

A Case in Point...

The use of a case scenario to enhance student engagement, theory of cellular respiration and Higher Order Thinking skills in preparation for transition from FE to HE.

Christine Challen, South Tyneside College, South Shields, UK

ABSTRACT

Cellular respiration has always been a difficult topic to teach; the subject is full of endlessly complex biochemical pathways and students often struggle to see their purpose and relevance. In this article I discuss the use of 'real-time' case scenarios to enhance the teaching of cellular respiration while also encouraging higher-order critical thinking skills and better preparation for the transition from further education to higher education for Access Level 3 students. This research shows that while the use of a case study can enhance engagement, relevance and teaching of theory, more work is required to prove this conclusively, including greater student feedback and example assessment grades, along with the provision of more time and deeper questioning techniques.

INTRODUCTION

The changes in adult education funding have undoubtedly brought many challenges, particularly in the further education (FE) sector. Five years ago the funding for adult education was paid directly to the provider. Now it has been diversified and comes through supporting apprenticeships and 'advanced learner loans to those between 19–23' (Skills Funding Agency 2016).

However, funding is not the only barrier facing adults in education. Other issues can impact, including confidence, lack of knowledge of what courses are available and, importantly,

where to get relevant advice as to what choice to make. Some of these adults may have part-time jobs/family and are worried about how they will juggle studying around them.

At College X, advice and guidance nights are available to advise prospective adult students of the courses available to those with GCSE grades or other qualifications. They are also told about subject content and the assessment assignments involved, so that they can judge and plan if they will be able to succeed in putting in the appropriate commitment to fully achieve the qualification.

KEYWORDS

CELLULAR RESPIRATION

CASE STUDIES; ENGAGEMENT

STUDENT AUTONOMY

CRITICAL THINKING

QUESTIONING TECHNIQUES

One of the many Level 3 (L3) courses that College X runs is the Access HE L3 (science pathway). This course mainly attracts mature students who have been out of education for a while and want to further their education; in particular some are keen to go on and progress to higher education (HE).

As with all stages and levels of education, adult education poses various challenges. Some of these include 'being positive, encouraging and patient', allowing time for students to answer the question and the need to 'avoid being condescending' (Promising EFA practices 2015). Polson (1993) describes in detail the characteristics of adult students,

and sets out the desirable implications for their teaching and learning. These include coursework that is relevant to employment or previous life experiences, the use of different strategies both theoretical and visual to embrace different reaction times, and the importance of being able to condense and break down complex problems into smaller and easier understandable ideas, thereby facilitating students who may struggle with classroom learning, otherwise known as 'the imposter syndrome'.

Interestingly, Polson also suggests the use of case studies based on situations that students have been confronted with either in employment or as 'real-time' scenarios.

I first used a case scenario, 'Mr Terrified's molar extraction' (MTME), when teaching first-year dental students carbohydrate metabolism. This was then extended to include Mr Terrified's daughters Sophia Sugarsnap and Molly Muffintop, to enhance the teaching of nutrition, with a colleague at Northumbria University, to first-year applied biology students. This technique allows one to embed employability skills in the curriculum, e.g. as a nutritionist part of your role will be to advise people of all ages about healthy diets and what comprises one, and the metabolic and biochemical effects of this on the body. This case scenario tackles these issues and their consequences, thereby mimicking the professional employment role, a driving force encouraged both in FE and HE.

The success of this experience, realised in both enhanced achievement results in the metabolism questions and student engagement as seen after using the case studies, compared with previous experience in the dental school and at Northumbria, inspired me to adapt and develop some of these scenarios to try and help FE students apply this theory to 'real-time' situations that they would be familiar with, eg a visit to the dentist and the effects of fear and fasting on the body's metabolism, as well as increasing

their ability to use higher-order/critical thinking skills and problem-solving skills, both of which are essential in HE.

The aim of this small action research project as defined by McNiff (2011), Davis, B. & Sumara, D. (2005) and Cook (2009) as part of my Postgraduate Certificate in Education (PGCE) was to ascertain whether the use of case studies enhanced the theory of teaching, engagement of students as well as encouraging higher-order thinking skills.

