

NUMBAS for Chemistry – Adaptive Marking in Chemistry Practicals

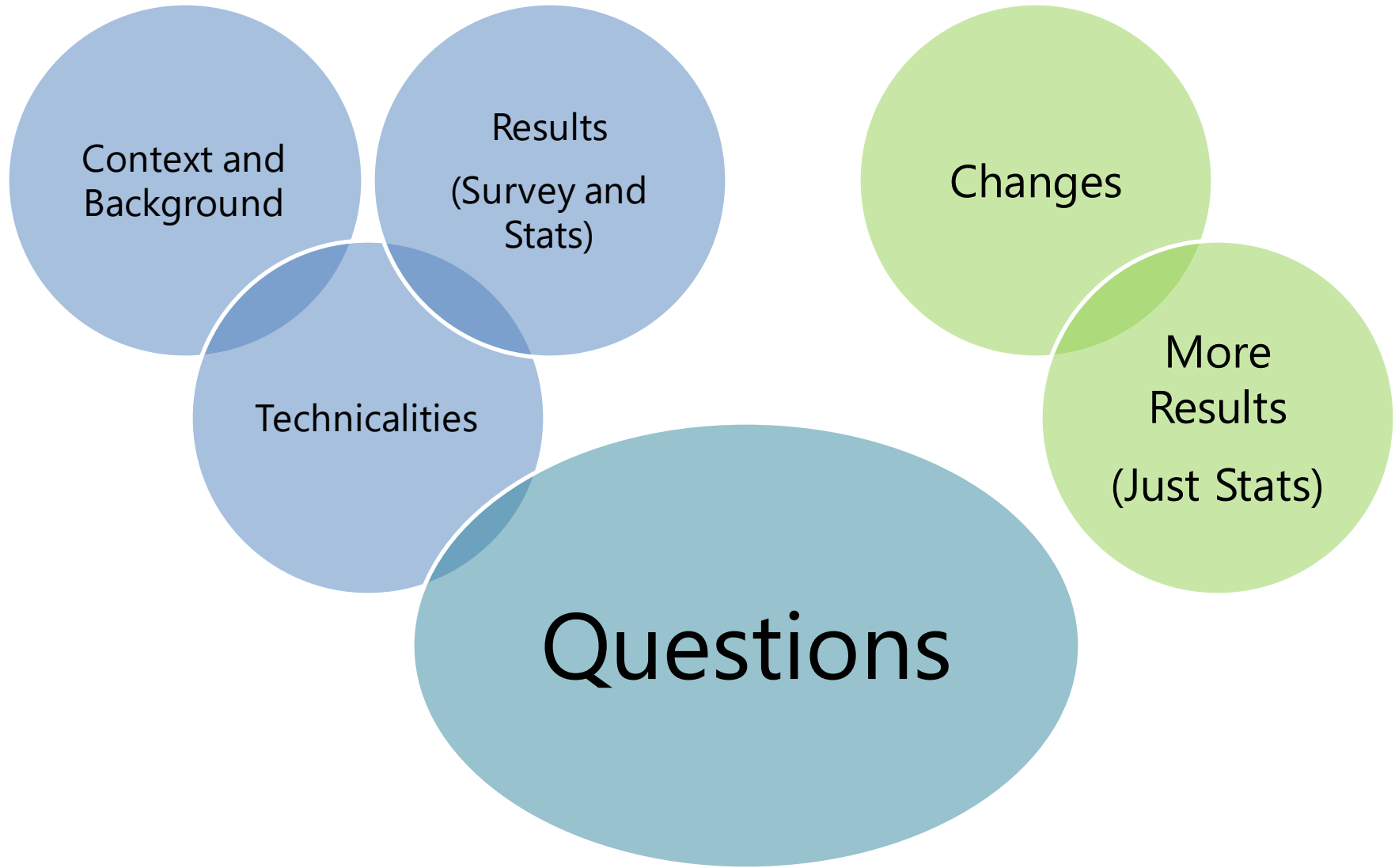
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Overview

