

# Authentic Assessment in STEM

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## Abstract

Recent years have seen debate forming around 'authentic assessment' in schools and universities, broadly defined as assessment practice that relates to what students experience in the real world. This poster introduces the concept of authentic assessment with reference to pedagogical literature, and explores the guiding principles that underpin assessment design. Authentic assessment can play an important role in enhancing students' employability, as well as the overall student experience, by moving assessment practice away from contrived examples involving recall of information towards student-centred activities linked to real-life application – highlighted by examples drawn from a range of STEM disciplines from across the Faculty of Science.

## Introduction to Authentic Assessment

Traditional models of assessment are often characterised by standardised testing, used in a summative way to test for knowledge and low-level cognitive skill acquisition (Gulikers, Bastiaens and Kirschner, 2004). However, the Higher Education sector is under increasing pressure to provide skilled graduates, ready to enter the workplace and capable of meeting twenty-first century challenges with thoughtfulness and creativity. This has been emphasised by a new skills agenda (European Commission, 2017) and employability is now recognised as a key metric within the Teaching Excellence Framework. As such, new pedagogical approaches are necessary in order to shift the focus of learning away from factual knowledge and towards higher-order thinking processes and competencies.

In order to assess higher-order thinking it is necessary for students to demonstrate application of knowledge, as well analytical skills and creativity. These are difficult to capture by traditional assessment methods and attempts to do so often result in synthetic or contrived examples, which are often just rote bookwork problems masquerading as knowledge application. Conversely, authentic assessment tends to focus on contextualised tasks, enabling students to demonstrate their competency in a more realistic or 'authentic' setting. According to Ormiston (2011), "authentic learning mirrors the tasks and problem solving that are required in the reality outside of school" (pp. 2-3).

Definitions of authentic assessment vary, though most agree that authentic assessment should be *high fidelity*, which is to say that there is congruence between the authentic task and the conditions under which it would normally occur in its typical practical application. Similarly, Savery and Duffy (1995) define authenticity as the similarity between the cognitive demands of the assessment and the situation upon which it is based.

Gulikers, Bastiaens and Kirschner (2004) propose a five dimensional framework for authentic assessment, based on: the task, physical (or virtual) context, social context, assessment outputs and assessment criteria. The following examples demonstrate elements of these five dimensions, while also contributing to students' development in other areas, which are often difficult to evidence in traditional assessment models.

## Acknowledgements

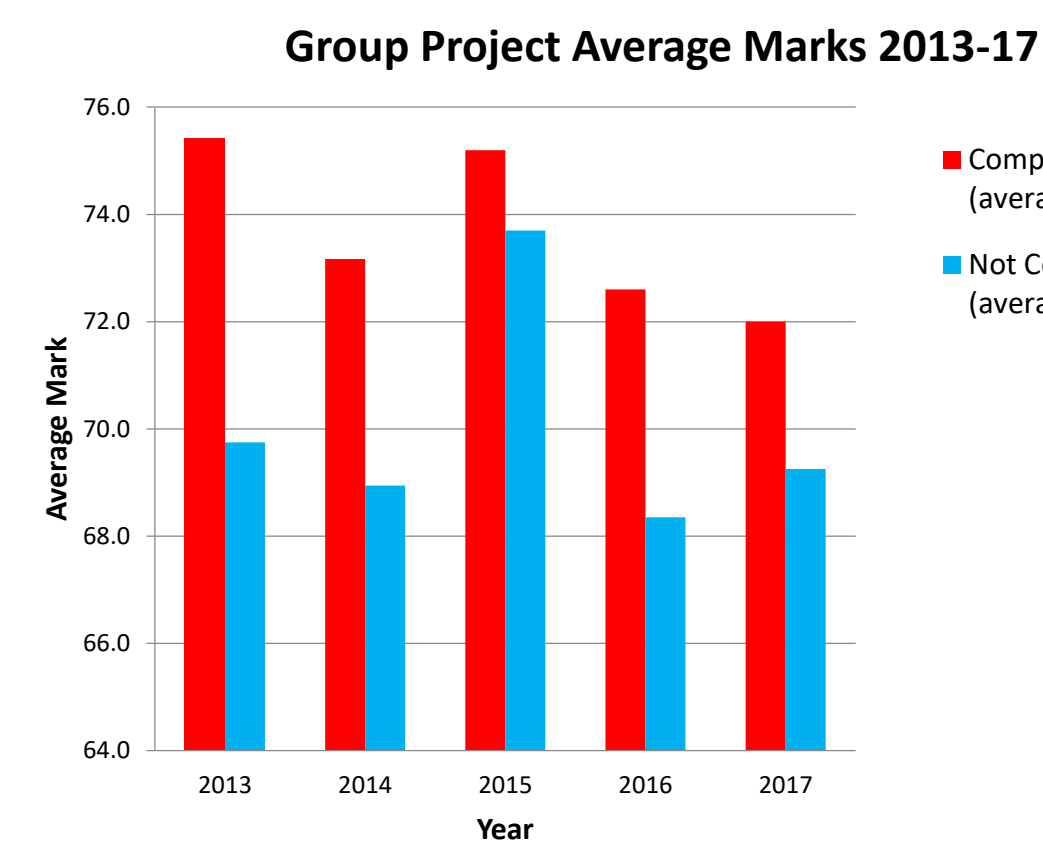
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## 1. Warwick Sub: Competitive Group Engineering Project

