



YUMI DEADLY CENTRE
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Finance Booklet C

Developing a family budget: Teaching the algebra of linear equations and multi-step problem-solving in money situations



Shalom Christian College-QUT Deadly Maths Group
Accelerated Numeracy Project

**FINANCE
BOOKLET**

C

**DEVELOPING A FAMILY BUDGET:
Teaching the algebra of linear
equations and multi-step problem-
solving in money situations**

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YuMi Deadly Maths
Past Project Resource

Acknowledgement

We acknowledge the traditional owners and custodians of the lands in which the mathematics ideas for this resource were developed, refined and presented in professional development sessions.

YuMi Deadly Centre

The YuMi Deadly Centre is a Research Centre within the Faculty of Education at Queensland University of Technology which aims to improve the mathematics learning, employment and life chances of Aboriginal and Torres Strait Islander and low socio-economic status students at early childhood, primary and secondary levels, in vocational education and training courses, and through a focus on community within schools and neighbourhoods. It grew out of a group that, at the time of this booklet, was called “Deadly Maths”.

“YuMi” is a Torres Strait Islander word meaning “you and me” but is used here with permission from the Torres Strait Islanders’ Regional Education Council to mean working together as a community for the betterment of education for all. “Deadly” is an Aboriginal word used widely across Australia to mean smart in terms of being the best one can be in learning and life.

YuMi Deadly Centre’s motif was developed by Blacklines to depict learning, empowerment, and growth within country/community. The three key elements are the individual (represented by the inner seed), the community (represented by the leaf), and the journey/pathway of learning (represented by the curved line which winds around and up through the leaf). As such, the motif illustrates the YuMi Deadly Centre’s vision: *Growing community through education*.

More information about the YuMi Deadly Centre can be found at <http://ydc.qut.edu.au> and staff can be contacted at ydc@qut.edu.au.

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This booklet was developed using funding from a Financial Literacy Grant from the Commonwealth Bank Foundation, for a 2008 project at Shalom Christian College in Townsville called *Shalom Accelerated Numeracy*. The booklet and accompanying virtual activities are based on financial mathematics material trialled by the researchers as part of a 2007 Australian Studies in Science, Technology and Mathematics (ASISTM) project, *Using finance and measurement applications to improve number understanding of Indigenous students*, conducted at schools in Aboriginal communities in central and southern Queensland.

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DEADLY MATHS

Deadly Maths is the name of a group of researchers at QUT, Griffith and ACU in Brisbane who undertake projects in Indigenous schools and Communities to improve mathematics learning outcomes for Indigenous students. Projects focus on enhancing Indigenous students’ learning of mathematics, improving teachers classroom practices in mathematics, training Indigenous teacher aides to effectively tutor mathematics and developing materials to improve mathematics learning of Indigenous VET students. For further information, contact Gillian Farrington at 07 3138 0061 or gh.farrington@qut.edu.au, or access website <http://ydc.qut.edu.au>.

COMMONWEALTH BANK FOUNDATION

This is the third of three booklets, Finance Booklets A, B and C, which, together with six virtual mathematics activities, have been developed by Deadly Maths using funding from a Financial Literacy Grant from the Commonwealth Bank Foundation. The booklets and virtual activities are based on Financial Mathematics material trialled by the authors as part of a 2007 Australian Studies in Science, Technology and Mathematics (ASISTM) project. The aim of the booklets is to use money activities to reteach and reinforce number and operation understandings of Indigenous students at the Indigenous boarding and day school, Shalom Christian College. The three booklets focus on two-digit numbers, addition and subtraction, and the mathematics of shopping (booklet A); three-digit and decimal numbers, the four operations and the mathematics of planning a party (booklet B); and variables, multi-step problem solving and the mathematics of family budgets (booklet C).

