Unpacking the Engineering subject report 2021

External assessment

220579

Long time ago by Kargun Fogarty

Presenters

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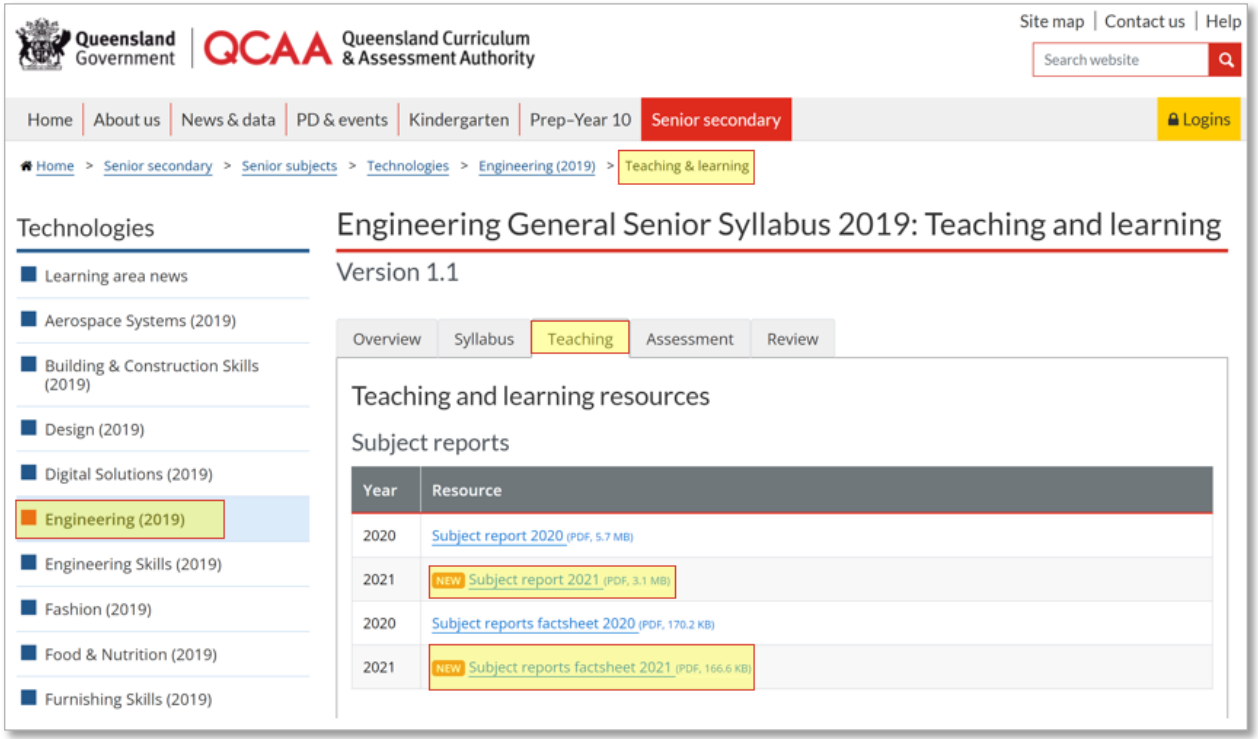
Learning goals

Learn how to use the QCAA Engineering subject report to inform teaching and assessment practice.