Pre-covid

Post-covid



Introduction

- Student's might expect:



- In context:

- ... and many employers like it

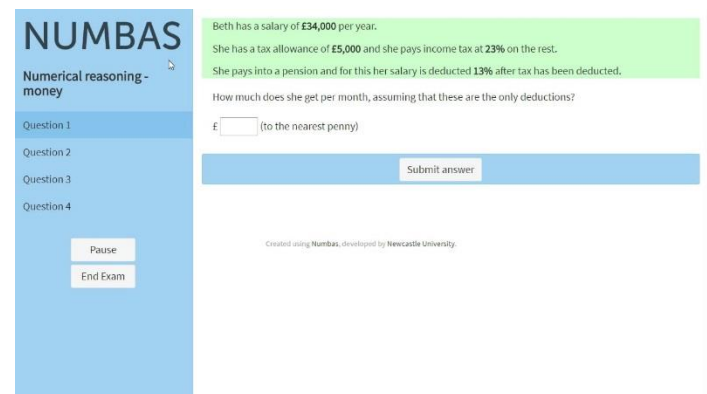
$$\textcircled{b} i) \nu = \frac{1}{2\pi} \sqrt{\frac{k}{m}} \quad \text{so} \quad (2\pi\nu)^2 m = k$$

$$\frac{(2\pi \times 6.424 \times 10^3)^2}{\text{s}^{-1}} \times 1.138 \times 10^{-26} \text{ kg} = 1854 \text{ N m}^{-1}$$

[As an aside, because $F = ma$ then $1 \text{ N} = 1 \text{ kg} \times 1 \text{ m s}^{-2}$ which accounts for the units used in the equation above]

Objectives

- Enhance chemistry students' numeric skills
- Boost students' confidence tackling challenging mathematical problems
- Generate practice questions and feedback that support learning cycles
- Develop skills in using NUMBAS to deal with all of the above



Methods

- **Number entry** and conventional questions (MCQ/Gapfill)
 - *Good interface and functionality (partial credit, visibility)*
- Improving **feedback**
 - *Quick Turnaround, <1 week, quick feedback*
 - **“Fair”** marking – no errors, consistency (vs. multiple markers)
 - *Data as variables – mistakes become calculation errors*
 - *Feedback tailored to focus on needs*



Adaptive Marking

- Adaptive marking

Data Entry

Mass of the sphere (6 s.f.): $m =$ g

Average volume of the sphere (2 s.f.): $=$ $cm^3 =$ dm^3

Calculations

Using the averaged volume of the inner sphere and its mass, determine the density and the radius of the sphere. Refer to the equations given in the lab manual.

Density of the sphere (4 s.f.): $d =$ g/dm^3

Given $V = \frac{4}{3}\pi r^3$, radius of the sphere (4 s.f.): $r =$ cm

[Click to edit](#)

Marking settings

Marking algorithm

Scripts

Adaptive marking

To account for errors made by the student in earlier calculations, replace question variables with answers to earlier parts.

Variable	Answer to use	Must be answered?
<input type="text" value="Vsphere1"/>	<input type="text" value="sphere_volume"/>	<input checked="" type="checkbox"/>

[+ Add another replacement](#)

Variable replacement strategy

Penalty when adaptive mark Marking settings

To account for errors made by the student in earlier calculations, replace question variables with answers to earlier parts.

Marking algorithm

Scripts

Adaptive marking

Variable	Answer to use	Must be answered?
<input type="text" value="msphere"/>	<input type="text" value="sphere_mass"/>	<input checked="" type="checkbox"/>
<input type="text" value="Vsphere2"/>	<input type="text" value="sphere_volume_dm3"/>	<input checked="" type="checkbox"/>

[+ Add another replacement](#)

Variable replacement strategy

Penalty when adaptive marking is used

Precision

- $\pm 2\%$ - rounding
- 50% mark penalty for s.f.

sphere_radius Number entry

Copy this gap Delete this gap

Marking settings

Marking algorithm

Scripts

Adaptive marking

Marks 0.5

Minimum accepted value $\text{rsphere} - (\text{rsphere}/50)$

Maximum accepted value $\text{rsphere} + (\text{rsphere}/50)$

Show correct answer on reveal?