1. BACKGROUND

1.1 VARIABLE

Many money situations have to be solved by balancing computing amounts. Therefore, often amounts have to be varied or are not given, which means that the activity is part of algebra. For example, suppose we set the problem "I had \$50 to spend on clothes and food. How much did I spend on food?" The answer would be: "I can't work it out" and "It depends".

Another problem might be "I buy a shirt at \$20. I pay \$300 rent for a stall at the market. How many shirts do I need to sell to make \$200 for myself for the day?" Once again, "it depends" on how many shirts are sold and how much you charge, how much you make per shirt (i.e. your profit per shirt). So the problem becomes "What if". If I sell the shirts for \$25 each and sell 50 shirts, I make \$5 per shirt or \$250 profit. But I have to pay \$300 rent, so I actually make a loss of \$50. If I sell the shirts for \$30 each and I sell 50 shirts, I make \$10 or \$500 profit, with rent of \$300 to pay, which means I make \$200 profit. But will charging \$30 per shirt reduce the number of shirts I sell? If I only sell 30 I make no profit.

The notion of variable is best introduced through three methods:

1. From generalising patterns and changes:

$$\begin{array}{ccccccc} \text{e.g. } 3 & 5 & 7 & 9 & _ & _ & _ \\ & 1 & 2 & 3 & 4 & & n \end{array} \quad 2n+1$$

2. From formulae, e.g. area = length by width ($A = L \times W$)
3. From problems where we solve for unknowns.

In this booklet, we will be using method 3 (with money problems) to introduce variable. Of course, we will really be doing what is called pre-algebra (a halfway house between arithmetic and algebra) where there is an unknown but the calculations only use arithmetic (no variables in calculations).

1.2 MULTI-STEP PROBLEM SOLVING

When working with money, it is common for problems to have more than one step. For example, "I bought 4 lunches for \$17 each and drinks for \$22. How much did I pay all together?" This requires the addition of $4 \times \$17$ to get the lunches and \$22 for the drinks, to get the answer, or solve the problem. In this scenario there are two steps required – multiplication and addition: $4 \times \$17 + \$22 = \$68 + \$22 = \$90$.

To be able to determine what each step does, and doing each step, is operations (i.e. computation). To be able to determine there are two steps is problem solving.

Problem-solving skill is based on strategies (rules of thumb which point in the directions towards the solution for a wide variety of problems) e.g. make a drawing, guess and check, use a table or chart, break the problem into parts, and so on.

The major strategies are:

- Make a drawing – draw something useful that will help solve the problem.
- Given, needed and wanted – determine what is given, what is needed to get you to where you want to go and what is wanted (where you want to go).
- Restate the problem – rethink the problem in your mind so it becomes easier.

Overall it is also good to have a general plan of attack. Polya's is best – SEE, PLAN, DO, CHECK (see section 3 on multi-step problems).

Special note: This booklet is an outline only with respect to what could be developed for this area. Thus, full descriptions of lessons, worksheets and games are not provided.

2. SOLVING MONEY EQUATIONS

2.1 REPRESENTING MONEY SITUATIONS WITH EQUATIONS

Objective Comprehending how to represent variable money situations with equations.

Materials Picture of money balance, pens, paper, cards, game.

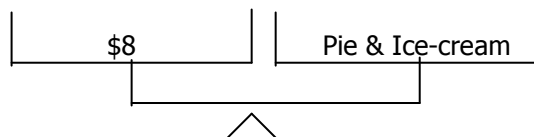
Activities

1. Set up problem:

Ask students to look at problem: "I spent \$8 on a pie and ice-cream. How much was the ice-cream?" Ask "Can we answer this? What do we need to know? How can we think about it?"

