

# Student reaction to a modified concept inventory

Sally Jordan, Mark Parker, Holly Hedgeland and Nick Braithwaite.

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# Acknowledgements



David Sands

Ross Galloway

Christine Leach

Usability lab participants



# Background

- PhD project: “Establishing Physics Concept Inventories Using Free-Text Questions”
- Adapted the Force Concept Inventory (FCI) [1] to include a range of question types, not just multiple-choice.
- Did this to address criticisms over reliance of concept inventories on multiple-choice questions [2]

# An example of a change to a question

## Original question

### Question 1 Not yet answered

Marked out of 1.00 |  Flag question |  Edit question

Two metal balls are the same size but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same instant of time. The time it takes the balls to reach the ground below will be:



Select one:

- A. about half as long for the heavier ball as for the lighter one.
- B. about half as long for the lighter ball as for the heavier one.
- C. about the same for both balls.
- D. considerably less for the heavier ball, but not necessarily half as long.
- E. considerably less for the lighter ball, but not necessarily half as long.

# An example of a change to a question

Current version of the question

## Question 1 Not yet answered

Marked out of 1.00 |  Flag question |  Edit question

Two metal balls are the same size but Ball A weighs twice as much as Ball B. The balls are [Test this question](#) dropped from the roof of a single storey building at the same instant of time. Which ball, if either, will hit the ground first?

Answer:

## Background cont.

- Otherwise, as few changes to the FCI were made as possible.
- Some questions were unchanged.
- Usual mode of operation remained i.e. for use as pre- and post-test, no feedback to students.

# Development of the project of the whole

- Questions written using Moodle “Pattern Match” which automatically marks responses of up to 20 words.
- For accurate marking, iterative rule-generation based on real student responses is required.
- At the same time, we were keen to find out about user reaction to an instrument of this type.

# Usability lab

## Formal usability testing

- OU usability lab used for the next level of testing.
- 8 participants recruited; 4 OU undergrads, and 4 OU post-grads.
- Participants were filmed as they worked through the quiz. Semi-structured interview followed, also recorded.



# Thematic analysis strategy

## Qualitative analysis strategy used

- Thematic analysis was chosen as underlying themes were sought.
- Version chosen is outlined by University of Auckland [3], and has 6 steps.

# Thematic analysis strategy

## Qualitative analysis strategy used

- Familiarization with the data: Organise, transcribe and read the data.
- Coding/Tagging: Labels are assigned to identify key features of the data set.
- Search for themes: Tags collected under broader themes of the data.