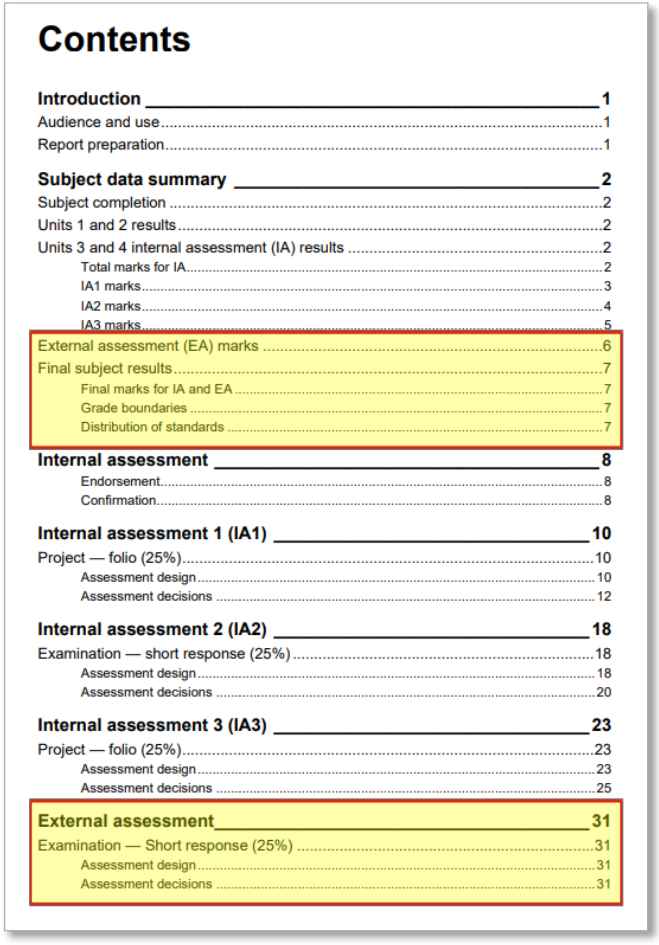
Success criteria

You will know you are successful if you can reflect purposefully on the information provided in the subject report to determine how you can improve your school's support for external assessment in Engineering.

Locating the subject report



Sections



Contents

The purpose of the subject report

2021 summative assessment cycle key outcomes:

- Quality assurance: Endorsement and Confirmation
- External assessment results

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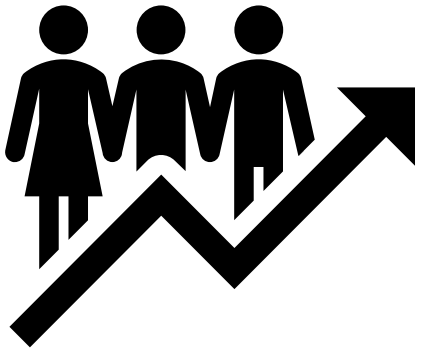
- Effective practices and practices to strengthen
  - Internal assessment
    - Assessment design (Validity, Accessibility)
    - Assessment decisions (Reliability)
  - External assessment
    - Teaching and learning



Structure of the webinar

CELEBRATE

UNPACK

DISCUSS
REFLECT

STRENGTHEN

QUESTIONS

Subject data summary

Subject progress

Year	2020	2021
Growth of Year 12 cohort (+104)	1255	1359
Number of students achieving an A standard (+95)	168	263
Number of students achieving a B standard (+60)	386	446
Number of students achieving a C standard (–36)	576	540

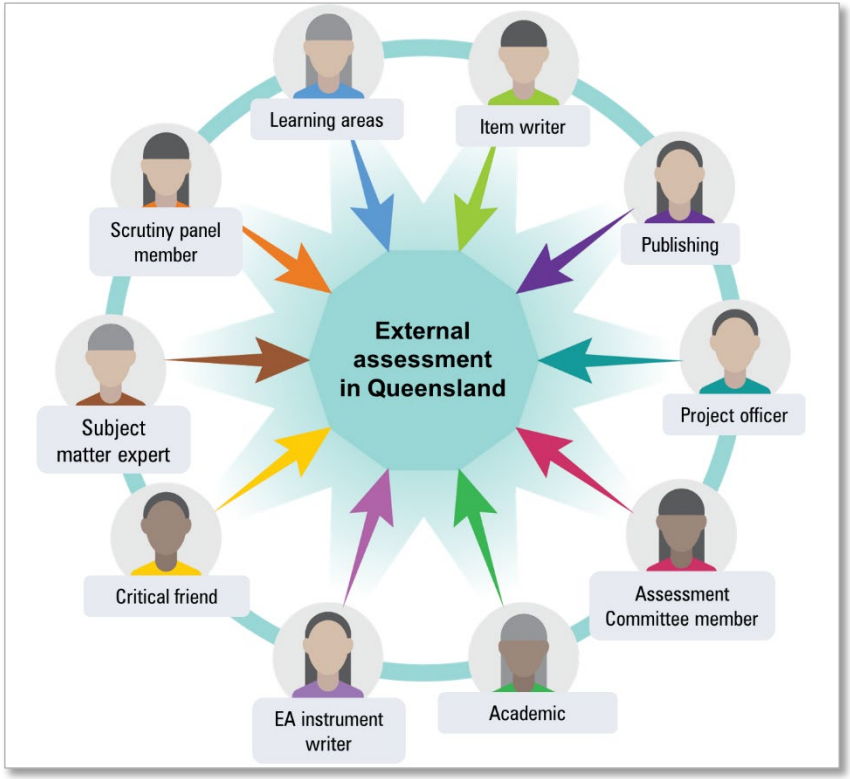
Engineering is a growing subject with a larger number of students achieving an A standard in 2021.