2. Introduce representation:

Propose a way of thinking about it based on balance – a mathematical balance that can do anything (+, ×, −, ÷)



How could we write that these two sides are the same value? Show the equation:

$$\text{Pie and Ice-cream} = \$8$$

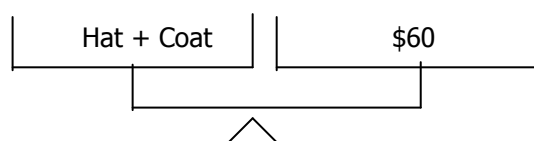
Turn around balance in the mind:

$$\$8 = \text{Pie and Ice-cream}$$

3. Extend to all operations:

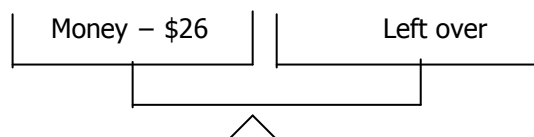
Make up balances and equations for all operations.

(A) I bought a hat and coat for \$60. How much was the coat?



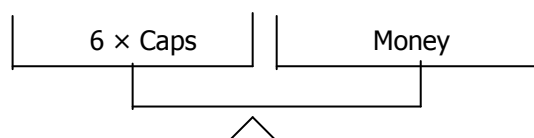
$$\begin{aligned} \text{Hat} + \text{Coat} &= \$60 \\ \$60 &= \text{Hat} + \text{Coat} \end{aligned}$$

(B) I had saved some money. I bought a \$26 lunch. How much do I have left to spend?



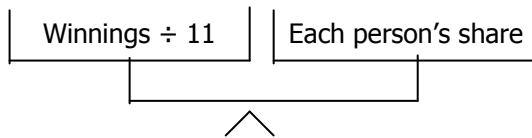
$$\begin{aligned} \text{Money} - \$26 &= \text{Left} \\ \text{Left} &= \text{Money} - \$26 \end{aligned}$$

(C) I bought 6 caps with my money. How much did each cap cost?



$$\begin{aligned} 6 \times \text{Caps} &= \text{Money} \\ \text{Money} &= 6 \times \text{Caps} \end{aligned}$$

(D) I shared the winnings amongst 11 people. How much did each get?



Winnings \div 11 = Each person's share
 Each person's share = Winnings \div 11

4. Reinforce concept:

Use worksheets to reinforce – 3 columns with 2 to fill in is a good worksheet style.

Story	Balance	Equation

5. Can also make up "mix and match" cards, "cover the board" cards/board, "bingo" cards/boards and "snap/rummy" cards.

2.2 SOLVING FOR UNKNOWNNS

Objective Comprehending how to represent and solve the unknown in various situations.

Materials Picture of money balance, pens, paper.

Activities

1. Set up problem:

"I spent \$8 on a pie and ice-cream. How much was the ice-cream?" Represent this with an equation:

$$\text{Pie} + \text{Ice-cream} = \$8$$

Now consider the pie was \$3 – this changes the equation:

$$\$3 + \text{Ice-cream} = \$8$$

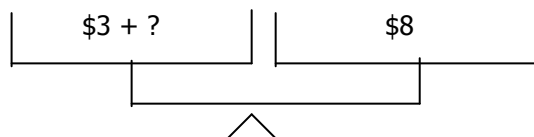
Ask the students: What is **unknown**? (cost of ice-cream)? How could we represent this?

Note: should adopt your class's choice for unknown, but we'll use "?" (or the name of the object) for unknown in this booklet.

Rewrite the equation: $\$3 + ? = \8

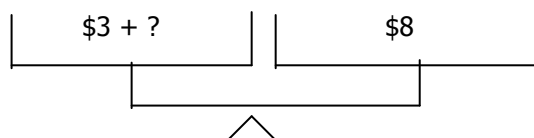
2. Solve equation:

Ask students to think of the equation on a balance.