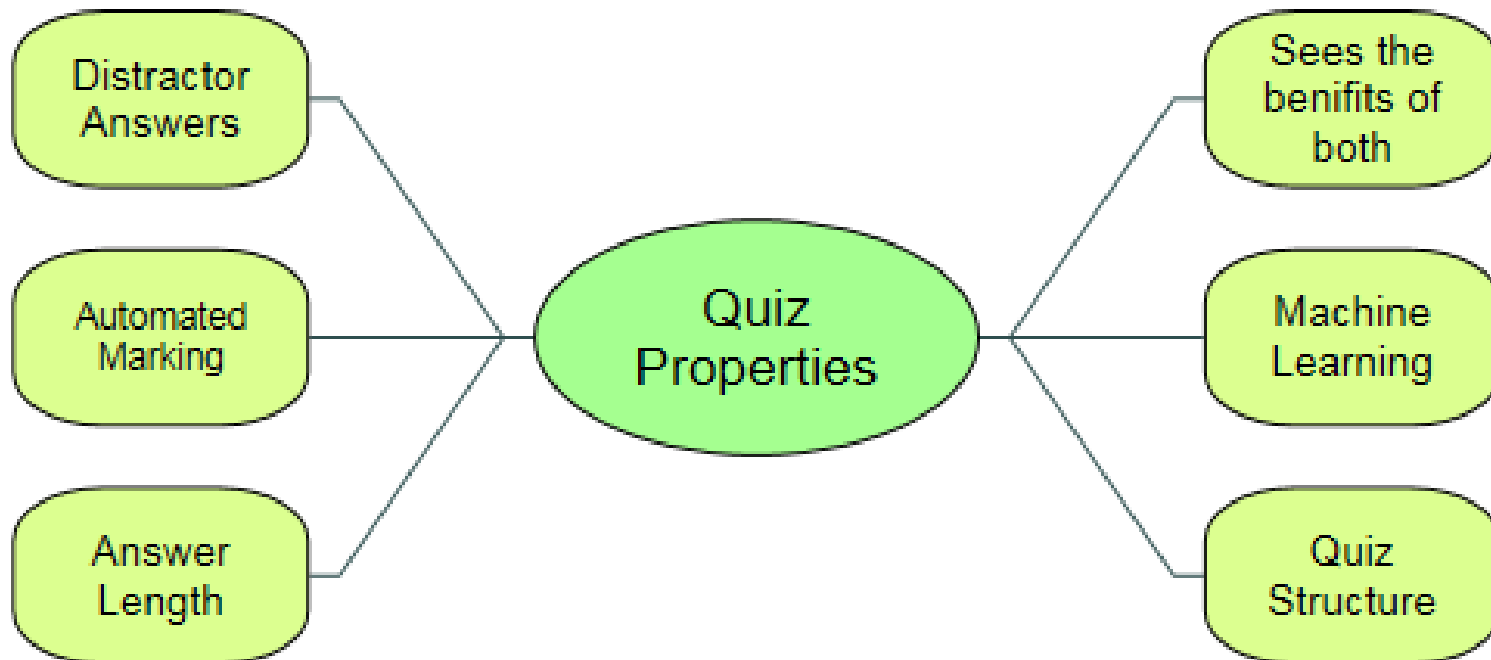
# Thematic analysis strategy

## Qualitative analysis strategy used

- Reviewing themes: Are the identified themes viable?
- Defining and naming themes: Themes are finalised and analysed in-depth.
- Writing up: Everything is put together into a cohesive narrative.