Show score feedback icon?

Advanced settings

Precision restriction Significant figures

Significant figures 4

Require trailing zeros?

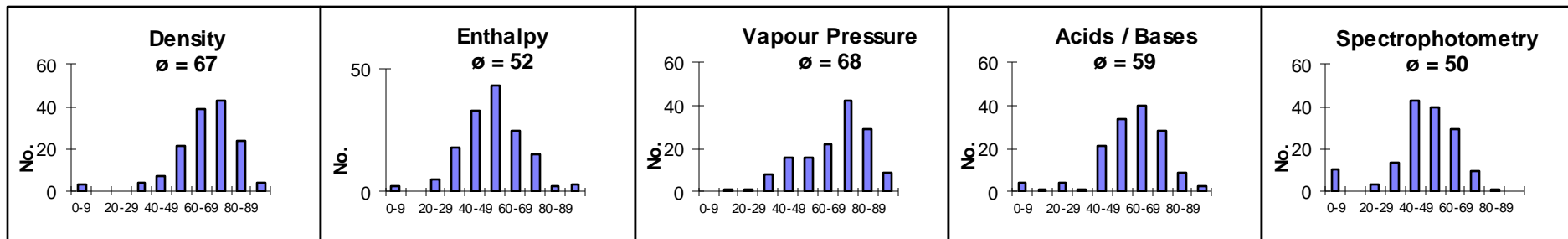
Show precision restriction hint?

Partial credit for wrong precision 50%

Initial Statistics (2018 and 2019)

- Comparatively low N/A rates (~3%)
- Considerable fail rates by experiment (up to 15%)
 - ~5% lab component fail
- Discrimination of marks
- Individual question evaluation

2018



2019

$\bar{x} = 73$

$\bar{x} = 61$

$\bar{x} = 71$

$\bar{x} = 66$

$\bar{x} = 58$

Pilot Survey 2018

- Quantitative: $n \sim 60$, Qualitative: $n \sim 35$
 - Relatively clear connection between learning activity and assessment
 - More guidance when completing assessment – use formatively?
 - Learning most from **using** equations
 - Students didn't trust the algorithm



Evolution

- **Pre-covid**

- **2018-19:** Introduction, 5 summative tests - 20% of 20c module = total 4c
 - Graph submission (20%), Notebook record (10%) and NUMBAS score (70%)
- **2019-20:** correct mistakes, generate new ones (adaptive marking)

- **Covid-affected**

- **2020-21:** No laboratory work, videos and LabSims (LS) – switch to **random**
 - P/F tests with randomised variables as data to ensure continuous engagement (part of “skills record”)
 - Final summative test using randomised variables for data
- **2021-22:** mix and match
 - 2019 resources with **adaptive** marking
 - 2020 **randomised** data summative assessment (20% of 20c module)
 - [2020 P/F resources for non-attendees (PEC)]

Statistics: Summative assessment (2020 and 2021)

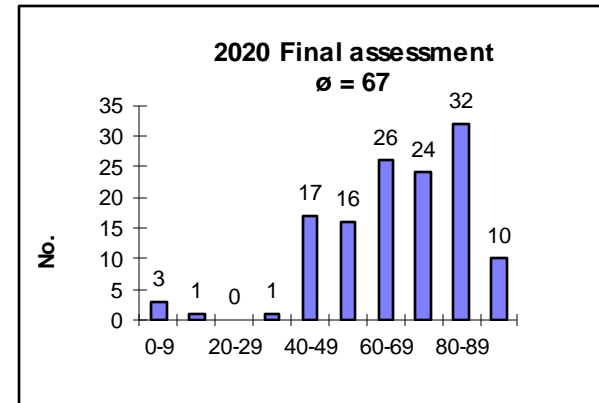
- 2020 (no labs, all online)

