Essential Mathematics 2019 v1.1

Unit 2 sample assessment instrument

September 2018

Problem-solving and modelling task

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Schools develop internal assessments for each senior subject, based on the learning described in Units 1 and 2 of the subject syllabus. Each unit objective must be assessed at least once.

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

1. select, recall and use facts, rules, definitions and procedures drawn from Fundamental topic: Calculations and Unit 2 Topics 1 and 2
2. comprehend mathematical concepts and techniques drawn from Fundamental topic: Calculations and Unit 2 Topics 1 and 2
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from Fundamental topic: Calculations and Unit 2 Topics 1 and 2.

Queensland Government | Queensland Curriculum & Assessment Authority

For all Queensland schools

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Subject	Essential Mathematics
Technique	Problem-solving and modelling task
Unit	2: Money, travel and data
Topic	Fundamental topic: Calculations 1: Managing money (Budgeting) 2: Time and motion

Conditions			
Duration	5 weeks (including 10 hours of class time)		
Mode	Written report	**Length**	• up to 8 pages (including tables, figures and diagrams) • maximum of 1000 words • appendixes can include raw data, repeated calculations, evidence of authentication and student notes (appendixes are not to be marked)
Individual/ group	Individual	**Other**	—
Resources available	The use of technology is required, e.g. • spreadsheet program • scientific calculator • computer/internet.		

Context

The ‘travelling salesman problem’ (TSP) is a famous mathematical problem that poses the following question:

> Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city and returns to the origin city?

Generalised versions of the TSP include the ‘travelling purchaser problem’ and the ‘vehicle routeing problem’.

Task

As a travel agent, you are to plan a trip to different locations in Queensland based on the 'vehicle routeing problem' and the following conditions:

1. You will travel to four different locations, visiting each exactly once and ending the journey where you started (back at home).
2. You will stay overnight at each location.
3. You must travel by car, air and one other mode of transport.
4. You wish to travel more than 3000 kilometres in total, to experience the vast size of Queensland.
5. You have a budget of $2500 to fund your trip.

Your aim is to ensure the trip is as efficient as possible, requiring the minimum amount of travel time.

You will present your day-to-day itinerary as a plan, outlining the distance travelled to each location, the time of departure and arrival at each location, and the cost estimates for transportation, accommodation and food.

You must:

- make decisions about the order you will visit the locations
- include distances and travel times estimated from maps, as well as approximations of associated costs
- check your calculations to consider if refinements are required
- explain your mathematical reasoning and give reasons for the choices you made.

To complete this task, you must:

- use your knowledge of the Topic 1: Managing money and Topic 2: Time and motion subject matter to investigate the problem
- ensure you cover both simple and complex subject matter
- ensure your response demonstrates characteristics in the instrument-specific standards
- develop a unique response in a coherent and concise written format that is appropriate to the genre, and includes a suitable introduction, body and conclusion
- show all calculations to support your response
- follow the approach to problem-solving and mathematical modelling used in the syllabus
- use a spreadsheet and/or websites to demonstrate how you solved the task.

Stimulus

A map of Queensland

The following websites may be useful:

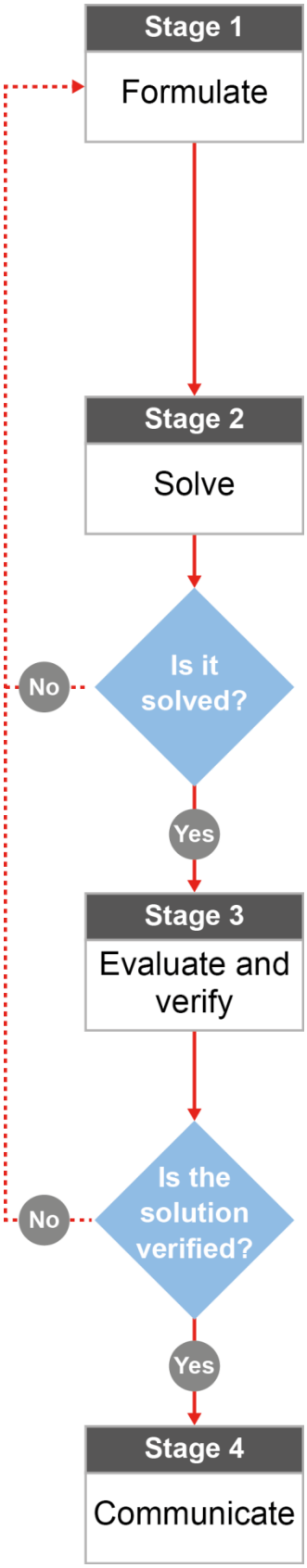
- www.webjet.com.au/flights (for availability and cost of flights)
- https://distancecalculator.globefeed.com/Australia_Distance_Calculator.asp (distance calculator and driving directions)
- www.queenslandrailtravel.com.au/Documents/Timetables/CompleteTimetable.pdf (for train schedules and costs)
- www.rome2rio.com (for transport, accommodation and rental car information).

Checkpoints

☐	One week after issue date: Students email individual data variations (e.g. flight costs, modes of transport, length of stay) to teacher.
☐	Two weeks after issue date: Check student progress, teacher gives class general feedback.
☐	Three weeks after issue date: Students emails progress update to teacher.
☐	Four weeks after issue date: Students email draft to teacher. Teacher provides feedback through questioning.
☐	Five weeks after issue date: Students submit their final response.

Feedback
Authentication strategies
• The teacher will provide 10 hours of class time for task completion.
• Students will each produce a unique response by using individualised data and producing individualised plans.
• Students will provide documentation of their progress at checkpoints during class time and email two progress updates to their teacher (progress updates will not be marked or annotated by teacher).
• Students will use plagiarism-detection software at submission of the response.
• Students must acknowledge all sources.
• Students must submit a declaration of authenticity.
Scaffolding
The task-specific approach to problem-solving and modelling must be used (see next page).

Approach to problem-solving and mathematical modelling



In this task, you will plan the shortest route between four locations in Queensland, visiting each place exactly once and returning to where you started from.

Describe how you plan to solve the problem and document any appropriate assumptions, variables and observations, such as:

- the four different locations in Queensland, ensuring they allow you to travel a total distance greater than 3000 kilometres
- travel times for each mode of transport
- costs and availability of modes of transport
- accommodation and food costs.

Develop your solution from the assumptions and observations identified in Stage 1.

Apply previously learnt mathematical procedures, concepts and techniques to solve the problem. It is important that you demonstrate the highest level of mathematics you can achieve by including:

- calculations of speed, distance and/or time using the formula speed = $\frac{\text{distance}}{\text{time}}$, and costs for the journey using distances estimated from scales on maps
- interpretations of timetables
- a budget
- an accurate and appropriate use of technology, including online calculators and travel planning websites.

Review the itinerary for your trip, ensuring it lists the day-to-day plan for the route and includes the travel times and cost estimations for transportation, accommodation and food.

Is your solution a reasonable and valid response?

- Evaluate your results and make a judgment about your response.
- Document the strengths and limitations of your solution.
- Show how the itinerary ensures that the budgetary, overnight stay and minimum travel time requirements have been met (make refinements if necessary).
- Show working to support how the order of travel to the locations has minimised the time travelled.

Justify all decisions made.

Communicate using appropriate language. Refer to the calculations you included in previous sections. Your plan should be communicated clearly and concisely, and include an introduction, body and conclusion. Include headings and, if appropriate, an appendix at the end of the plan.

Ensure you have:

- used appropriate technical vocabulary, procedural vocabulary and conventions, without spelling and grammatical errors
- written a conclusion that discusses your results
- summarised your overall plan.