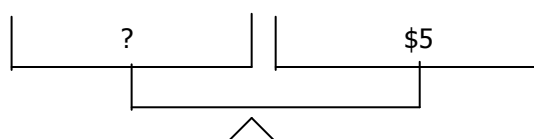
$$\$3 + _ = \$8$$

Ask students: How can we change the sides so that it still remains balanced? What do we need to do to make sure the balance is maintained? How can we make the "?" alone on the left hand side. [subtract 3]? What do we then do to the right hand side?



$$\$3 + ? = \$8$$

Subtract \$3 from both sides:



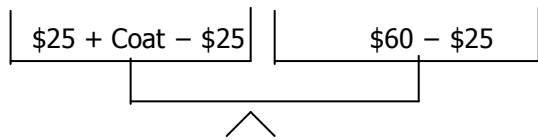
$$\begin{aligned} \$3 + ? - \$3 &= \$8 - \$3 \\ ? &= \$5 \\ (\text{ice-cream} &= \$5) \end{aligned}$$

3. Extension:

Extend this to other problems from Section 2.1.

(A) The hat was \$25

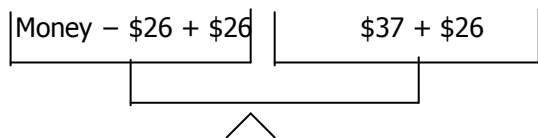
To get the cost of the coat alone subtract \$25



$$\begin{aligned} \$25 + \text{Coat} &= \$60 \\ \text{Coat} &= \$60 - \$25 \\ \text{Coat} &= \$35 \end{aligned}$$

(B) I was left with \$37

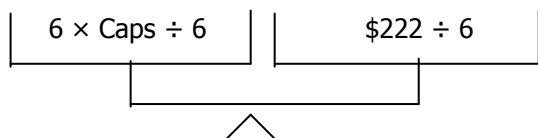
To get the amount of the money alone add \$26.



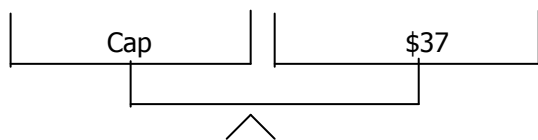
$$\begin{aligned} \text{Money} - \$26 &= \$37 \\ \text{Money} - \$26 + \$26 &= \$37 + \$26 \\ \text{Money} &= \$63 \end{aligned}$$

(C) The total amount was \$222

To get the cost of the caps alone $\div 6$:



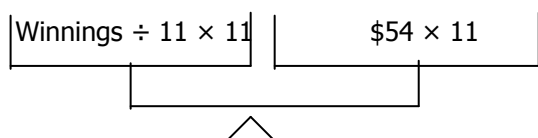
$$\begin{aligned} 6 \times \text{Caps} &= \$222 \\ 6 \times \text{Caps} \div 6 &= \$222 \div 6 \end{aligned}$$



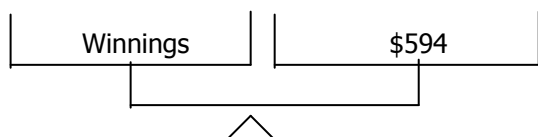
$$\begin{aligned} \text{Cap} &= \$222 \div 6 \\ \text{Cap} &= \$37 \end{aligned}$$

(D) Each person got \$54

To get the amount of the winnings alone $\times 11$:



$$\begin{aligned} \text{Winnings} \div 11 &= \$54 \\ \text{Winnings} \div 11 \times 11 &= \$54 \times 11 \end{aligned}$$



$$\begin{aligned} \text{Winnings} &= \$54 \times 11 \\ &= \$594 \end{aligned}$$

4. Reinforce:

Relate balance approach of unknown equations to real-world problems, e.g. 2 column worksheets with one column empty on the left

Problem	Balance	Equation

Again use mix and match cards, snap and rummy cards.

5. Create worksheets of type:

(A) $? + \$16 = \57

(B) $? \div 4 = \$17$

(C) $3 \times ? + \$7 = \43

etc.

2.3 APPROACHING VARIABLE MONEY PROBLEMS

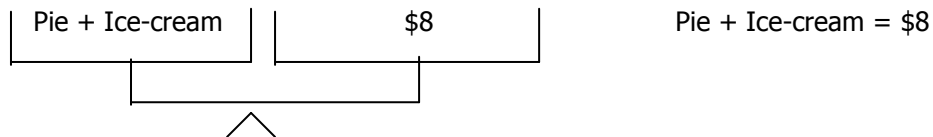
Objective Comprehending how to approach variable money problems.