What improvements have you seen at your school?

What impact has external assessment had on the subject and students?

Subject report reference: page 7

External assessment in Queensland



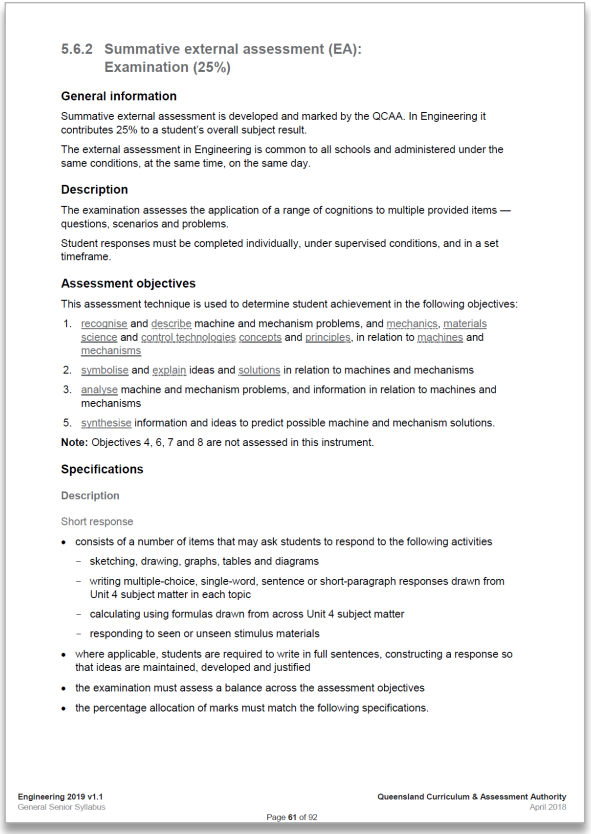
Structure of external assessment — Engineering

Assesses objectives 1, 2, 3 and 5:

- recognise and describe
- symbolise and explain
- analyse
- synthesise

Does not assess objectives 4, 6, 7 and 8:

- determine
- generate
- evaluate and refine
- communicate



5.6.2 Summative external assessment (EA): Examination (25%)

General information

Summative external assessment is developed and marked by the QCAA. In Engineering it contributes 25% to a student's overall subject result.

The external assessment in Engineering is common to all schools and administered under the same conditions, at the same time, on the same day.

Description

The examination assesses the application of a range of cognitions to multiple provided items — questions, scenarios and problems.

Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Assessment objectives

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

1. recognise and describe machine and mechanism problems, and mechanics, materials science and control technologies concepts and principles, in relation to machines and mechanisms
2. symbolise and explain ideas and solutions in relation to machines and mechanisms
3. analyse machine and mechanism problems, and information in relation to machines and mechanisms
5. synthesise information and ideas to predict possible machine and mechanism solutions.

Note: Objectives 4, 6, 7 and 8 are not assessed in this instrument.