- Design and build a human-powered sub-marine according to ISR / eISR regulations
- Annual competition alternating between the US and Europe/UK



- Both events attract truly international competition, from countries as far afield as New Zealand, Canada, USA, Netherlands, Germany, Mexico and the UK



- Real-World experience of sponsors, outreach, media coverage
- Enhanced student engagement
- Paired t-testing suggests highly significant difference between average marks for competitive and non-competitive projects



Verena Oetzmann  
2016-17 Team Leader

"The lessons I have learnt throughout my time, coupled with the many skills procured along the way, have been invaluable as preparation for working life after university".

## 2. Structural Mechanics: From "Hard Sums" to Concepts

$$M = EI \frac{d^2y}{dz^2}$$

$$0 = \frac{wL}{2}z - \frac{wz^2}{2} - M$$

$$M = \frac{wLz}{2} - \frac{wz^2}{2}$$

Using  $M = -EI \frac{d^2y}{dz^2}$

$$\frac{wLz}{2} - \frac{wz^2}{2} = -EI \frac{d^2y}{dz^2}$$

$$-\frac{wLz^2}{4} + \frac{wz^3}{6} = EI \frac{dy}{dz} + A \quad (1)$$

$$-\frac{wLz^3}{12} + \frac{wz^4}{24} = EIy + Az + B \quad (2)$$

BCs: At  $z=0, y=0$  and at  $z=L, y=0$

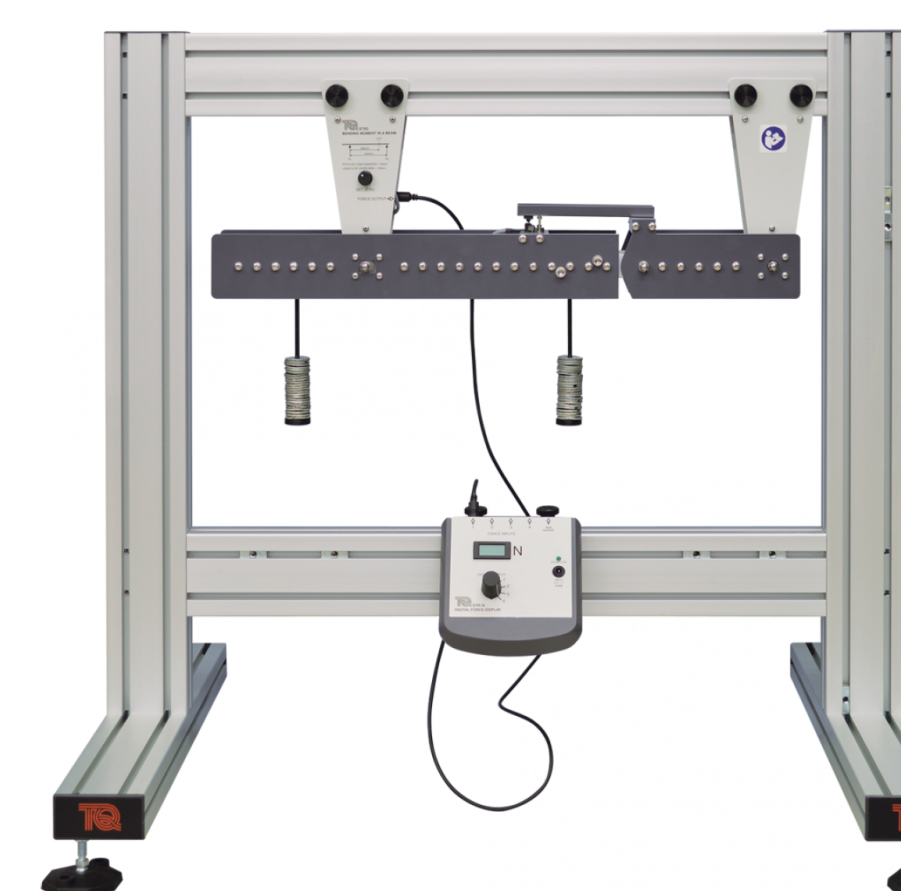
∴ From (2)  $B=0$   
From (1)  $A = \frac{wL^2}{24}$

