Guinea schools is based on the counting systems in different languages spoken by the different ethnic groups in the country. Every ethnic group has its own instinctive mathematical knowledge that culturally demonstrates ways of counting, measuring quantities, classifying quantities, and inferring other mathematical relations or knowledge. Unfortunately, much of this knowledge has been ignored in teaching mathematics at elementary levels of the education system in Papua New Guinea. For example, the use of patterns that are popular in weaving have not been considered in teaching elementary mathematics. Weaving is most popularly done by women who develop different cognitive patterns that can be correlated to the Cartesian coordinates of the x and y axes. It is unfortunate that most women in Papua New Guinea perceive mathematics more as a male–oriented subject thus 'shying away' and perceive it as difficult to comprehend. Such perceptions tend to discourage women from taking up mathematics related courses such as science and engineering. Thus, the focus in introducing cognitive patterns is to encourage more female participation in learning mathematics in order to alleviate the gender gap in mathematics related professions.

Kuruti Number Systems

The Kuruti language is spoken by about 8000 people of the north-central part of Manus Island (see Figure 1) in Papua New Guinea. The Kuruti language is related to other languages spoken by the other group of people around the island with distinct features as described by Carrier [2] in his study on the Ponam language. Although a number of authors [2] and [3] mentioned the Kuruti counting system, none of them has taken an in-depth look at the structure of the counting systems as well as calculations. Kuruti number system can be defined as an orderly and systematic way of counting aggregations of items or objects. It is perceived as a decimal system with radix of 10 and with the numbers seven, eight, and nine composed of words for three, two and one and the prefix *ndro* is used for seven and eight. The prefixes *en*, *an*, and *on* and as well as *ndro* are used for nine as indicated in Table 1. As described further by Carrier [2], the numbers seven, eight, and nine are constructed on the principles of ten minus three, ten minus two, and ten minus one respectively. He described the counting system as a system of numeral classifiers that resembles that of other Austronesian systems. Figure 2 depicts the number one as the basis used in counting objects, piles, sliced of objects. Note the different words for one as shown in the diagram (Figure 2) demonstrating the different counting systems used in counting different objects. Table 1 provides the first ten numerals of the Kuruti counting system which is a system of numeral classifiers for counting different objects, piles of objects, parcels, and even how these objects are chopped or sliced. It can be noted from the table that in counting pieces of sliced object one is *hombul* which is different from counting split objects such as woods in which one is *hendrek*. In counting chopped objects such as logs, one is *sehir*. Further, counting parts of animals and plant differ from counting other items. As an example, Figures 3 illustrates counting different parts of banana plants. Appendix A provides the first ten numerals in counting different parts of a banana plant.

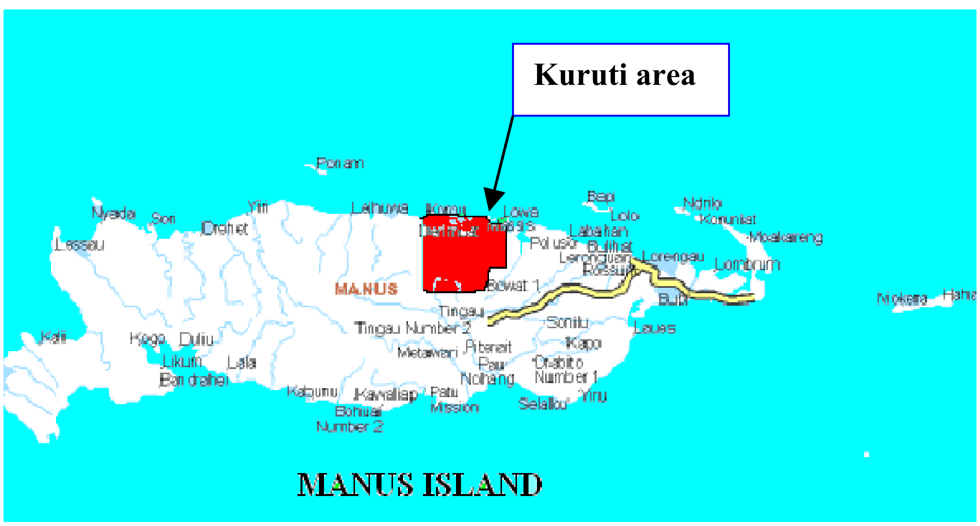


Figure 1 Map of Manus Island showing Kuruti area (shaded) [7]

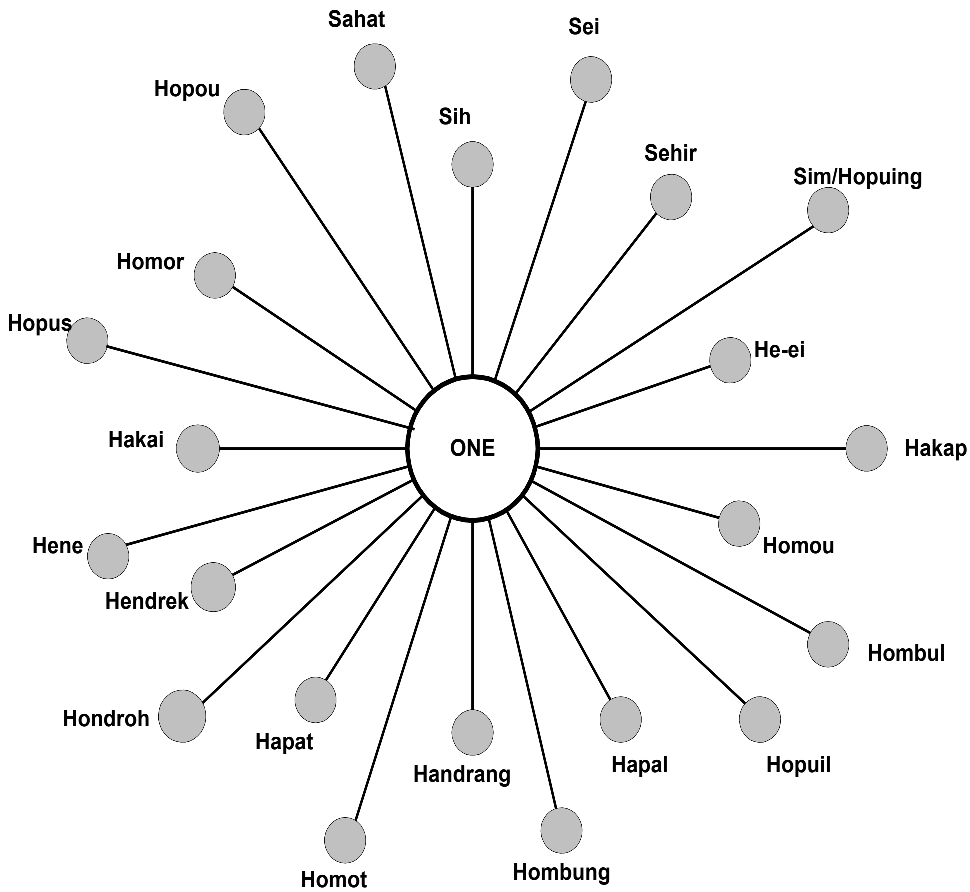


Figure 2 The number one expressed in counting various objects/items

Table 1 Kuruti numeral classifiers (only the first 10 numerals given)