Specifications

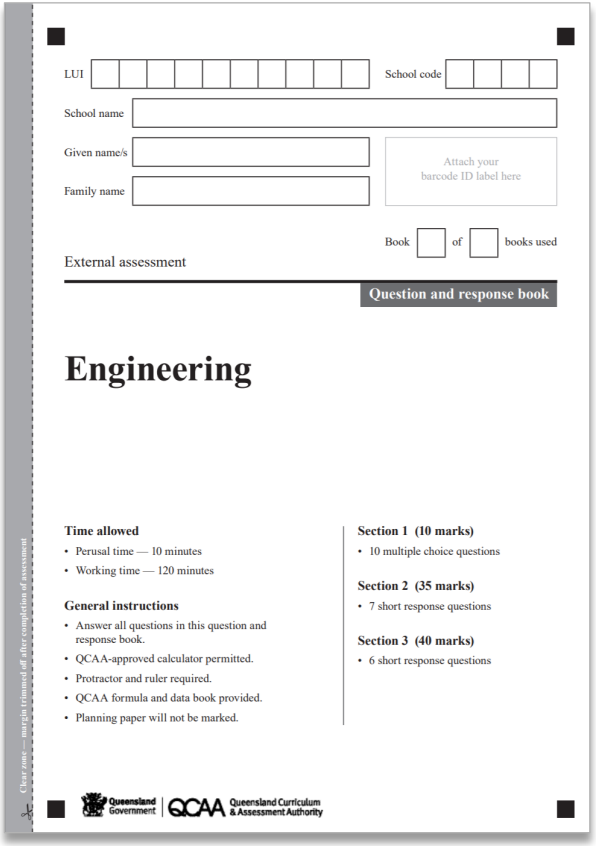
Description

Short response

- consists of a number of items that may ask students to respond to the following activities
  - sketching, drawing, graphs, tables and diagrams
  - writing multiple-choice, single-word, sentence or short-paragraph responses drawn from Unit 4 subject matter in each topic
  - calculating using formulas drawn from across Unit 4 subject matter
  - responding to seen or unseen stimulus materials
- where applicable, students are required to write in full sentences, constructing a response so that ideas are maintained, developed and justified
- the examination must assess a balance across the assessment objectives
- the percentage allocation of marks must match the following specifications.

Structure of external assessments

- Multiple-choice question book
- Question and response book
  - MCQ response space
  - Short response questions
- QCAA formula and data book



LUI

School code

School name

Given name/s

Family name

Attach your barcode ID label here

Book of books used

External assessment

Question and response book

Engineering

Time allowed
- Perusal time — 10 minutes
- Working time — 120 minutes

General instructions
- Answer all questions in this question and response book.
- QCAA-approved calculator permitted.
- Protractor and ruler required.
- QCAA formula and data book provided.
- Planning paper will not be marked.

Section 1 (10 marks)
- 10 multiple choice questions

Section 2 (35 marks)
- 7 short response questions

Section 3 (40 marks)
- 6 short response questions

Clear zone — margin trimmed off after completion of assessment

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

Subject matter addressed in 2021

Questions and stimulus were derived from the context of Unit 4 subject matter in:

- Topic 1: Machines in society
- Topic 2: Materials
- Topic 3: Machine control

What are your strategies for preparing students for the external short-response examination?

Do you teach Units 3 and 4 differently? If so, why?

Multiple choice

Question	A	B	C	D
1	9.08	4.43	23.04	**63.15**
2	9.53	**55.1**	24.52	10.04
3	**71.57**	16.54	9.75	1.85
4	9.23	25.41	**45.42**	19.13
5	6.87	**66.47**	11.82	14.48
6	8.27	12.85	**71.94**	6.72
7	14.55	11.74	15.21	**57.9**
8	4.06	2.14	7.09	**86.56**
9	18.83	5.76	**73.34**	1.7
10	**42.84**	14.4	19.65	22.9

Multiple choice — Practices to strengthen

What does the data indicate?

Some better performing students need more support in the areas of:

Topic 1: Questions 4, 5, 9

Topic 2: Questions 1, 3, 10

Topic 3: Question 2

Short response written — Effective practices

Questions 11–17

Overall, students responded well to the following assessment aspects:

- simple familiar and some complex familiar questions that required students to explain concepts, principles and situations using knowledge of mechanics, materials science and engineering technology knowledge subject matter
- simple familiar questions that required the use of Topic 3 subject matter knowledge to solve logic control problems where relationships and interactions were obvious and had few elements, and all the information to solve the problem was provided.

Short response written — Practices to strengthen

Questions 11–17

Overall, students require further support with the following assessment aspects:

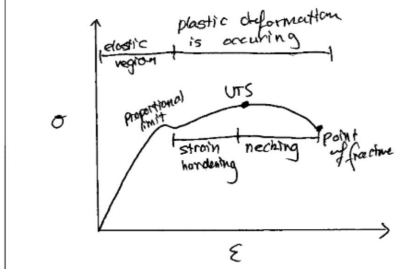
- responding to questions fully and accurately
- key features of stress–strain diagrams, e.g. Young's Modulus, toughness, ductility
- iron–carbon phase diagram (cast-iron section), e.g. the microstructure and how it changes for different percentages of carbon and temperatures.