∴ From (1) and (2)

$$\frac{dy}{dz} = \frac{w}{EI} \left[ \frac{z^2}{6} - \frac{Lz}{4} + \frac{wz^3}{24} \right]$$

$$y = \frac{wz}{24EI} \left[ L^3 - 2Lz^2 + z^3 \right]$$

- Structural mechanics traditionally assessed by "set-piece" calculations, as in the example (left)
- These are *never* undertaken in practice, except in early year university classes
- This approach tends to assess low-level algebra, rather than mechanics concepts and highlights only procedural errors in rote-learned processes
- Intellectual parts (highlighted) are better assessed by online tools and experimentation
- Allows breadth and depth of knowledge to be better assessed
- Reflects expertise needed in engineering practice
- Provides analytics data on student misconceptions and gaps in teaching



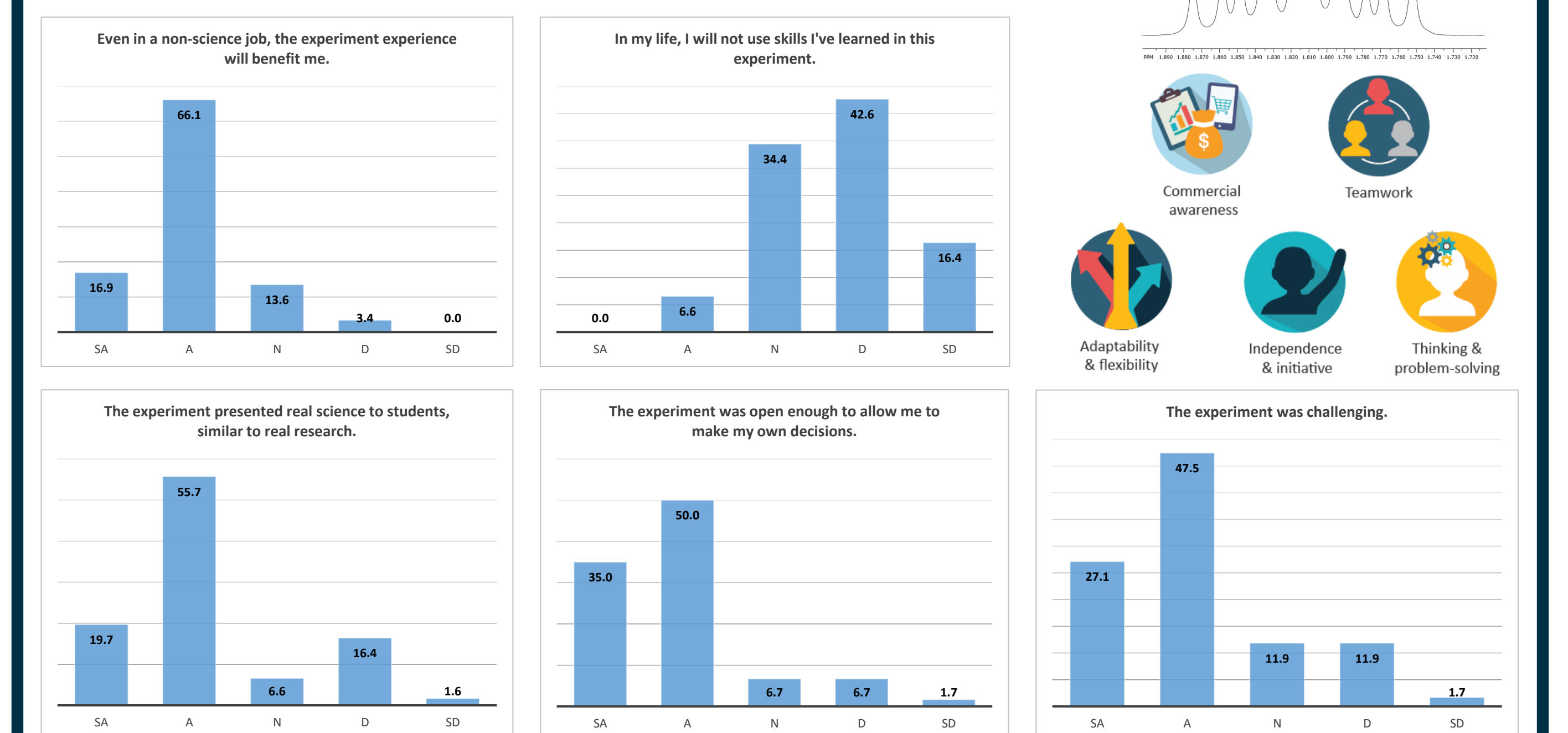
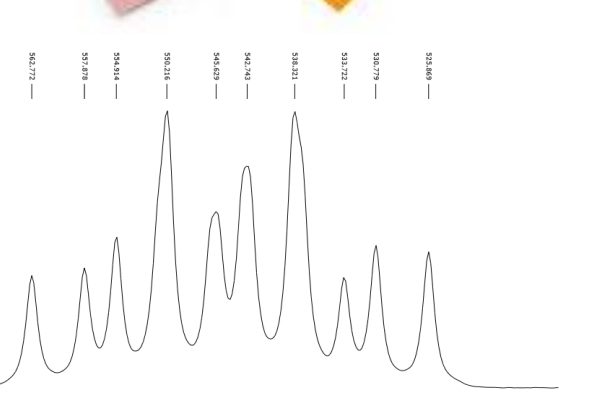
## 3. External Peer Review of Medical Device Engineering Projects

- Student project manuscripts sent to two expert external reviewers
- Reviewers invited to provide comments as if the manuscript was a journal submission
- Feedback from reviewers and module leader sent to students
- Students submit revised manuscript and response to reviewer comments
- Students have accurate feedback from three experts in the domain and the opportunity to meaningfully engage with it, while also experiencing authentic academic journal processes



## 4. Structure Elucidation Through Game-based Practical Experiments

- Incorporate a mock-business element in a game format
- Student teams assign themselves roles and make a business case for a "loan" to establish a business, characterising unknown compounds of varying complexity
- Correct identification of a compound yields money to reinvest, but most analytical techniques come at a price
- Student-led activity, developing business strategy while applying chemistry knowledge gained in spectroscopy labs



## References

European Commission, 2017. *A renewed EU agenda for higher education*, Brussels: European Commission.

Gulikers, J., Bastiaens, T. and Kirschner, P., 2004. A five-dimensional framework for authentic assessment. *Educational technology research and development*, 52(3), 67-86.

Ormiston, M., 2011. *Creating a Digital-Rich Classroom: Teaching & Learning in a Web 2.0 World*. Bloomington, IN: Solution Tree Press.

Savery, J. and Duffy, T., 1995. Problem based learning: An instructional model and its constructivist framework. *Educational Technology*, 35, 31-38.