Spreadsheet as an innovative tool for traditional counting in Papua New Guinea

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Abstract

This paper seeks to highlight Excel spreadsheet as a mathematical tool in the creative teaching and learning of traditional counting systems in Papua New Guinea (PNG). PNG is known for its diversity in culture and tradition and so this paper wants to take advantage of the available technology such as spreadsheet to articulate the sort of diversity that exists in our traditional counting systems. In this paper 3 different types of traditional counting systems in certain parts of PNG are being discussed. The first traditional counting system from Mikarew village in the Madang Province, uses a base 2 counting system and is taught in the native language call 'Aruamu' or 'Big Man'. The second one uses a base 5 counting system and comes from Manam in the Madang Province. And finally from East New Britain Province, the traditional counting system is taught in the native language call 'Kuanua' and uses a base 10 approach. Each of this traditional counting system has been taught in the past and at present but without the use of computer-based learning technologies. It is our intention however, that with the current expansion of the One Laptop Per Child project (OLPC) in Primary schools around the country, spreadsheet can be better utilized as a dynamic tool for mathematics education especially in this area of traditional counting. The paper concludes that the way forward for mathematics education in Papua New Guinea, is to embrace technological tools like spreadsheet and use it creatively.

Key words: traditional counting system, Papua New Guinea, Excel Spreadsheet, Aruamu language, Kuanua language, Manam language

Introduction

Microsoft Excel has been used extensively in a various domain areas of interest, particularly in the mathematical modelling of real world applications; whether it be finance, health or education (Ozdemir, 2014; Sinex, 2013; Albright, 2011; Dalton, 2008) Because Microsoft Excel is widely made available, educators and researches alike are also embracing this software as a potential tool, in the creative teaching and learning of mathematical concepts (Baker, 2013). Baker highlighted spreadsheet as an innovative tool to illustrate the Pascal pyramids. He made use of Excel functions to demonstrate how spreadsheet can be used to create number pyramids with students (pp. 1-7). Notably in Drier (2001), he too emphasized that spreadsheet can be used as an interactive tool to illustrate mathematical concepts and ideas (pp. 1-2). Others have used Excel spreadsheet to explore ethno mathematical concepts which

then applies to a local context (Abady, 2011). Abady highlighted aspects of geometry and algebraic patterns using cultural artefacts suitable for teachers and students in Papua New Guinea (pp. 22-38).

It is these studies that inspired this study of how traditional use of mathematical ideas and concepts can be taught using Microsoft Excel. In this case, traditional counting systems of Papua New Guinea are explored using this software (Excel) with the hope that mathematics educators and researchers alike can embrace this technology and use it to their advantage.

Traditional counting in Papua New Guinea

Papua New Guinea is known for its diversity in traditional and cultural groups of people that make up the country's total population of over six million. What is even more interesting about this multilingual society (Papua New Guinea) is that, within these 800 languages a wide variety of counting systems exist (Wolfers, 1971; Lean, 1988; Owens, 2000). Each of the mentioned studies employed different methods to identify types of counting systems that are found in various parts of Papua New Guinea. For example, Wolfers found an assorted number of tallying devices such as tying of small knots on a rope or cutting little notches in a stick to represent a unit of whatever was being counted (p.77). Wolfers also found that the use of body parts, particularly fingers and toes were commonly used throughout the country as another tallying and recording device (pp. 77-78). The use of body parts (fingers, toes, eyes and ears to mention a few) were also noted in Lean, para.1 and in Owen, para.7, respectively. Using these counting devices, quantities of items counted are annotated using numerical bases and expressed in native languages of places surveyed in Papua New Guinea (Wolfers, p. 78; Owen, para. 2; Lean, para. 4).

For example, the Kiwai people of Western province use a base 2 counting system to count objects that are also expressed in their native language (Wolfers, p. 78); One to five is counted as follows;

1 *nau*
2 *netewa*
3 *netewa nau*
4 *netewa netewa*
5 *netewa netewa nau* and so on.

In another example, Wolfers also highlighted that the Wedau people of Milne Bay province use a base 5 counting system where '10' is expressed as 'two hands are finished' (p. 78). One to five in Wedau language is counted as follows;

1 *tagogi*
2 *ruaga*
3 *tonuga*
4 *tonuga tagogi*
5 *nima tagogi* to mean 'one *hand*' or '*five fingers*' and so on.

In Owen (2001, p. 51), she too provided a summarised table showing other forms of counting systems (base 3, 4, 6 and 10) that were largely used across the highlands as well as the coastal areas of Papua New Guinea.