What strategies do you use to prepare students for the external assessment short response written questions? e.g. analysing the question fully and understanding the type of response required, i.e. identify the cognitions.

Short-response written example

Question 14

Excerpt 1



Note: If you make a mistake in the sketch, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this question and response book.

Low carbon steel is a very soft and ductile material containing between 0.07 and 0.15 % Carbon. As a result it can endure a large quantity of strain after reaching it's proportional limit as shown on the graph. The tensile test of low carbon steel will observe a large quantity of kneching after the UTS has been reached which is an indicative property of a ductile material. Thus, based on the amount of deformation post proportional limit the tensile test can be used to determine it's ductility

Short-response written example

Question 16

Excerpt 1

Work is calculated by effort force exerted, multiplied by the distance the effort wheel must be moved. In this situation, the handle operated lifting arm provided a mechanical advantage. The velocity ratio supplied by the machine is $\frac{de}{dL}$, which is $\frac{1\,M}{\pi \times 0.25M} = \frac{4}{\pi} = 1.27$. Assuming 100% efficiency, $MA = VR = \frac{f_L}{f_E}$, so $f_E = \frac{f_L}{1.27}$. To lift the 98 N bucket, the effort force is $\frac{98}{1.27} = 76.97\ N$. Additionally, one revolution of handle A raises the bucket 0.785M, so 12.73 revolutions are required to lift the bucket 10m. So, work $= 76.97 \times 12.73 = 979.83$ Nm. Power is the rate at which work is done, so it is $\frac{work}{time} = 979.83/30 = 32.66W$. So, the power required is 32.66 W.

Short-response calculation — Effective practices

Questions 18–23

Overall, students responded well to the following assessment aspects:

- simple familiar calculation questions that required knowledge of Topic 1 and Topic 2 mechanics and materials science concepts and principles.

The subject report provides information for you to reflect on regarding teaching and learning. What is going well and what needs more attention?

What errors can be avoided through focused teaching and learning?

Short-response calculation — Practices to strengthen

Questions 18–23

Overall, students require further support with the following assessment aspects:

- application of Topic 1 knowledge in a range of complex familiar and complex unfamiliar engineering situations in relation to machines and mechanisms.

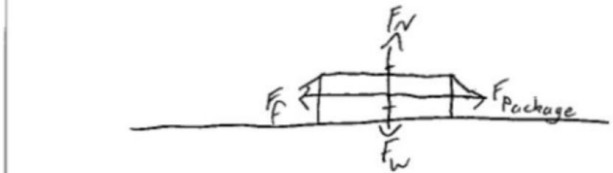
Complex unfamiliar questions: How do you prepare students for these types of questions?

What teaching strategies do you use to encourage students to attempt difficult questions?

Short-response calculation example

Question 19a)

Excerpt 1



Note: If you make a mistake in the diagram, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this question and response book.

$F_N = F_W$ ∴ 1N must have been applied to overcome F_f & make it move

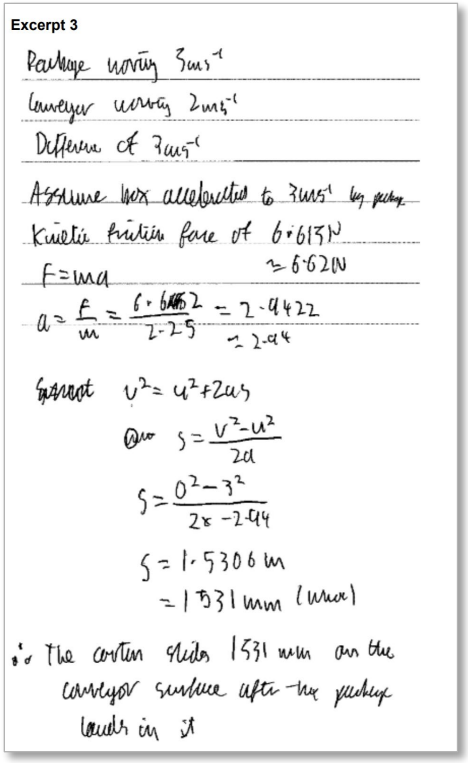
~~$= 2.25 \times 9.8$~~ 0.25×9.8

~~$= 22.05N$~~ $2.45N$

F_f ~~$= 8.82$~~ $= 0.98N$

Short-response calculation example

Question 19b)