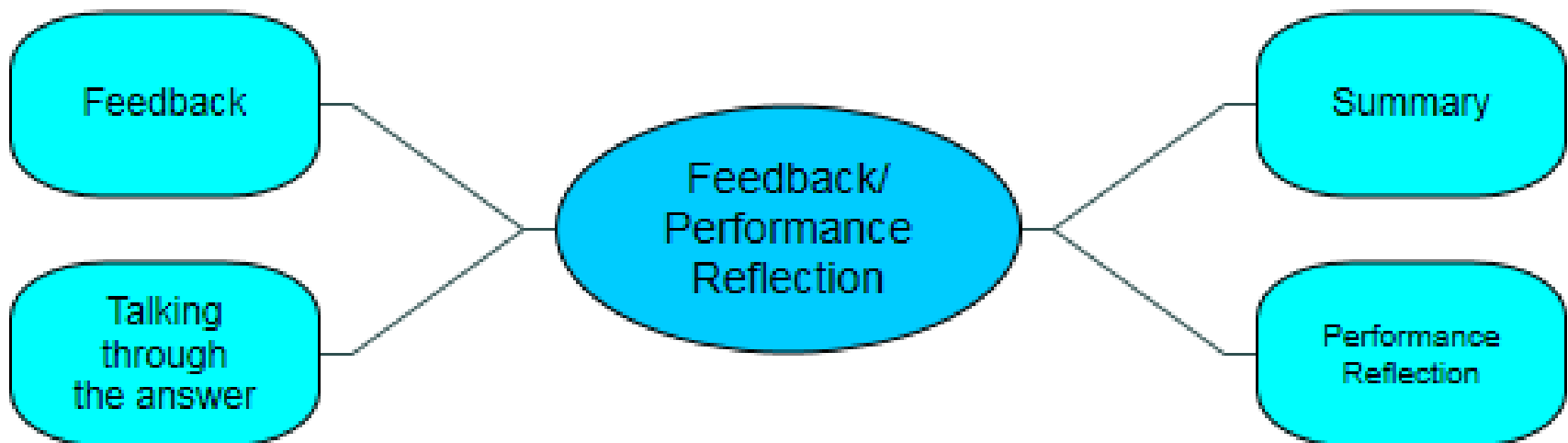
# Findings: At a glance

Tags associated with each theme



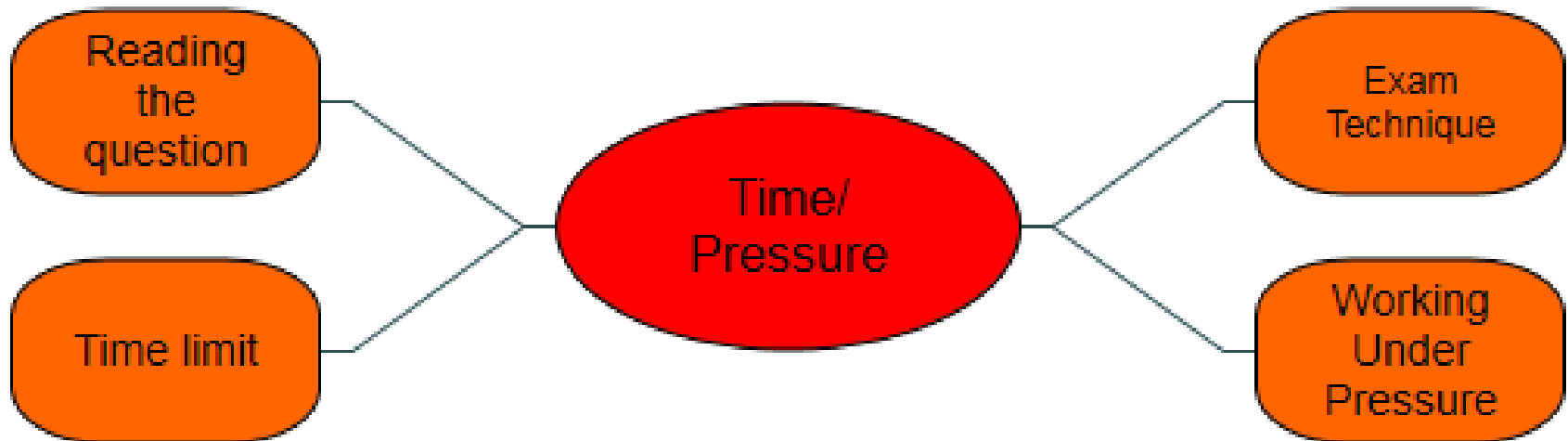
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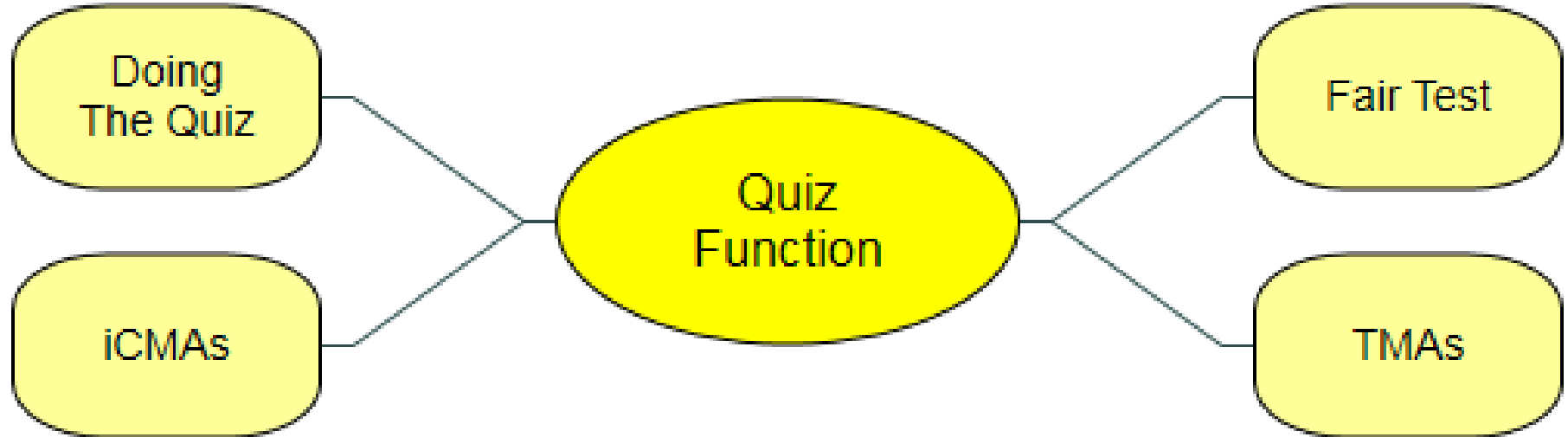
# Findings: At a glance