- Late submissions: 8.4%



- No submission: 2.3%

- Fail: 1.5%

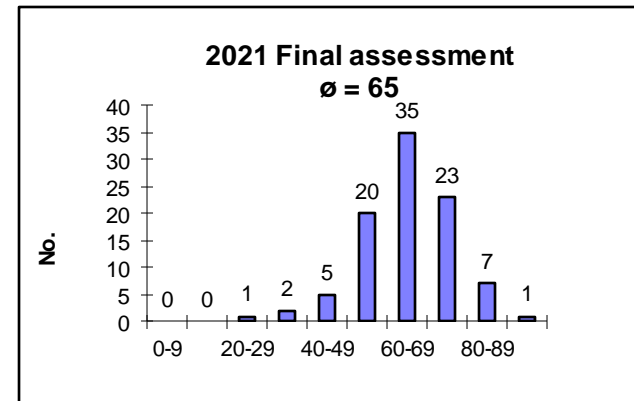


- 2021 (labs in person)

- No late submission

- No submission: 5.1%

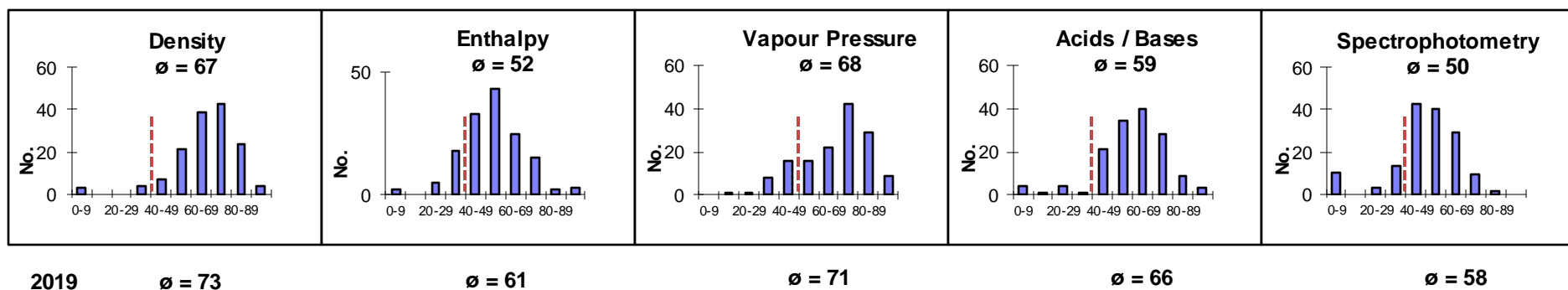
- Fail: 3.1%



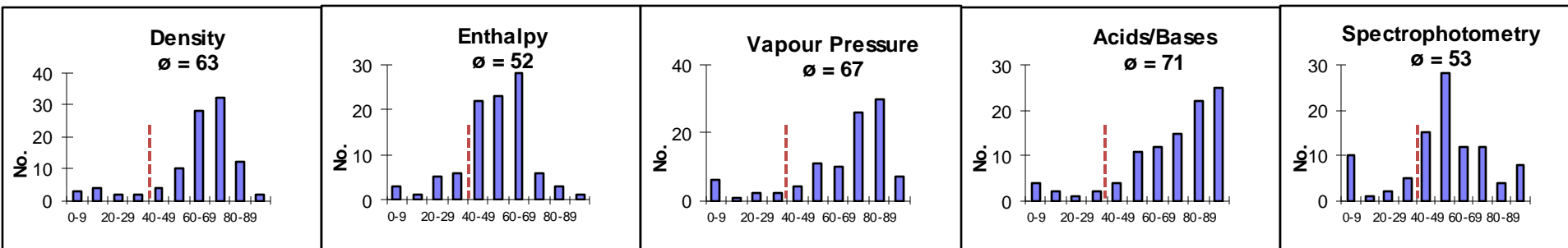
Statistics: Experiments (2020 and 2021)

- Previous data

2018



- 2021 (shorter, some challenging questions removed)



Questions