While preliminary studies mentioned above provided evidence of a wide spread in the counting systems particularly in this part of the world (Papua New Guinea), these counting systems are also known to have a significant impact in the traditional livelihoods of the people. This study however, looks at an educational approach towards utilizing technology as a teaching and learning tool to visually capture some of these traditional counting systems. In this study, traditional uses of bases of 2, 5 and 10 from selected places in Papua New Guinea are visually represented using Microsoft Excel.

Normal representation of bases 2, 5 and 10 in Microsoft Excel

In computer terminology, the base 2 is also referred to as binary counting number system; meaning that only two digits (zero and one) are represented when counting. This is because computers are electronic devices and can only communicate using a binary translation. However, in an Excel Spreadsheet, if we begin counting at one, this number (one) can be represented using base 2 in this order; $=\mathbf{0\times2^1 + 1\times2^0}$**.** The same number (one) when translated to nodes and ones (in binary terms), one is also represented as zero-zero-zero-zero-one using an 8 bit structure.

Base $_2$
1
$= \mathbf{0\times2^1 + 1\times2^0}$
= 00001
= zero-zero-zero-zero-one

Similarly, twenty-six when represented using base 5 can be expressed in this order; $=\mathbf{5\times5^1 + 1\times5^0}$**.** The same number (twenty-six) is also (as seen below) represented in binary as **zero-zero-one-zero-one.**

Base $_5$
26
$= \mathbf{5\times5^1 + 1\times5^0}$
=00101
=zero-zero-one-zero-one

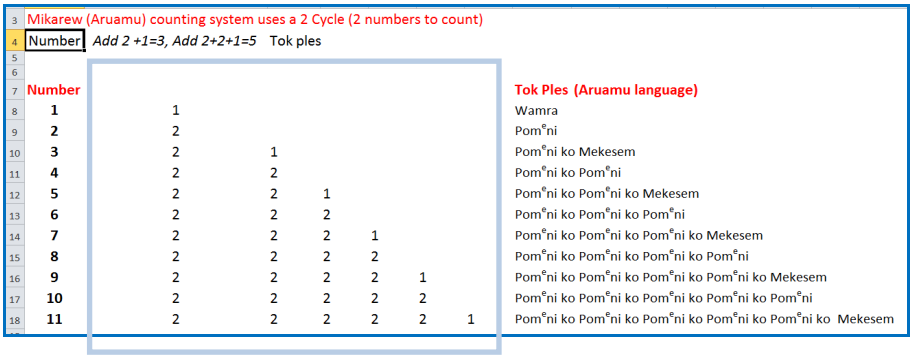
Likewise counting twenty in base 10, would be expressed in this manner; $=\mathbf{2\times10^1 + 0\times10^0}$**.**

Base$_{10}$
20
$= \mathbf{2\times10^1 + 0\times10^0}$
=20

Base 2 representation in Aruamu language, Mikarew

Mikarew village is located north-west of the main highway linking Madang town and Bogia district and is home to a population of over 40, 000 people. The people speak the Aruamu language, which means 'big man'. In my data collection (and as shown in Figure 1 below), traditional counting is done using a perfect base 2. By this (perfect base 2), I mean that whilst counting the traditional way, the people make use of numbers 1 and 2 only as indicated inside the blue square. This is also evident given its traditional translation across the sheet.

What is fascinating about counting in the Aruamu language is that the higher you go, the longer the traditional translation will be as you can also see in the Excel Spreadsheet below. This however, can be a tedious task if you were to count large numbers. In such cases, large numbers are expressed using the plural of nouns when counting items. For example, instead of saying 'twenty pigs', aruamu language speakers would say 'daravuriba' to mean 'many pigs'.



3	Mikarew (Aruamu) counting system uses a 2 Cycle (2 numbers to count)						
4	Number	*Add 2 +1=3, Add 2+2+1=5*	Tok ples				
5							
6							
7	**Number**						**Tok Ples (Aruamu language)**
8	**1**	1					Wamra
9	**2**	2					Pom^{e}ni
10	**3**	2	1				Pom^{e}ni ko Mekesem
11	**4**	2	2				Pom^{e}ni ko Pom^{e}ni
12	**5**	2	2	1			Pom^{e}ni ko Pom^{e}ni ko Mekesem
13	**6**	2	2	2			Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni
14	**7**	2	2	2	1		Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Mekesem
15	**8**	2	2	2	2		Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni
16	**9**	2	2	2	2	1	Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Mekesem
17	**10**	2	2	2	2	2	Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni
18	**11**	2	2	2	2	2	1 Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Pom^{e}ni ko Mekesem

Figure 1 shows counting in the Aruamu language using base 2**.**

Figure 1 is further developed into a more user-friendly page where users can interact more fully with the spreadsheet when learning about the different kinds of traditional counting systems. Figure 2 below shows an example of how food items are counted in the Aruamu language using base 2. What is worth noting in this user interface is the Excel features that I have utilized which allows for both teachers and students to explore mathematical concepts (in this case traditional counting systems) in an interactive environment.