Tags associated with each theme



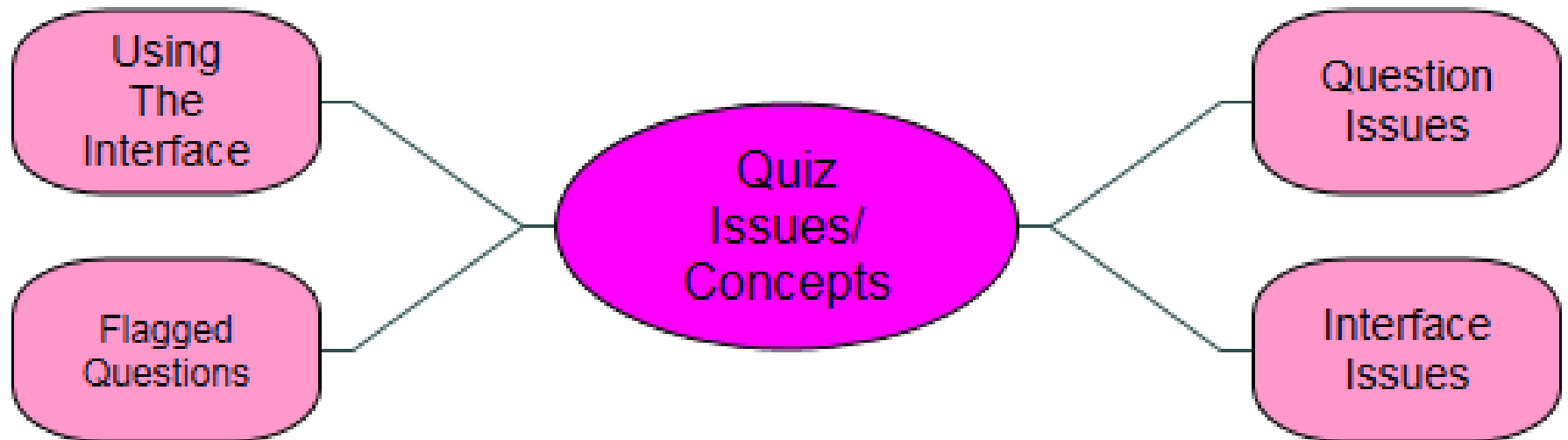
# Findings: At a glance

Tags associated with each theme



# Findings: At a glance

Tags associated with each theme





# Findings: Quiz properties

- Answers of a few words sufficient for the free-text answers, but participants had answers of varying lengths.
- Participants tended to write answers of sufficient detail, and some likened the thought process to that used when writing tutor-marked assignment answers.
- Multiple-choice questions were seen as easier than free-text questions.

# Findings: Quiz properties

- Using distractors to draw students into giving an incorrect answer was seen as an unfair way of making the questions harder.
- Free-text questions gave students the chance to express the answer in their own words; this required them to think more.
- Question wording was seen as inconsistent in its treatment of air resistance and other frictional forces.

# Findings: Feedback

# Findings: Feedback

- Participants in general liked getting feedback when doing the quiz.
- Views on how much feedback should be given varied. Some thought that being told whether you were right or wrong was sufficient. Some thought that a detailed model answer should be given.
- The detail of feedback was also thought to depend on what the purpose of the quiz was.

# Conclusions and future work

## What next for the project?

- Responses to the quiz have been collected from roughly 300 university students and high school students. These can be used quantitatively to look for patterns in the responses, and to check the accuracy of the marking rules.
- A draft general relativity concept inventory (GRCI) has been assembled, and the questions are in the process of being tested.

# References

## References mentioned in the presentation

- [1] Hestenes, D., Wells, M., Swackhamer, G. (1992) 'Force concept inventory', *The Physics Teacher*, vol. 30, pp. 141-158.
- [2] Rebello, N., Zollman, D. (2004) 'The effect of distractors on student performance on the force concept inventory', *American Journal of Physics*, vol. 72.

# References

References mentioned in the presentation

- [3] University of Auckland (2017). Available at <https://www.psych.auckland.ac.nz/en/about/our-research/research-groups/thematic-analysis/about-thematic-analysis.html> (Accessed 24th July 2017).