The Hypothesis; Does the use of case/scenario based problems enhance the teaching of cellular respiration through student engagement, autonomy and higher-order/critical thinking skills to improve transition from further education (FE) to higher education (HE).

Question: Does the use of case studies help to develop theory?

METHODOLOGY

The theory of cellular respiration/cellular metabolism is a very difficult and complex area of biology, renowned for being challenging to teach in an engaging and successful way. Whilst teaching in the dental school, we noticed that first-year students' assessment grades on carbohydrate metabolism were poor compared to other topics. To try and improve these achievement grades we introduced a 'real-time' case scenario, MTME. Following its introduction, some improvement was noted in the assessment grades on this topic.

While working at Northumbria University as a visiting/associate lecturer, a similar situation was brought to my attention by the module leader of the Applied Biology Nutrition course,. She had found that her students' exam results and achievement on metabolism and nutrition were consistently poor, and having tried different techniques to achieve some improvement it still needed additional work. I suggested she try a case study approach, and we developed MTME into a more suitable 'real-time' scenario for

her students, 'Molly Muffintop and Sophia Sugarsnap'; again some enhancement of assessment grades was noted.

Both these experiences were in HE, but I first experimented with case studies in an informal way whilst teaching cellular respiration to students at Sunderland College, when again this was found to enhance their theoretical understanding, as seen in a formative assessment exercise in class.

In view of this initial success in terms of students' understanding of theory, engagement and critical thinking skills, I decided to use this approach again, in a more formal and 'educational action research' setting, to teach L3 science pathway access students cellular respiration/metabolism as one of the learning outcomes in the organ systems unit which includes the digestive and respiratory systems. The scheme of learning and case scenario for this session are reproduced in Tables 1 and 2 respectively.

NOTES

On reflection, the previous session had not run well, the students did not understand the metabolic pathways and, in my view, more teaching at a basic level was required. The carbohydrate and glucose metabolism needed to be simplified and broken down into clearer and easier-to-follow stages.

I reran a different lecture/session on carbohydrate and glucose metabolism where the stages were broken down and including more assessment and questioning to ensure that the students understood this topic and would be ready to evaluate this in the case scenario.

Developing higher-order thinking with the case/scenario problem was also part of embedding employability into the curriculum.

LEARNING OBJECTIVES

Mild Students will be able to define metabolism	Medium Students will be able to describe protein, glucose and fat metabolism	Hot Students will be able to evaluate, through participating in the case scenario, the importance of glucose metabolism during fear and starvation and research analyse what happens during longer-term starvation.
Teaching and learning activities	Assessment activities	Development of: <ul style="list-style-type: none"> • English, maths & ICT • Personal social development and employability • Equality and diversity
<p>Interactive power-point with student activities and assessment to ensure knowledge of metabolism</p> <p>Digestion and metabolism: Mr Terrified's Molar Extraction a case study on Carbohydrate and effects of fear and fasting on the body.</p> <p>Student Directed Activity</p> <p>Finished off with discussion and teaching of protein/fat metabolism in relation to starvation</p>	<p>Quizzes from power-point to check student knowledge.</p> <p>Fill-in-the-missing-words activity</p> <p>Main assessment MTME students in groups and they have to work out/ describe what happens to the body in fear and fasting with respect to hormones, and glucose metabolism.</p> <p>Some will go on to analyse what happens when starvation goes on for longer.</p> <p>Exchange for peer group's additional ideas. Fill in feedback sheets</p>	<p>E&D: Working as a group, all students and a mixture of groups of students of different backgrounds.</p> <p>British Values: Learners are encouraged to develop self-esteem through positive working relationships with peers</p> <p>Learners take part in democratic group activities and respect group decisions that are reached democratically</p> <p>English: Oral and written skills as well as using the correct terminology tested in class activities</p>

Table 1 Scheme of learning for 'Mr Terrified's molar extraction' case scenario.

'MR TERRIFIED'S MOLAR EXTRACTION' CASE SCENARIO

Mr Terrified arrives at your dental surgery at 10am. He is anxious, and has had nothing to eat since 8pm the previous evening as his anxiety has caused him to lose his appetite. He is going to have a molar extraction.

Work as a team and describe what is happening to his metabolism with respect to:

- Hormones
- Carbohydrate
- How is blood glucose maintained?

