Specialist Mathematics 2019 v1.2

Unit 1 Topic 1 sample assessment instrument

May 2021

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 Unit 1 Topic 1
2. comprehend mathematical concepts and techniques drawn from Unit 1 Topic 1
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 Unit 1 Topic 1.

Queensland Government | Queensland Curriculum & Assessment Authority

For all Queensland schools

210394

Subject	Specialist Mathematics		
Technique	Problem-solving and modelling task		
Unit	1: Combinatorics, vectors and proof		
Topic	1: Combinatorics		
Conditions			
Duration	4 weeks (including 3 hours of class time)		
Mode	Written report	**Length**	Up to 10 pages, maximum 2000 words, excluding appendixes
Individual/group	Individual responses	**Other**	–
Resources available	The use of technology is required, e.g. • computer • internet • spreadsheet program • graphics calculator • other software.		

Context

In 1870, Mark Twain wrote a humorous story called 'Science vs. Luck' about a gambler accused of illegal involvement in a 'game of chance'. The gambler later escaped punishment by 'proving' that his gambling game was in fact a 'game of science' based on his understanding of mathematics rather than just luck.

These days, gambling is often portrayed as a source of entertainment and an opportunity to gain quick financial rewards. However, while the mathematical probabilities and associated rewards of the 'winning outcomes' vary for each game of chance, the reality is that gambling odds always favour the long-term profitability of the gambling venue or 'house'. Many long-term players have difficulty limiting the amount of money and time they spend gambling. This can harm the individual, their family and friends, and the wider community.

In Australia, the long-term expected return to the casino (the 'house edge') varies for each gambling activity as regulated by law. Electronic gaming machines ('pokies') are required to meet the regulation of a house edge of between 10% and 15%.[1]

[1]**Source:** Tasmanian Government, Department of Health and Human Services, *Know Your Odds*, 'The house edge', http://knowyourodds.net.au/house-edge.

Task

Your task is to design your own unique 'game of science', clearly outlining background information and rules. Your game design must be interesting enough to motivate people to play it.

Decide on at least three winning outcomes in your game from which a player can gain appropriate financial rewards commensurate with their relative probability of occurrence. Across these winning outcomes, you must:

- demonstrate an understanding of permutations and/or combinations calculations of the theoretical probabilities
- show evidence that you have applied the addition principle and multiplication principle.

Your game design must meet the required regulation of a house edge, as described in the context above, using the rule:

$$\text{House edge} = \frac{\text{expected return to the casino}}{\text{amount spent by gamblers}} \times 100\%$$

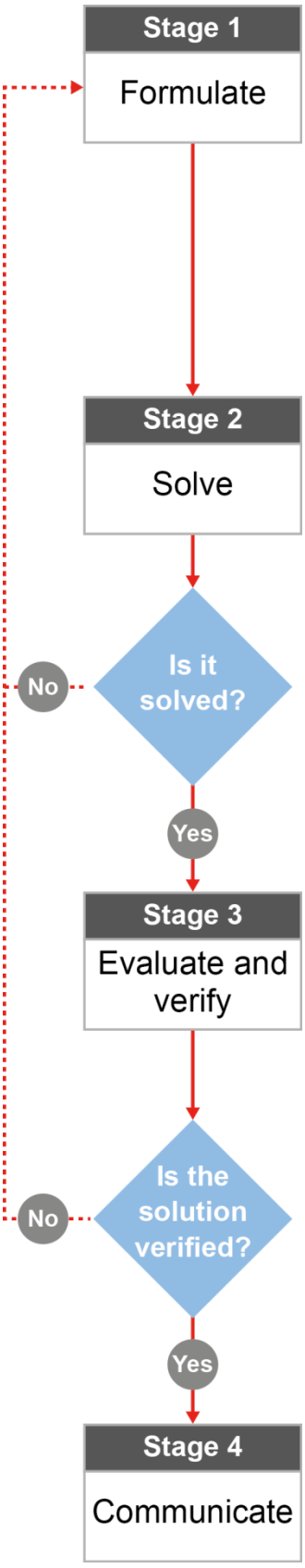
Simulate relevant observations of your game using technology. Compare the experimental results from your simulation against the theoretical probabilities associated with the winning outcomes of both the player and the house, and against the theoretical house edge.

To complete this task, you must:
• present your findings as an investigative report based on the approach to problem-solving and mathematical modelling outlined in the Specialist Mathematics syllabus and on page 4 of this instrument • develop a unique response.
Stimulus
–
Checkpoints
☐ One week after issue date: Students email evidence of their progress to their teacher.
☐ Two weeks after issue date: Students email evidence of their progress to their teacher.
☐ Three weeks after issue date: Students email a draft for feedback. A summary of feedback and advice is given to the whole class.
☐ Four weeks after issue date: Students submit their final response.

Criterion	Marks allocated	Result
Formulate Assessment objectives 1, 2, 5		
Solve Assessment objectives 1, 6		
Evaluate and verify Assessment objectives 4, 5		
Communicate Assessment objective 3		
Total		

Authentication strategies
• Students will each produce a unique response by using individualised data and producing unique reports.
• Students will provide documentation of their progress at the checkpoints.
• Students will use plagiarism-detection software at submission of the response.
• Students must submit a declaration of authenticity.
Scaffolding
The approach to problem-solving and modelling on the following page must be used.

Approach to problem-solving and mathematical modelling



Design a plan that outlines how you will implement all the requirements of the task. Your report should include:

- identification of the mathematical procedures, concepts and techniques — particularly those related to combinatorics, which are to be used in developing your theoretical probabilities, house edge calculation and game simulation
- documentation of the relevant observations from your simulations
- statement of variables used and documentation of appropriate assumptions relevant to the solution of the task
- explanation of the intended use of technology to simulate the game.

Determine a solution based on the required elements of the task. Your report should include:

- selection and application of appropriate mathematical procedures, concepts and techniques from the Combinatorics topic that will enable you to calculate the theoretical probabilities for
  - at least three winning outcomes for the player
  - the winning outcome for the house
  - the house edge for your game
- consideration of the complexity of your mathematical procedures to reach a result that complies with the required regulation of the house edge
- development of a suitable digital tool to simulate the game and subsequent use of relevant observations to determine the corresponding experimental probabilities for all winning outcomes and the house edge.

Evaluate and verify the reasonableness of your solution through:

- use of statistical measures to compare the relative frequency calculations from your game simulation observations against the calculations for each of the theoretical probabilities for winning outcomes and the house edge
- justification of the decisions made in the development (including any refinement) of your solution using mathematical reasoning
- review of the reasonableness of your solutions by considering the results, assumptions and observations
- consideration of relevant strengths and limitations, e.g.
  - to what extent does your model fulfil its intended purpose?
  - how well do your simulations agree with your model?
  - can your model easily be applied to other games?
  - how have your assumptions affected the results of your model?
  - are there any conditions under which your model doesn't accurately model your game?

The following aspects should be evident in the communication of your report:

- systematic, coherent and concise communication of your findings using mathematical, statistical and everyday language and conventions
- inclusion of a suitable introduction, body and conclusion which can be read independently of the task sheet
- conclusions that discuss the key results of your solution
- consideration of the strengths and limitations of your solution and/or game design.