	Counting round objects/nuts/fruits	Counting houses/huts	Counting living beings (humans/fish/ animals)	Counting trees/logs/sticks	Counting leaves/ears
1	Sih	Sim/Hopuing	Homou	He-ei	Hakap
2	Ruweh	Rupuing	Rumu-u	Rui-i	Rikep
3	Toloh	Tulpuing	Tulmu-u	Tuli-i	Tulkep
4	Hahu-u	Hapuing	Hamou	Haei	Hakap
5	Limueh	Lipuing	Limu-u	Limi-i	Likep
6	Onoh	Onpuing	Onmou	Ene-ei	Ankap
7	Ondro-toloh	Ndro-tulpuing	Ndro-tulmu-u	Ndro-tuli-i	Ndro-tulkep
8	Ndro-ruweh	Ndro-rupuing	Ndro-rumu-u	Ndro-rui-i	Ndro-rikep
9	Ndro-sih	Onsupuing	Onsomou	Ense-ei	Ansakap
10	Sungoh	Sungoh	Sungoh	Sungoh	Sungoh

Part of Table 1

	Counting Days	Counting pieces of sliced-objects	Counting pools of water	Counting flat-like objects/scoop of food/clothing	Counting whole bunches of fruits or nuts
1	Sei	Hombul	Hopuil	Hapal	Hombung
2	Ru-u	Rumbul	Rupuil	Ripel	Rumbung
3	Tul	Tulbul	Tulpuil	Tilpel	Tulbung
4	Hai	Hambul	Hapuil	Ha-apal	Hambung
5	Lim	Limbul	Lipuil	Lipel	Limbung
6	Onoh	Onbul	Onpuil	Anpal	Onbung
7	Ondro-toloh	Ndro-tulbul	Ndro-tulpuil	Ndro-tilpel	Ndro-tulbung
8	Ndro-ruweh	Ndro-rumbul	Ndro-rupuil	Ndro-ripel	Ndro-rumbung
9	Ndro-sih	Onsombul	Onsopuil	Ansapal	Onsombung
10	Sungoh	Sungoh	Sungoh	Sungoh	Sungoh

	Counting rivers/creeks	Counting sharp objects (spears/sticks/needles/ stitched roofing leaves)	Counting same species of trees or bamboos	Counting piles of objects/items	Counting bags
1	Handrang	Homot	Hapat	Hondroh	Sahat
2	Rundreng	Rumuet	Ripet	Rundreh	Ruhet
3	Tulndreng	Tulmuet	Tulpuet	Tulndreh	Tulhet
4	Handrang	Hamot	Ha-apat	Handroh	Hahat
5	Limndreng	Limuet	Lipuet	Limndreh	Limhet
6	Andrang	Onmot	Anapt	Ondroh	Anahat
7	Ndrotulndreng	Ndro-tulmuet	Ndro-tulpuet	Ndro-tulndreh	Ndro-tulhet
8	Ndrorundreng	Ndro-rumuet	Ndro-ripet	Ndro-rundreh	Ndro-ruhet
9	Ansandrang	Onsomot	Ansapat	Onsondroh	Ansahat
10	Sungoh	Sungoh	Sungoh	Sungoh	Sungoh

	Counting split objects	Counting pieces of cut objects	Counting loosed pieces of objects	Counting body parts/bunches of fruits	Counting parcels
1	Hendrek	Sehir	Hene	Hakai	Hopus
2	Rundrik	Ruhir	Runi	Rukei	Rupus
3	Tulndrek	Tulhir	Tulni	Tulkei	Tulpus
4	Handrek	Hahir	Handre	Ha-akai	Hapus
5	Limndrik	Limhir	Limndri	Limkei	Lipus
6	Endrek	Onmor	Endre	Ankai	Onpus
7	Ndro-tulndrik	Ndro-tulhir	Ndro-tulni	Ndro-tulkei	Ndro-tulpus
8	Ndro-rundrik	Ndro-ruhir	Ndro-runi	Ndro-rukei	Ndro-rupus
9	Ensendrek	Ansehir	Ensendre	Ansakai	Onsopus
10	Sungoh	Sungoh	Sungoh	Sungoh	Sungoh

Part of Table 1

	Counting firewood (loosed ones)	Counting taro (staple food)	Time/period (measured in terms of a pot of food to be cooked)	Months (from lunar cycles)	Other terms associated with numbers
1	Homor	Hopou	Kur sehir (kur = pot)	Ndrou sih (ndrou=moon)	
2	Rumuer	Rupueu	Kur ruhir	Ndrou ruweh	Hepe =half
3	Tulmuer	Tulpueu	Kur tulihir	Ndrou toloh	Sehir = half
4	Hamor	Hapou	Kur Hahir	Ndrou hahu-u	Hombul=half
5	Limuer	Lipueu	Kur Limihir	Ndrou limueh	
6	Onmor	Onpou	Kur Enhir	Ndrou onoh	
7	Ndro-tulmuer	Ndro-tulpueu	Kur ndro-tulihir	Ndrou ndrotoloh	
8	Ndro-rumuer	Ndro-rupueu	Kur ndro-ruhir	Ndrou ndroruweh	
9	Onsomor	Onsopou	Kur ndro-sehir	Ndrou ndrosih	
10	Sungoh	Sungoh	Kur puke sungoh	Ndrou sungoh	

Table 2 Full counting system

Full Kuruti counting system					
1	Sih	30	Tulngeh	8000	Po-ndro-rungeh
2	Ruweh	40	Hangoh	9000	Po-Onsopou
3	Toloh	50	Limngeh	10,000	Po-sangat
4	Hahu-u	60	Ongoh	20,000	Po-runget
5	Limueh	70	Ndro-tulngeh	30,000	Po-tulnget
6	Onoh	80	Ndro-rungeh	40,000	Po-hangat
7	Ondro-toloh	90	On-sungoh	50,000	Po-limnget
8	Ndro-ruweh	100	Sede/sangat	60,000	Po-anangat
9	Ndro-sih	200	Rupueu	70,00	Po-ndro-tulnget
10	Sungoh	300	Tulpueu	80,000	Po-ndro-runget
11	Sungoh-pe-sih	400	Hapou	90,000	Po-ansangat
12	Sungoh-pe –ruweh	500	Lipueu	100,000	Po-hopou
13	Sungoh-pe-toloh	600	Onpou	200,000	Po-rupueu
14	Sungoh-pe-hahu-u	700	Ndro-tulpueu	300,000	Po-tulpueu
15	Sungoh-pe-limueh	800	Ndro-rupueu	400,000	Po-hapou
16	Sungoh-pe-onoh	900	Onsopou	500,000	Po-lipueu
17	Sungoh-pe-ondro-toloh	1000	Po-sungoh	600,000	Po-onpou
18	Sungoh-pe-ndro-ruweh	2000	Po-rungeh	700,000	Po-ndro-tulpueu
19	Sungoh-pe-ndro-sih	3000	Po-tulngeh	800,000	Po-ndro-rupueu
20	Rungeh	4000	Po-hangoh	900,000	Po-onsopou
.21	Rungeh pe sih	5000	Po-limngeh	1,000,000	
.22	Rungeh pe ruweh	6000	Po-ongoh		
	etc…	7000	Po-tulngeh		