Materials Picture of money balance, pens, paper

Activities

1. Initial analysis:

Look at opening problem again:



Discuss possibilities and likelihoods. For example, if cost of both items was in whole dollars, what would be reasonable options? List them and describe them. Use a table.

Pie	Ice-cream	Explanation
\$2	\$6	Upmarket ice-cream with a cheap pie
\$3	\$5	Normal pie and upmarket ice-cream
\$4	\$4	Boutique pie with a normal double ice-cream
\$5	\$3	Large pie with a simple ice-cream
\$6	\$2	Family pie with a cheap cone

2. Extension:

Apply the same strategy to the problems in Section 2.1 (keeping costs to whole dollars). Examples:

- (a) Problem B: Could the money be \$22? Is there a limit?
- (b) Problem C: What would the range be for the price of a cap?
- (c) Problem D: How big could this be? How small?

3. Working it out:

Set out problem: I made 20 clapsticks to sell at the markets. How many do I need to sell to make over \$200?

- What are the possibilities?
- What normally would a student artist get for selling clapsticks?
- Say it was \$20 each – would I have to sell all 20?
- What would I have to charge to get the money for 10 sticks?
- What is the most reasonable price to sell the clapsticks for?

4. Reinforce:

Set up problem situations and give a parameter (no more than this, only have this amount, etc). Ask for the most reasonable solution.

3. MULTI-STEP PROBLEM SOLVING

3.1 POLYA'S STAGES

This first lesson will focus on Polya's four stages of problem solving:

1. See – work out what you have to do
2. Plan – make a plan to do it
3. Do – do the plan
4. Check – check your answer and see what you can learn from the problem.

The best way to do this is to make a POSTER of the 4 stages and put it in front of the class and always use the 4 steps when discussing, adding, problem solving, etc.

For example: Problem: I sell CDs for \$30 which I buy for \$15. I pay \$200 rent for the stall. I sell 25 CDs. How much did I make for the day?

- (a) See – What is going on here?

Stall, CDs for sale, bought for \$15 sell for \$30. To sell 25 CDs means the profit is added for each CD.
Have to pay \$200 rent.

- (b) Plan – What strategy is best? I'll choose to break the problem into parts.

I buy CDs at \$15 and sell them at \$30 each means profit on each CD.

25 CDs sold means 25 lots of this profit.

Have to reduce this profit by \$200 for rent to be paid.

- (c) Do – do the steps.

$\$30 - \$15 = \$15$ profit per CD

$25 \times \$15 = \375 made from 25 CDs.

$\$375 - \200 rent means I make \$175 profit.

- (d) Check

$\$175 + \200 rent = \$375 – My answer means that this is the profit that I make in a day.

25 discs is $\$375 \div 25 = \15 – My answer means that this is the profit on each disc.

$\$30 - \15 is \$15 – My answer means that this is the amount I pay for each disc I sell for \$30.

So checking/working backwards gives me the correct starting point — so my answer is correct.

What have I learnt?

- (a) Do each step in turn.
- (b) Finish each step before moving on to next.
- (c) Make sure you take everything into account. (remember to $-\$200$ at end)

It is necessary to reinforce Polya's 4-stage method with many other examples.