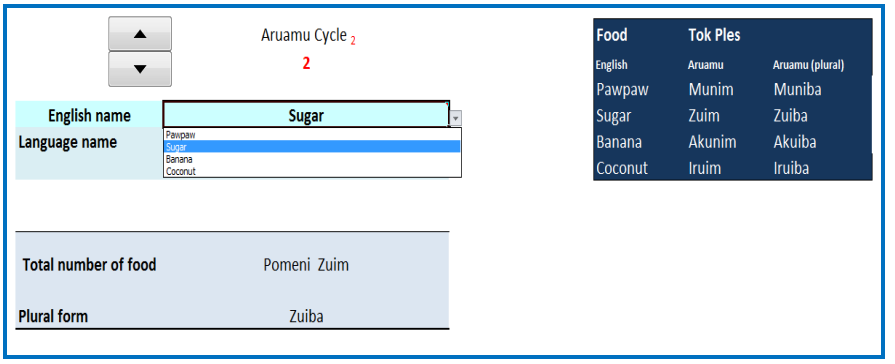


Figure 2 shows the use of Excel tools in the creative teaching and learning of traditonal counting in Aruamu language.

In Figure 2, I have first of all created a simple list of food names (in the dark blue background) and their traditional language translations. This table (in dark blue) is fundamental as it provides two key functionalities for the user interface; first it allows users to create a drop-down list for food items under their English translations. Second, when a food item is selected from the drop-down list the corresponding translations and number of food being counted also appear simultaneously. At the top of the spreadsheet, I have used the scroll button feature of Excel. This button allows for both teachers and students to navigate through the number system with the corresponding translations.

Arguably the above demonstration may be more suitable for secondary and perhaps tertiary level students given the level of mathematical formulas used and which they may need to also understand. Nevertheless, I have also experimented with other mathematical features of Excel to accommodate for students in primary and elementary levels.

For example, in Figure 3, I used the Excel chart to illustrate different types of traditional counting systems and their traditional translation. The x and y chart is created using a lookup function. Although understanding this math formula (lookup) may not be required at the elementary level, the use of interactive charts however, can be a better alternative to demonstrate the diversity in Papua New Guinea's traditional counting systems. The students interact with the chart by simply navigating through the scroll button. The higher a user counts using the scroll button, the red dots on the chart change in correspondence with the number as they count. Meanwhile, for whichever number they are at, the corresponding traditional translation also appears at the top of the spreadsheet as shown below.

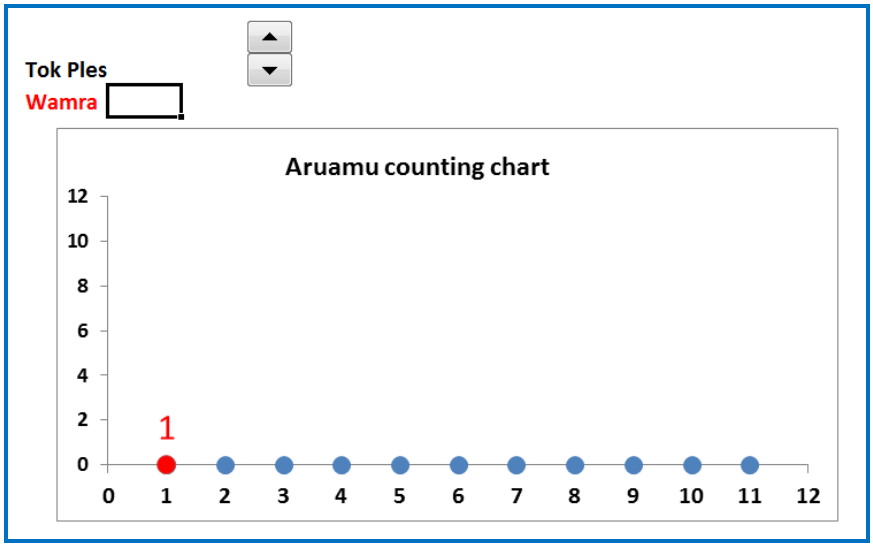


Figure 3 shows how Excel chart features are used as an alternative teaching tool.