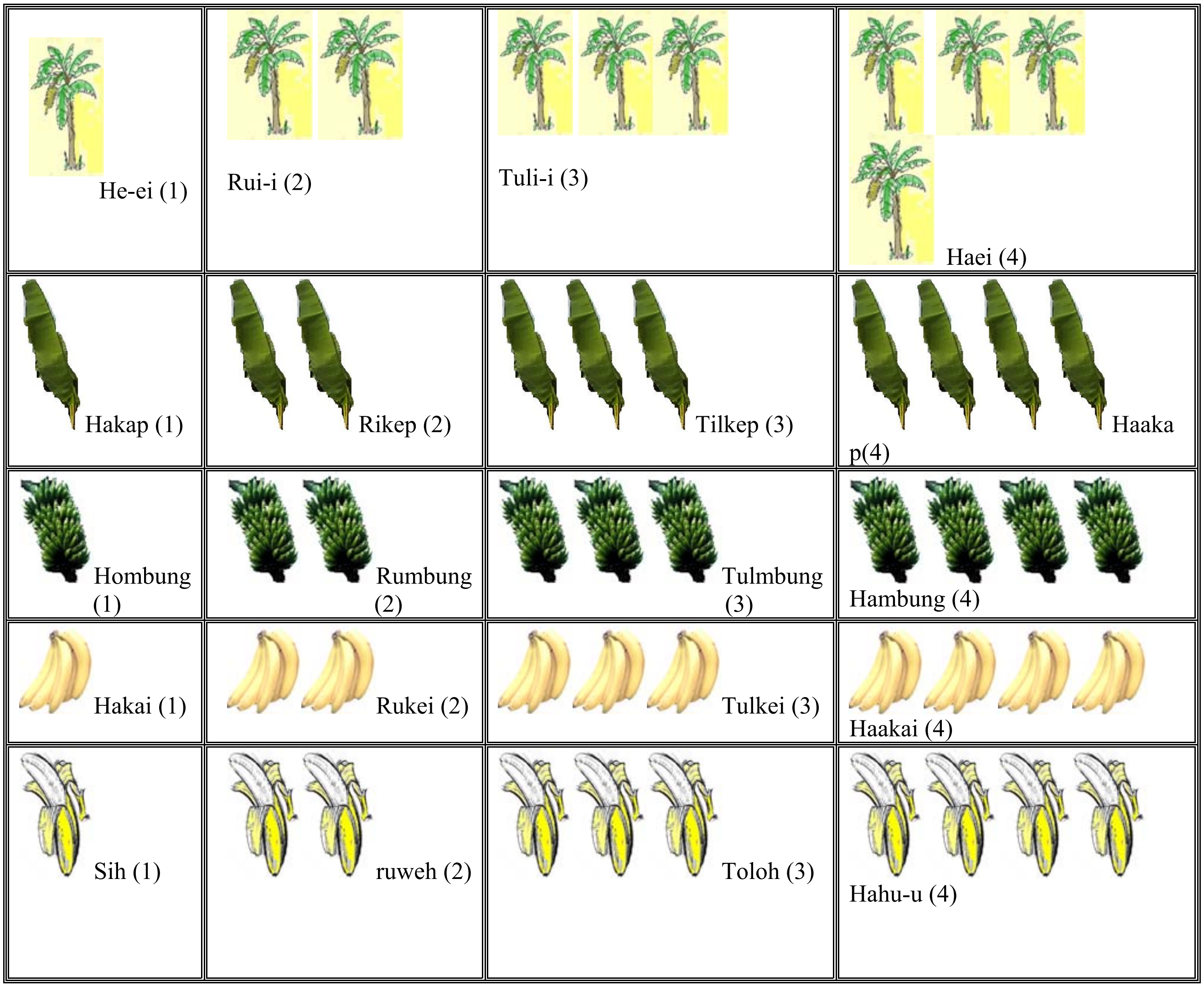


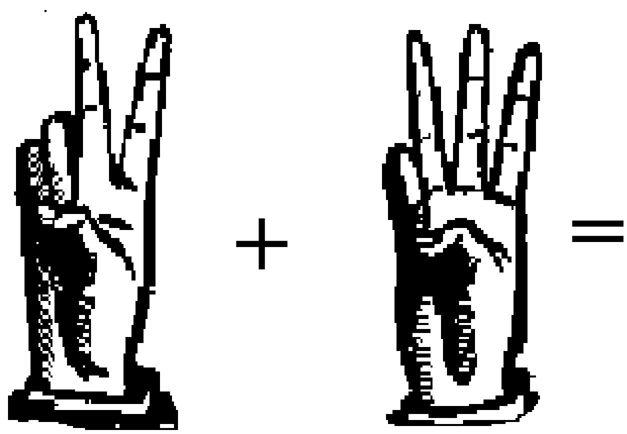
Figure 3 Counting different parts of banana plant (only first four numerals used here). Row 1 outlines counting of banana trees, row 2 for banana leaves, row 3 for whole bunches of banana fruits, row 4 for single bunches, and similarly, row 5 is that of counting loose fruits.

Counting and Calculations

Kurutians derived skills in arithmetic especially in counting traditional money (*lehmueh*) for bride-prize or dowry (paid to the bride's family). In counting money, large numbers are known to be used which can reach a million as shown in Table 2. Note from Table 2 that the terms for hundreds are composed of the terms used in counting taros (given in Table 1). Taro is a traditional staple food crop usually cultivated in wet soil and is associated with wealth in the Kuruti society. Furthermore, in counting to thousands and hundreds of thousands, the terms for tens and hundreds are used with the prefix *po*.

A large number such as 352, 567 can be expressed in the Kuruti counting system as *po(n)-tulpueu pe po-limnget pe po-rungeh, pe lipueu pe ongoh pe ndro-tulndrik* .The word *pe* is used to denote 'and' as in the English counting system. However, Kurutians tend to round down numbers for verbosity, that is, to avoid lengthy terms used; so such a number as 352, 567 would simply be expressed as *po(n) tulpueu pe ndrungyen* implying the sum is '300, 000 and over.' Thus rounding off to the nearest whole number makes addition much easier as is the practice in dowry payments which usually comprises of both the groom's mother's side people and father's side people contributing money separately. At a set time the two groups would convene to add the money and make the payment to the bride's family. Addition is usually done in hundreds or thousands mentally or using fingers. For instance, if the groom's mother's side clan contributed 2450, and the father's side clan contributed 3432, addition would be performed only for the thousands (excluding the remainders) using fingers as demonstrated in Figure 4. The sum is simply counting the fingers together which make up 5000. The remainder is then counted separately. Thus, rounding off to tens or hundreds or thousands makes addition easier using fingers. Simple subtraction is done in a similar way.