3.2 STRATEGIES

This second lesson will focus on three strategies:

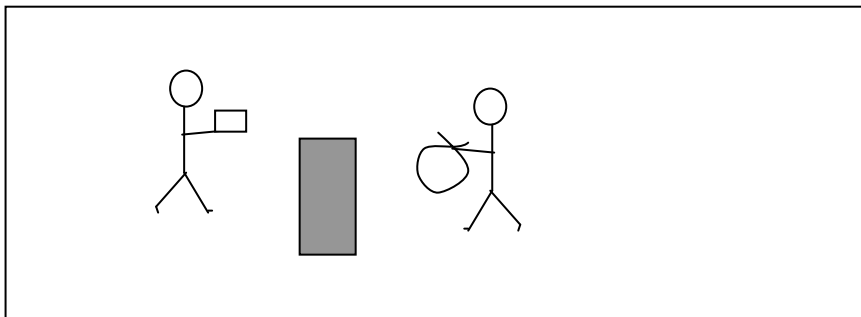
1. Drawing
2. Given, needed, wanted
3. Restate problem
 - (a) To do this, use the template "Strategy framework" on the next page.
 - (b) Let's see how this works in an example: "I bought 4 lunches for \$17 each and drinks for \$22. How much did I pay?"

1. Drawing:

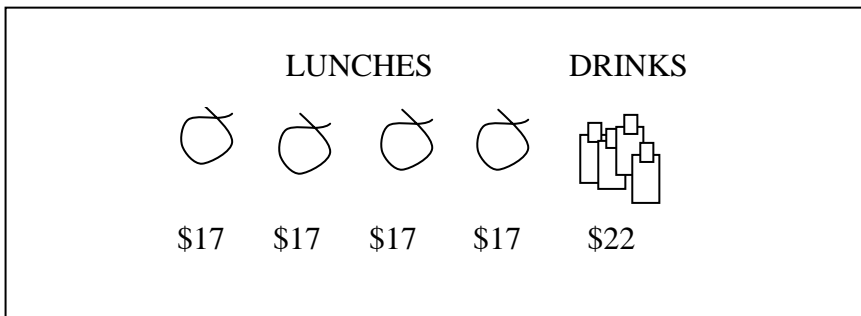
Get students to show drawing and discuss with them which is the most useful picture and why?

Example (obviously b helps with solution more than a):

a.



b.



2. Given, needed and wanted:

Get students to identify and record these three things:

- (a) Given: 4 lunches
 \$17 for each lunch
 \$22 for drinks
- (b) Needed: $4 \times \$17$ to work out lunches.
- (c) Wanted: the total amount (food and drinks).

3. Restate the problem:

Think of it in an easier way and write it down. (How could you make the problem easier for a student without giving them the answer?) For example, "work out what 4 lunches at \$17 is and add the answer to \$22 for drinks to get how much I spent in total".

Reinforce the strategies with similar problems before changing the problem type.

3.3 SOLVING PROBLEMS

In this final step we focus on solving the problems. We will use the template "Strategy framework" from the previous page to move on from strategies and plans of attack to solving the problems (working out answers).

1. Match–Mismatch:

In doing this stage, the Match–Mismatch method is recommended. To do this, organise the students to initially do a set of problems that are matching (or similar to each other). This enables the students to focus on getting to know the strategy and to understand the process that they will follow in problem solving. They can become familiar with the plan of attack and with the strategies.

When students are able to do these matching problems, then move on to problems that are mismatched (or dissimilar/not matching). In this situation, the students have to think about when to use a strategy.

The method is based on the sequence:

- (a) Teach students about a strategy
- (b) Teach students how to use a strategy
- (c) Teach students when to use a strategy

2. Breaking problem into parts:

This is the global method used when there is more than one step to a problem – you break up the problem and do the parts one-by-one until it is finished.

3. Get sequencing/language right:

First give problems where the language is very simple and the order of the solution procedure is the order of the language.

e.g. I had \$56, I spent \$37, how much change?

I bought 3 bags of Easter eggs for \$17 each. How much change do I have from \$60?

Then start to make the language more complex and break the nexus between the order of mathematics and the order of the language.

e.g. I went to the shop and spent \$37. I had \$56. What was my change?

The Easter eggs were \$17 a bag. I paid with \$60. What change did I get back if I bought 3 bags of eggs?