Excerpt 3

Package moving $3 ms^{-1}$

Conveyor moving $2 ms^{-1}$

Difference of $3 ms^{-1}$

Assume box accelerated to $3 ms^{-1}$ by package

Kinetic friction force of $6.613 N$

$\approx 6.62 N$

$F = ma$

$a = \frac{F}{m} = \frac{6.613}{2.5} = 2.6452$

≈ 2.64

Suvat $v^2 = u^2 + 2as$

$s = \frac{v^2 - u^2}{2a}$

$s = \frac{0^2 - 3^2}{2 \times -2.64}$

$s = 1.5306 m$

$= 1531 mm$ (nearest)

∴ The carton slides 1531 mm on the conveyor surface after the package lands on it

Short-response calculation example

Question 23

Excerpt 1

Assume that 10m is the complete distance travelled and the box stops instantly:

$U = 0 m/s$
$V = ?$ →
$a = 2 m/s^2$
$t = ?$
$s = 10m$

$s = ut + \frac{1}{2}at^2$

$10 = \frac{1}{2}(2)(t^2)$

$t^2 = 10$

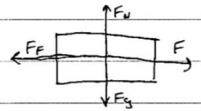
$t \approx 3.16\ s$

*Time reduced by 20%:

$T_F = 0.8\ T_I$

$= 0.8 \times 3.16$

≈ 2.53 s



$U = 0$
$V = ?$
$a = ?$
$t = 2.53s$
$s = 10m$

$s = ut + \frac{1}{2}at^2$

$10 = \frac{1}{2}(a)(2.53^2)$

$a \approx 3.12 m/s^2$

$F = ma$

$= 2 \times 3.12$

$\approx 6.25N$

$F_F = F$

$= 6.25N$

$F_g = 2 \times 9.8 = 19.6N$

$F_N = F_g$

$= 19.6N$

$F_F = \mu_s F_N$

$6.25 = \mu_s \times 19.6$

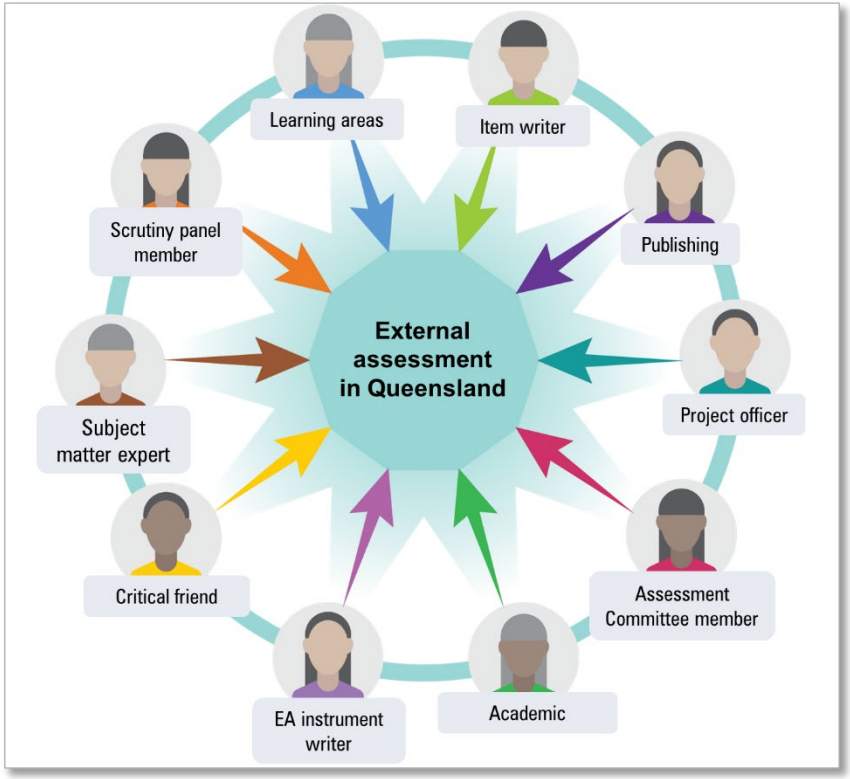
$\mu_s \approx 0.32$

Questions

Reflect on the strategies you use with your students to ensure that all short response questions are attempted.

Email questions to: engineering@qcaa.qld.edu.au

External assessment in Queensland



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