A finger represents a 1000 (*po-sungoh*)



***Po–limngeh* (5000)**

Figure 4 Demonstration of simple addition using fingers

Kuruti Cognitive Patterns

The mathematical subject of patterns and pattern recognition can be expressed through cultural patterns that appear in many intricate designs that Kurutians used in weaving baskets, mats, headbands, and armbands (bracelets). Weaving is mostly done by women and has always been an integral part of the society. The skills of weaving are taught to girls as young as ten years by their mothers, grandmothers, and older women. They incorporate different patterns in their weaving process which are considered unique to their tribes or clans and are personally meaningful work to the weavers. The uniqueness in the patterns developed in the weaving process can be considered as of high order ethnographic pattern generation that are often developed cognitively in the minds of the weavers.

The designs in Figure 5 and Figure 6 are classical example of how different designs in weaving can be correlated to the Cartesian coordinates of x and y axes. The design depicts how position of any design elements can be described according to a design coordinate relative to Cartesian grids with rows and columns. Weavers normally count the number of strands to the left and right, top or bottom of the origin at the start of the weaving process in order to make the design appear more symmetrical.

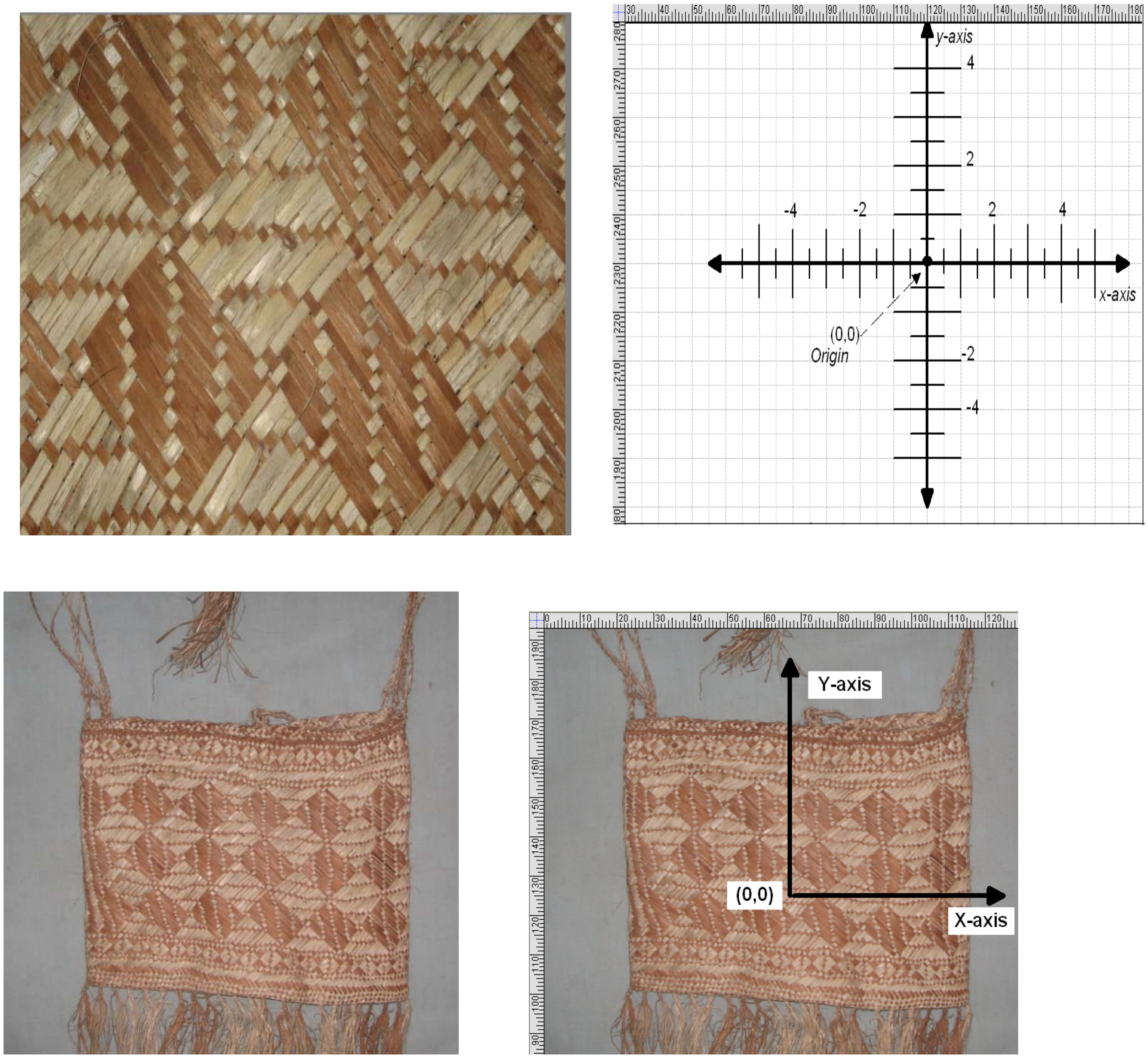


Figure 5 A typical design in weaving bag that resembles the Cartesian coordinates