Figure 4, shows another application of traditional counting, whereby Aruamu language is used to show coordinates on an *x,y* chart. Again, a simple lookup formula is used to identify known *x* and *y* coordinates on the chart. When a student clicks on the scroll button, the coordinates move gradually up or down the line graph with the corresponding language translation.

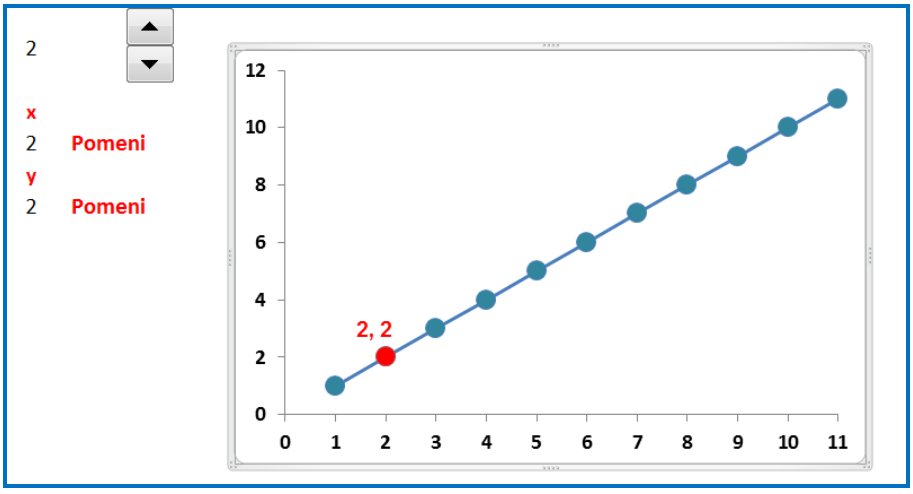


Figure 4 We see another alternative use of charts in traditional counting.

Base 5 representation in Manam Motu language, Manam

Another traditional counting system studied closely was from Manam Island also located in the Madang province. The people of Manam speak a common vernacular known as 'Manam Motu'. This study found that the Manam people use base 5 representation when counting items. Therefore, I have tried to capture this counting system in Excel spreadsheet using similar techniques previously discussed. Figure 5 shows how traditional counting is done in their native vernacular using a base 5 representation. At number 10, 'kulemoa' also means 'two hands complete'.

number *Add 5 +1=6, add 5+5+1=11*

Number		Tok Ples (Manam Motu)
1	1	Teke
2	2	Rua
3	3	Toli
4	4	Wati
5	5	Lima
6	5+1	Lima be Teke
7	5+2	Lima be Rua
8	5+3	Lima be Toli
9	5+4	Lima be Wati
10	5+5	Kulemoa
11	5+5+1	Kulemoa be teke
12	5+5+2	Kulemoa be rua
13	5+5+3	Kulemoa be toli
14	5+5+4	Kulemoa be wati
15	5+5+5	Kulemoa be lima
16	5+5+5+1	Kulemoa lima be teke
17	5+5+5+2	Kulemoa lima be rua
18	5+5+5+3	Kulemoa lima be lima
19	5+5+5+4	Kulemoa lima be wati
20	5+5+5+5	Kulemoa rua

Figure 5 shows traditional base 5 counting in the Manam Motu language.

Similarly, Excel tools and techniques described previously were also employed to create an interactive environment for both teachers and students. Figure 6 illustrates the number counted as well as its translation below.

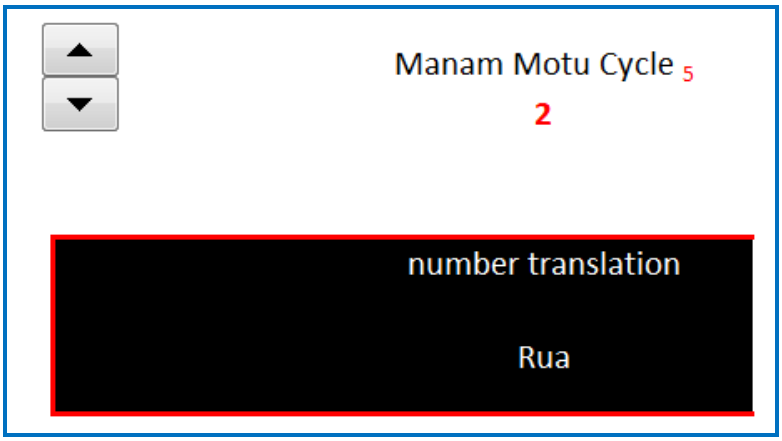


Figure 6 illustrates similar use of Excel tools to create an interactive environment for users.