4. RICH ASSESSMENT TASK: DEVELOP A FAMILY BUDGET

4.1 PRE-ASSESSMENT TASKS: WHAT IS INVOLVED IN DAILY LIVING

This third assessment on finance requires you to develop a budget for a typical family in your community.

1. The first pre-assessment task is, therefore, for you to:

- (a) List all of the things a family in your community would have to pay for in a week (expenditure)
- (b) Find the general cost of things in your community.

To start you off, here is the beginning of a list:

- (a) Housing:
 - rent or mortgage payments
 - electricity or gas
 - rates etc. (if applicable)
- (b) Food:
 - groceries for the week
 - drinks
- (c) Clothing:
 - ongoing purchases to keep the family in clothes
- (d) Furniture:
 - ongoing replacement of things broken or worn out.
- (e) Car/travel:
 - petrol
 - servicing
 - loan repayments (if applicable)
 - registration and insurance
 - public transport
- (f) Entertainment:
 - movies
 - parties, etc.
- (g) Obligations:
 - gifts
- (h) Other
 - things that are special to your family

2. Within the budget, the focus is to balance the expenditure with the income. The second pre-assessment task is, therefore, to:

- (a) List the various ways a family gets money (income).
- (b) Find the amounts that are generally spent by a family in your community (expenditure).

To start you off, here is the beginning of a list:

- (a) Wages/Salaries – all family members
- (b) CDEP
- (c) Allowances – Centrelink
- (d) Pensions – age, invalid, etc.
- (e) Other

4.2 RICH ASSESSMENT TASK: FAMILY BUDGET

This third assignment on finance requires you to develop a family budget which shows that how much money you pay each week (expenditure) is less than the amount that you receive each week (income).

Tasks:

- 1) Family description:
Describe the family – how many adults, teenagers, children, babies etc. Describe their forms of income – how many are working, how many on CDEP, allowances and pensions. Research their expenditure in terms of the list from the pre-assessment task.
Write a report on this family.

- 2) Income:
Make a list of income and work out average weekly amounts.

- 3) Expenditure:
Make a list of expenditure and work out average weekly amounts.

- 4) Budget:
Adjust (3) so it is less than (2) but represents a balance of expenditure.

- 5) Report:
Write a report on your budget, what you think of it and what it might lead to.

4.3 TEACHER HINTS AND ASSESSMENT RUBRIC

Teacher hints

The focus of this task is to involve the students with their family working on a budget that has some similarities with their family's budget. However, care must be taken that there are other options when this does not work out. It may be inappropriate to move into this area. But it would be good if they could consult their family on possible incomes and expenditures.

The focus is on family because Westpac educators found that the family (not the individual) was the most appropriate focus in Indigenous communities and families.

Again encourage creativity and chunking (putting things together into more general expenditure items).

It would be beneficial if students could do this in relation to Excel.

It may be that a simple family may have to be substituted for normal extended families.

However if this assignment could become a major task in which students worked with their family in some way, it would be good.

Assessment Rubric

Activity	Excellent (A)	Good (B)	Satisfactory (C)	Effort shown (D)	No effort shown – unsatisfactory (E)
Family description	Complete and detailed description	Good description	Adequate description, covering important points	Effort shown but limited description and missing important aspects	Limited description, missing important aspects and effort not shown
Income	Complete list, good amounts, correctly calculated	Good list and correct calculation	Adequate list, correctly calculated	Effort shown but only some income considered	Only some income considered and effort not shown
Expenditure	Complete list, good structure, correctly calculated, good amount	Reasonably complete list and structure, correct calculation	Adequate lists correctly calculated	Effort shown but only some expenditure considered	Only some expenditure considered and effort not shown
Budget	Creative modifications	Good modifications	Adequate modifications that work	Effort shown but modification does not work	Modification does not work and effort not shown
Report	Insight shown into effect of budgets	Some insight shown into effect of budgets	Readable report	Effort shown but does not meet requirements	Does not meet requirements and effort not shown