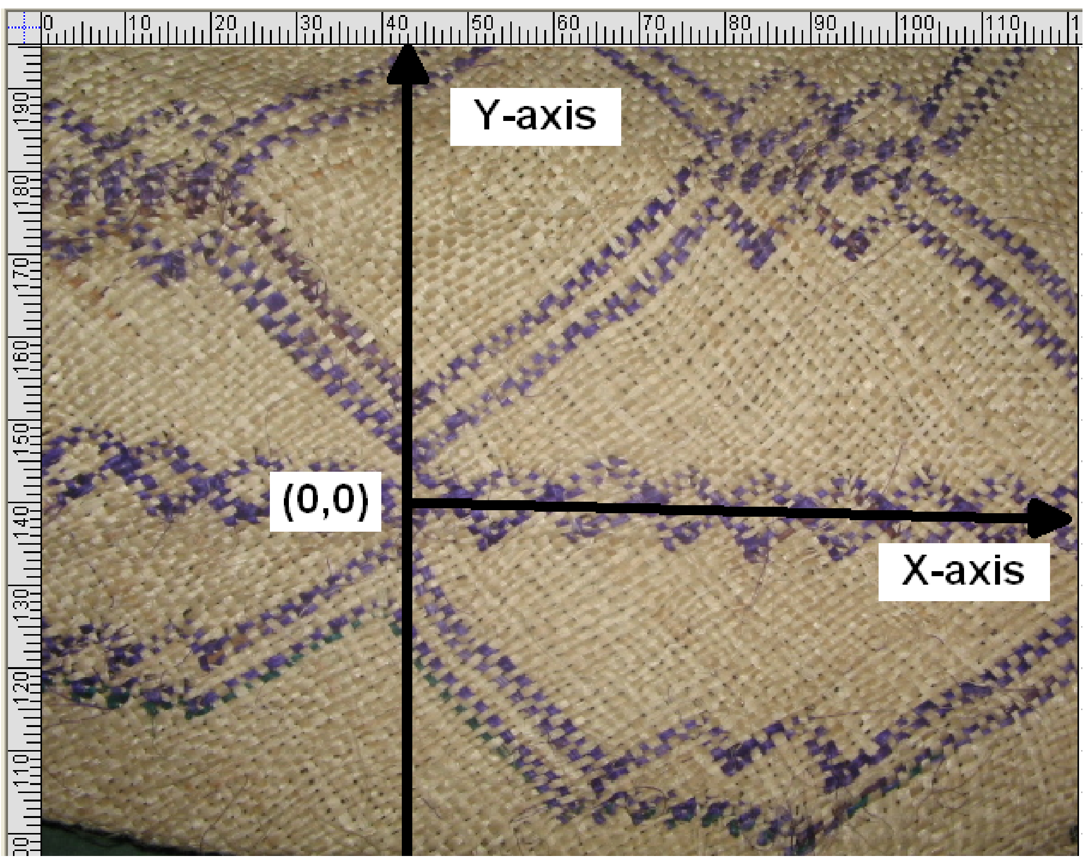


Figure 6 Symmetrical nature of cognitive patterns used in basket weaving

Enriching Learning through 'Fun with Numbers' and Patterns

In order to enrich ethnomathematics learning, the '***Fun with numbers***' concept is proposed as an initiative at pre-school and elementary level to enable young children to better comprehend mathematics. Fun with Numbers is a new approach that takes advantage of computing technology. The proposal is an interactive educational program that combines learning with fun through educational teaching games for children to read and develop their mathematical skills. A sample of Fun with Numbers is presented in Figure 7 that comprises an interactive animation of Luwot (possum in Kuruti language) eating bananas and dropping peelings for the kids to count the number of bananas eaten.

Similarly, patterns have been developed based on traditional designs for children at elementary level to use in pattern matching games. Figure 8 is a design of beads strung on strings used in making armbands and bracelets. Figure 9 depicts traditional patterns on walls woven from bamboo stalks. The design is colored for pattern matching games that can be utilized in classroom teaching at pre-school and elementary levels.

Educational teaching resources developed through Fun with Numbers and pattern matching games would give kids the opportunity to learn to read and to practice their mathematical skills. By teaching and reinforcing lessons in a fun environment, teachers can make mathematics and reading more fun for children at pre-school and elementary level. Young kids can learn such basics as counting, basic mathematics operations, patterns and geometry, and other mathematical facts in a safe and supportive environment through such teaching resources as the Fun with Numbers concept and pattern matching games.