In Figure 7, I have again employed the use of *x*,*y* charts in Microsoft Excel but this time include some additional features to emphasize Excel spreadsheet as an innovate tool for traditional counting. The vertical line in between each number shows decimal number places. For instance, when a user gets to number 8 a vertical line is also displayed automatically to indicate where 8.5 is on the *x* and *y* chart. The vertical line is obtained by creating a series of *x* and *y* coordinates together with their decimal places. So for example, if the user reaches a certain number value or in this number 8, the corresponding decimal place value is also displayed.

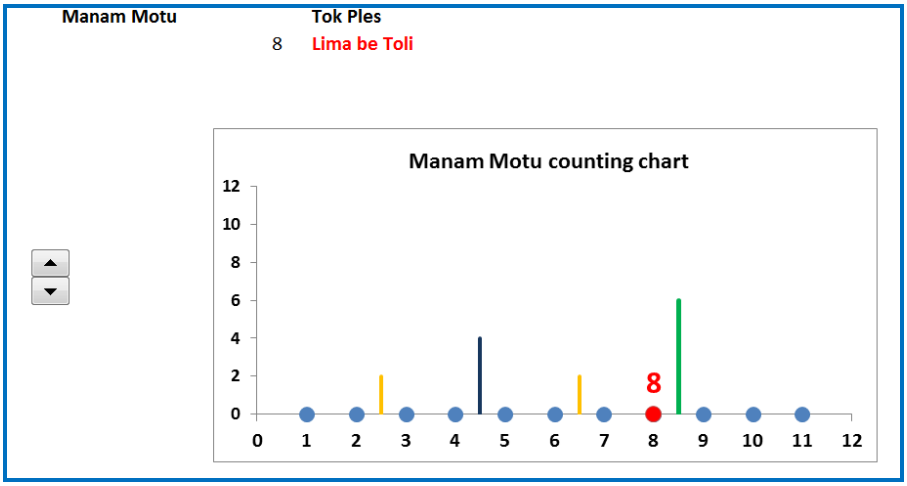


Figure 7 shows additional use of chart features in Excel in the teaching and learning of traditional counting.

Base 10 representation in Kuanua language, Rabaul East New Britain

The Tolai people in East New Britain on the other hand use the base 10 representation in their counting system. The Tolai people speak the Kuanua language. Figure 8 shows how numbers are counted from 1 to 10 in the Kuanua language and then at 11, 1 is added to 10.

Number	*Add 10 + 1 =11, Add 10+10=20*	Tok ples
1	1	*tikai*
2	2	*a urua*
3	3	*a utul*
4	4	*a ivati*
5	5	*a ilima*
6	6	*a lapikai*
7	7	*a lavurua*
8	8	*a lavutul*
9	9	*a lavuvati*
10	10	*a vinun*
11	10+1	*a vinun tikai*
12	10+2	*a vinun a urua*
13	10+3	*a vinun a utul*
14	10+4	*a vinun a ivati*

Figure 8: Base 10 as the traditional counting system in Kuanua language from the East New Britain province.

Suggestions for further development

The samples presented in the discussions show that addition of numbers in the native vernaculars was the only form of calculation that was explored using the tools of Excel in this study. Therefore, it is hoped that other forms of arithmetic such as subtraction, multiplication and division in the languages discussed can also be investigated in near future with possible use in Excel spreadsheet.

Another key feature that needs further development is the user interface itself. Developing appropriate user interfaces for the different student groups from elementary to tertiary level needs to be explored further for appropriate use in Excel spreadsheet. This will enhance the creative teaching and learning of traditional counting using the Excel spreadsheet.

This study shows that using traditional counting in Excel spread sheets is possible. This suggests that other possible Excel tools and functions can be explored apart from charts, table lists and scroll buttons. For example, teachers and or students can use pivot tables instead of charts to illustrate traditional counting with their corresponding translations. Additional features of Excel in

the form of macros can be added to the pivot table to create an interactive environment.

Conclusion

Traditional counting system of base 2, 5 and 10 can be used in Excel spreadsheets. Other potential teaching and learning tools exist in the area of mathematics. Microsoft Excel is just one of them. Further investigation into the use of number in various PNG counting systems may expose further potential for their application in Excel spreadsheets which can provide an avenue for innovative teaching and learning of mathematics in Papua New Guinea.

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