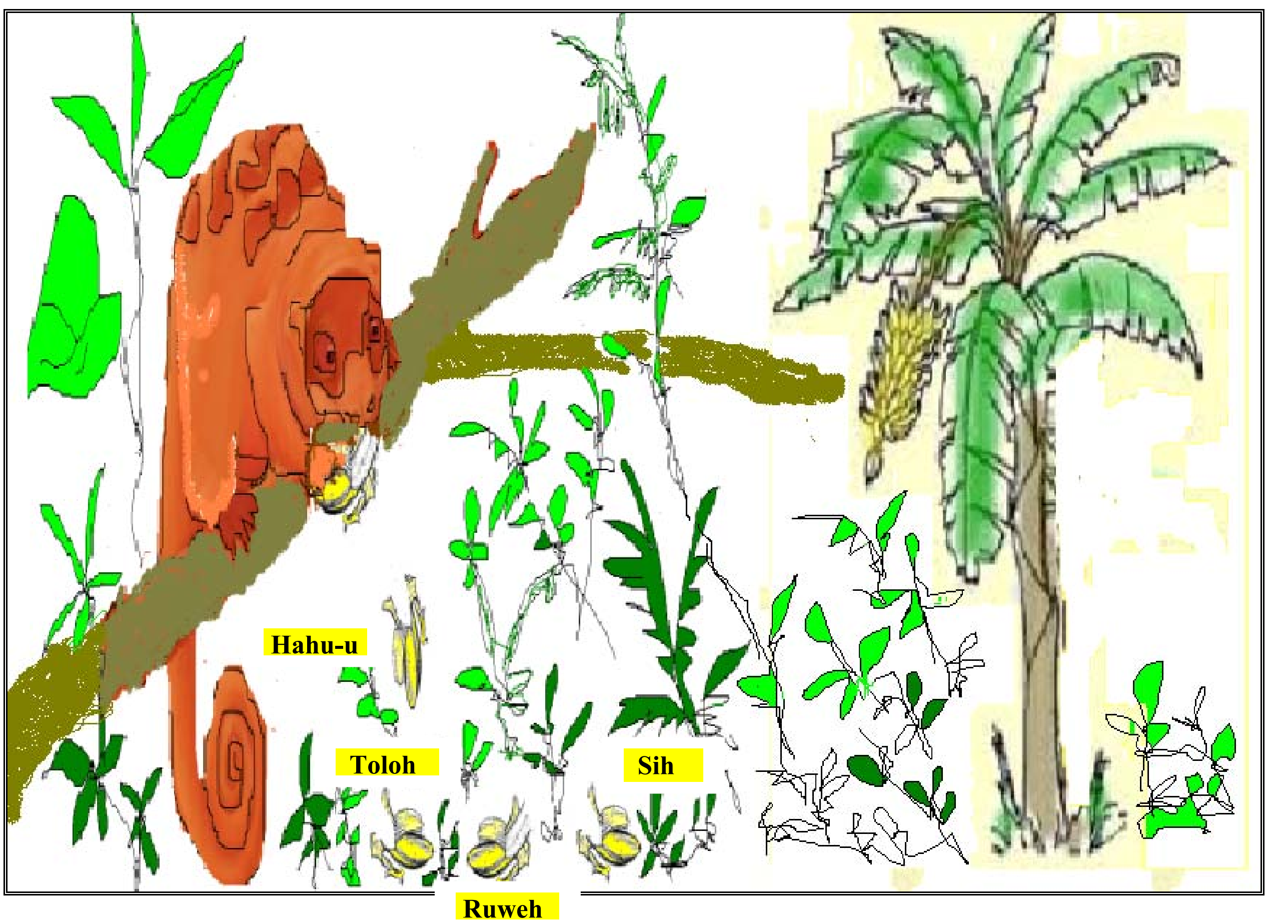


Figure 7 An interactive teaching resource demonstration for counting in Kuruti

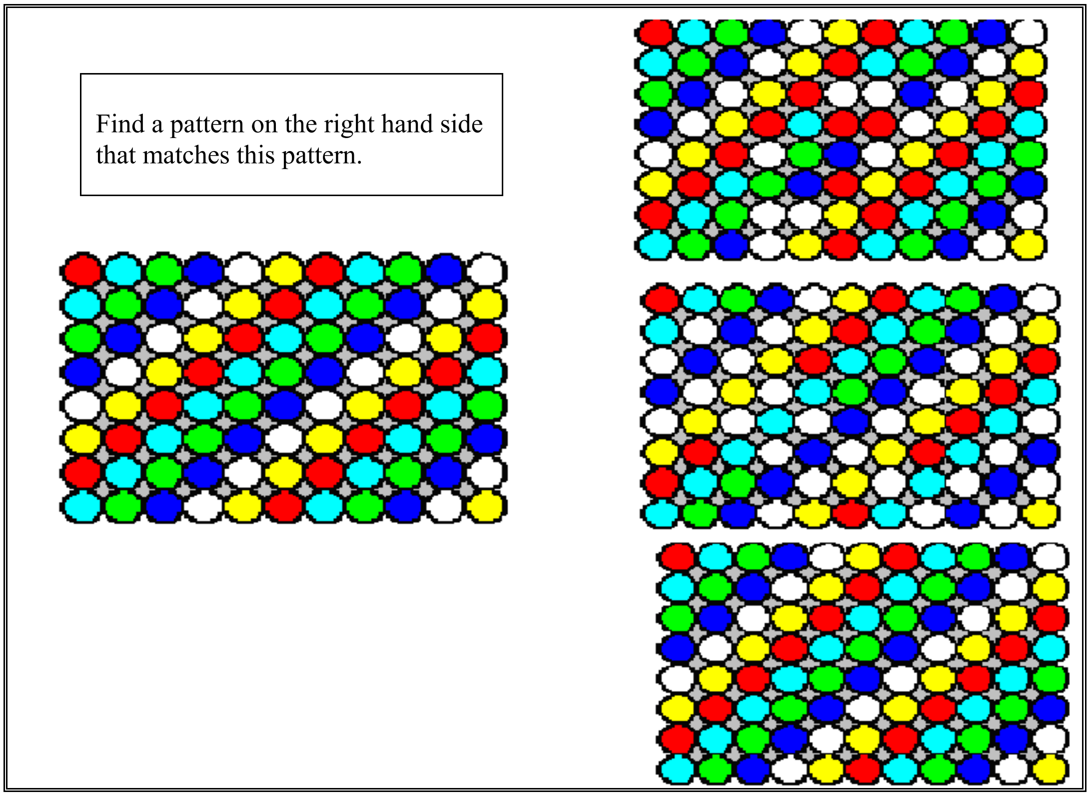


Figure 8 Pattern matching exercise using strung beads patterns used in armbands

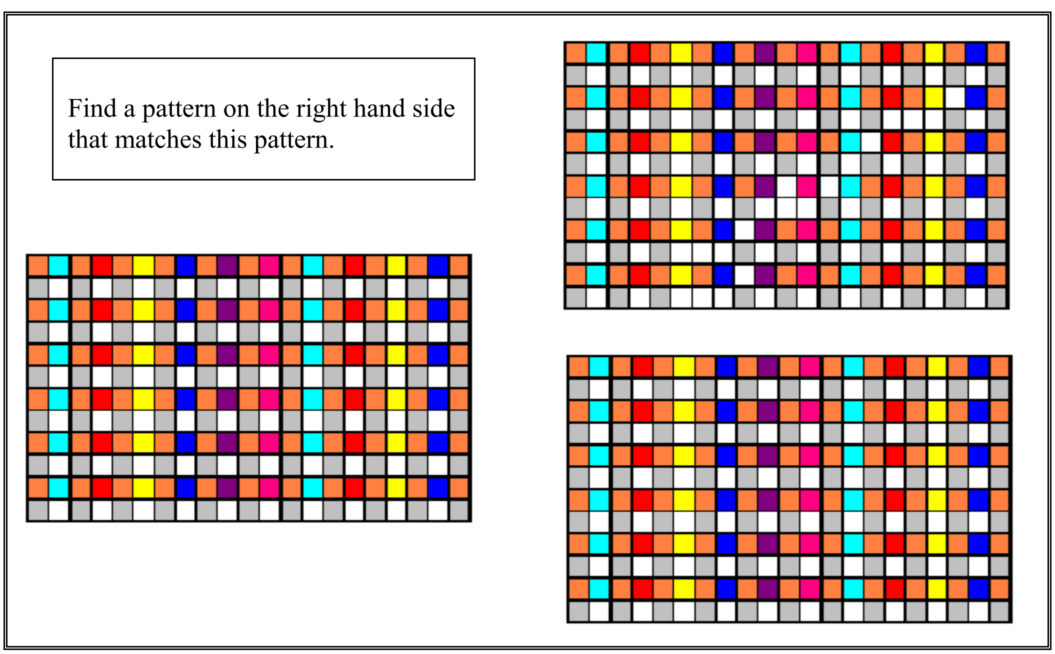


Figure 9 Pattern matching exercise using traditional bamboo-walls patterns woven from bamboo stalks.

Conclusion

The current educational reform in Papua New Guinea has enabled ethnomathematics (counting and calculations in different languages) to be introduced at elementary level for students as well as teachers to appreciate the connection that exists between mathematics and culture. By reinforcing their cultural "values, traditions, beliefs, language, and habits reflective of their culture, students can conceptually understand their culture and become more aware, more critical, more appreciative, and more self-confident in learning mathematics. Thus, the current research on the Kuruti counting system and calculation, and the Kuruti cognitive patterns has been undertaken to enrich students learning at pre-school and elementary level. Further work is being developed on computer animation and traditional patterns for pattern matching games. The work is aimed at supplementing the current curricular through interactive educational programs that combine learning with fun for children to read and develop their mathematical skills.

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Appendix A

The diagrams below give illustrations of counting different parts of banana plants. Figure A1 illustrates the counting of banana trees while Figure A2 provides that for banana leaves. Figure A3 illustrate the counting of banana fruits while Figure A4 outlines that of counting bunches of bananas. Similarly, Figure A5 outlines the counting of loose banana fruits.

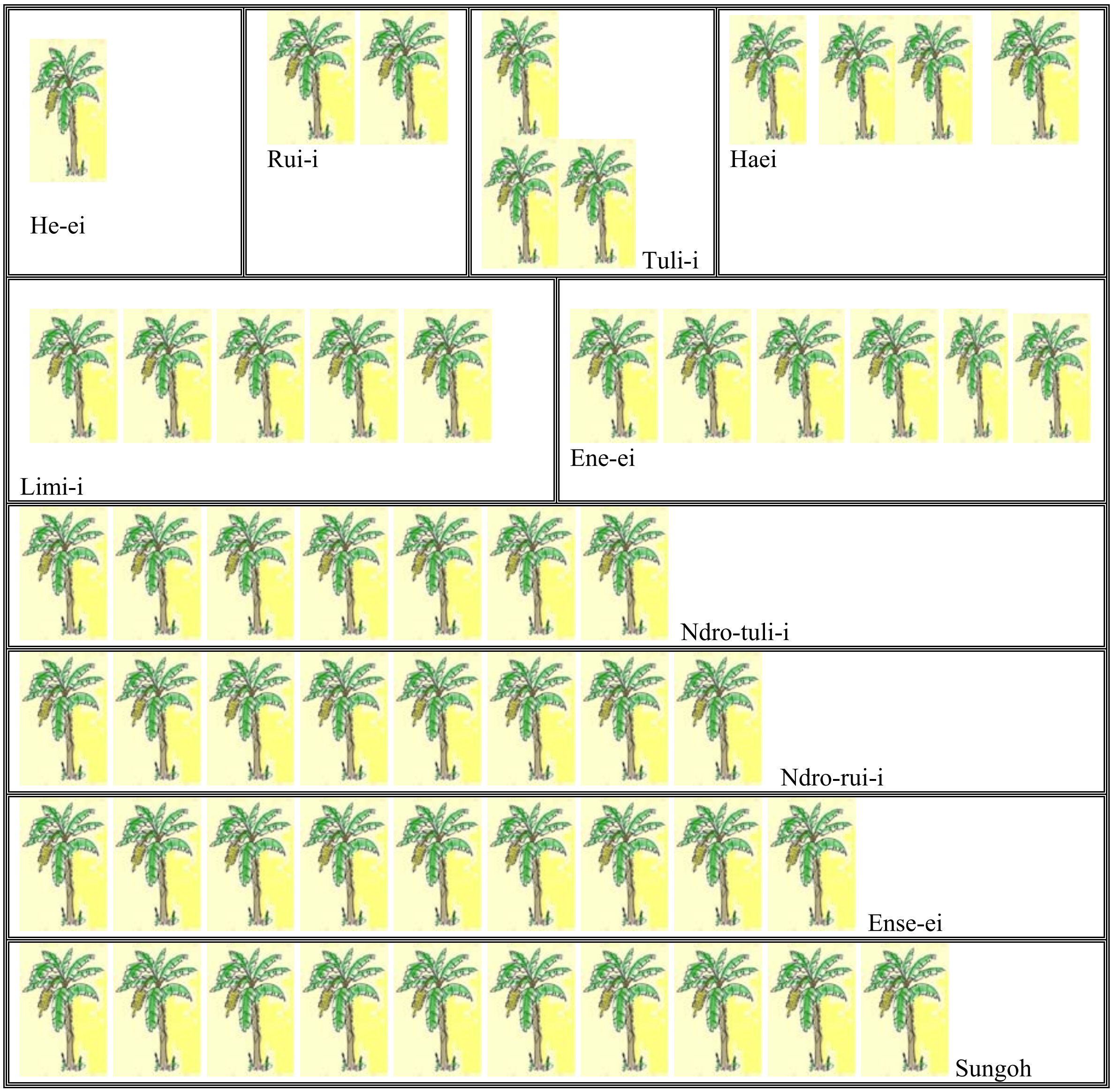

Figure A1 Counting banana trees

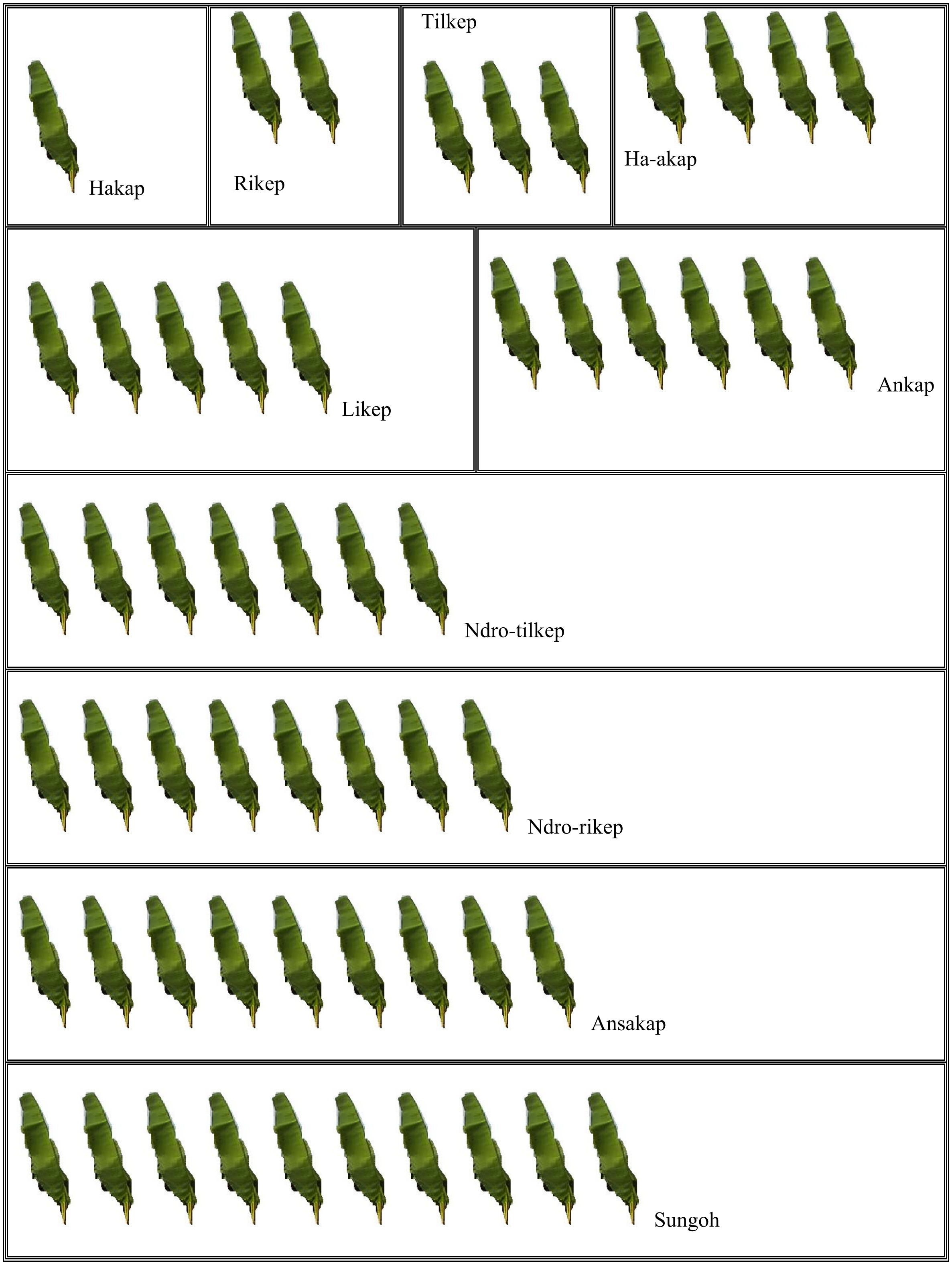

Figure A2 Counting banana leaves

Figure A3 Counting banana fruits

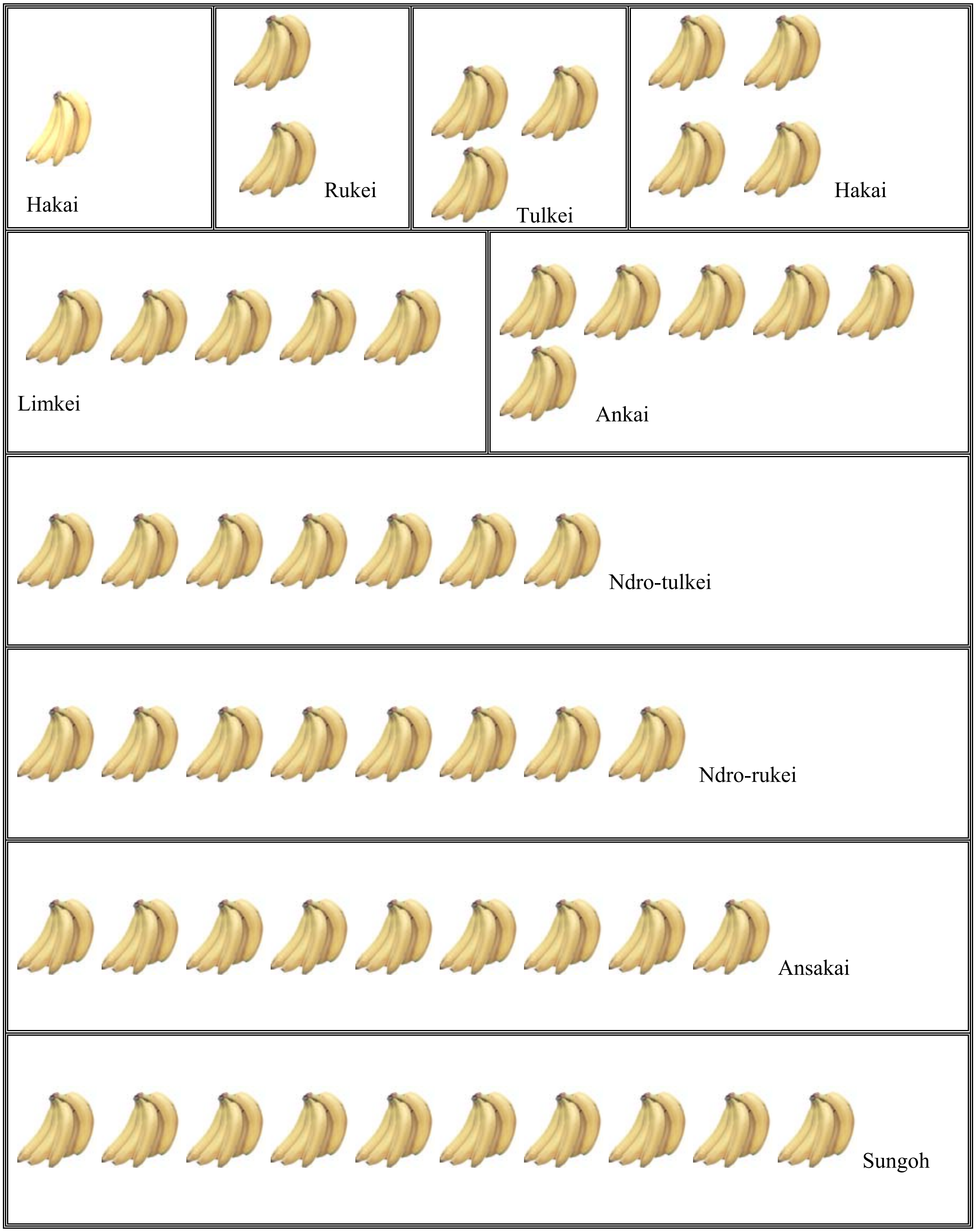

Figure A4 Counting bunches of bananas

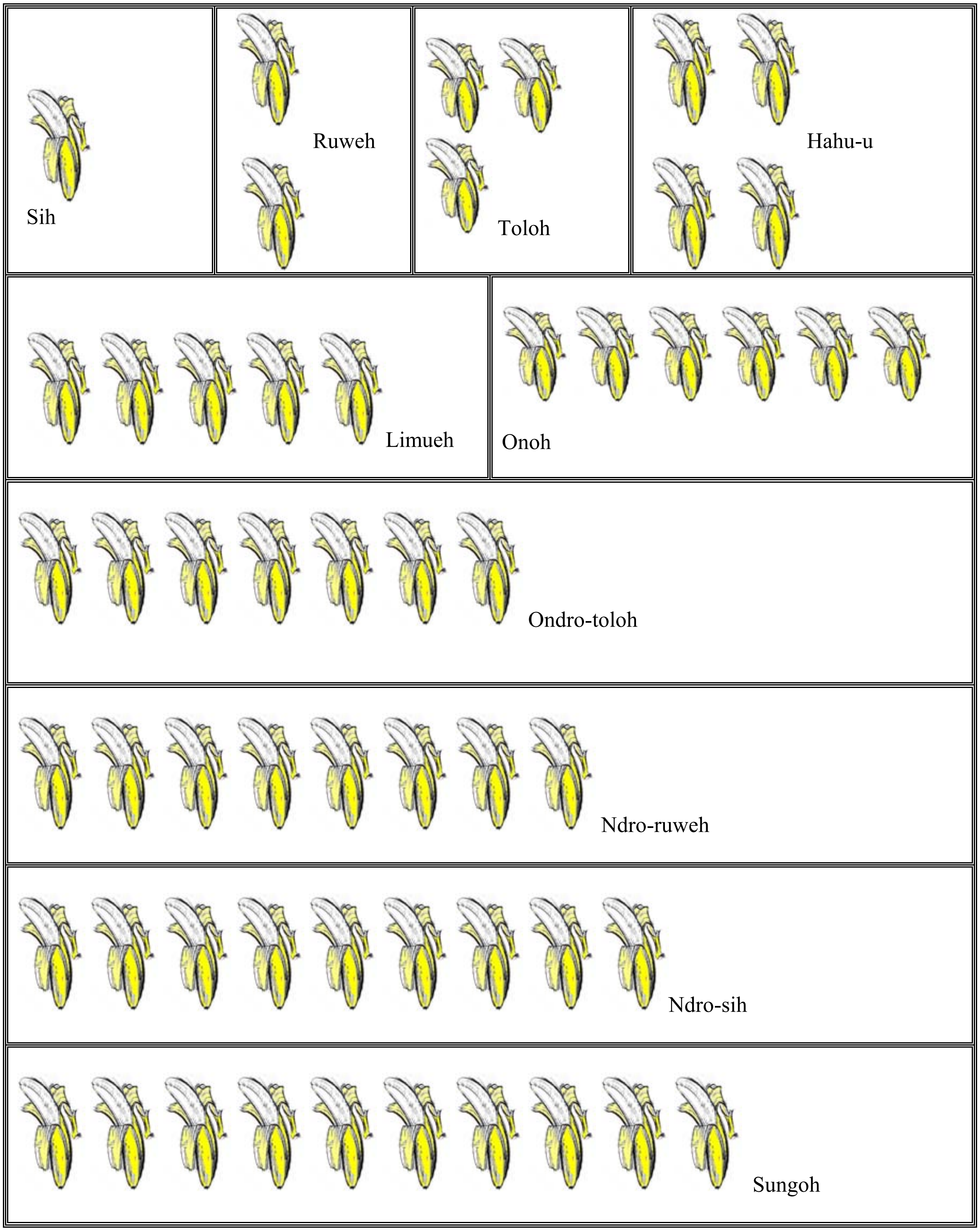

Figure A5 Counting loose banana fruits