Table 2 The 'real-time' MTME used and the questions the students had to discuss in groups.

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The students (20 in total) were divided into five groups of four and each student was given a specific prompt to help encourage and focus them on the areas they needed to think about. There was also a Challen's challenge to stretch and differentiate the more able students. Following the session they were asked to provide oral and written feedback both on a questionnaire and also some general feedback (shown in Table 3), the main focus being: do case scenarios help you engage, understand the theory and relevance of metabolism, do they assist in preparing you for HE by encouraging engagement, autonomy, critical/deep thinking and argumentative skills? This was then used in addition to observation feedback as well as my own personal experience at Newcastle and Northumbria Universities and Sunderland College as described in this methodology to provide evidence to prove or disprove the hypothesis/question.

Student Feedback Questionnaire for MTME Scenario	General Student Feedback on MTME Scenario
1. Describe in two or three sentences how well you understood cellular respiration from the previous teaching sessions.	Did the use of a 'real time situation', ie fear of the dentist and having a tooth out, help to consolidate cellular respiration and why?
2. Having taken part in a case/scenario problem where you had to consider the effects of fear and fasting on the body, again in two or three sentences describe how this has helped or not helped the learning process of cellular respiration in metabolism.	Did this activity encourage evaluation/analytical skills? Describe how and why.
3. Can you detail how using a problem type 'real time scenario' helps to relate the theory of respiration into practice compared to the previous teaching delivery techniques?	Describe in a few sentences how or why you think this activity helps in the progression to Higher Education (HE).
4. Please detail if you think this scenario has helped you to develop higher-order thinking skills (eg analysis, evaluation and justification) and why?	Give a score for this activity from one to ten stars, 10 being the maximum.
5. Do you think that biology teaching prepares you for HE in terms of autonomy in learning (ie being responsible for your own learning journey)?	
6. If you do not feel in the above question that you are being prepared for HE at L3, list what other activities or teaching styles would enhance this with respect to critical thinking skills, developing argumentative skills and your own opinion or views on ideas.	
7. Describe what skills you think are needed to prepare you for academic writing at HE and do we at the college give you enough direction on this. If yes say why, and if no say what we need to do to improve.	
8. Describe how your feedback from biology assignments helps you to progress and achieve higher grades to allow you to gain a place at HE and how if you think relevant this could be improved.	

Table 3 The questions on the questionnaire for both specific and general feedback for and on the use of the MTME case scenario.

RESULTS

Throughout my teaching career, particularly in HE, cellular respiration/metabolism has always been a challenging topic to teach. The subject is full of endlessly complex biochemical pathways and students often struggle to see their purpose and relevance. This is further substantiated by their poor performance in related formative and summative assessments.

I first encountered this problem whilst teaching with the Professor of Nutrition in the dental school at Newcastle University. MTME was specifically brought in after much reflection to try and enhance the achievement of this topic in summative assessments. After introducing this in a small group tutorial setting, we found that the initial assessment figures were encouraging. I also observed that the dental students were actively engaged in the task, and questioning of the students revealed evidence of problem-solving, critical deep learning and thinking skills. Interestingly, a deliberately chosen dental 'real-time' scenario was found to demonstrate the relevance of cellular respiration/metabolism (as the students commented to me and Professor X), an area previously found challenging.

These initial results were encouraging not only from a teacher/student perspective but because they re-emphasised the importance of continual and consistent reflection as a means of enhancing quality in teaching and learning and an asset in a 'lecturer's toolbox'.

While teaching at Northumbria, it was evident from the applied biology students' assessment grades on metabolism that changes were necessary to improve the teaching of this topic. Following discussions with the module leader (ML), I suggested she amend the dental scenario, this time using a more nutrition 'real-time' based theme. Mr Terrified's daughters were developed: Sophia Sugarsnap who was very fit and had a healthy diet, and Molly Muffintop

who did not. This new approach showed an overall increase in assessment grades, and according to ML the students were much more engaged and found this 'real-time' approach helped them to see the relevance of cellular metabolism on the body and as part of diet.

I therefore decided to trial using case scenarios at FE for L3 Access students, the results of which are presented here.

Most of the students when asked said that they enjoyed the session and that it helped them to think critically, develop argumentative skills and show the relevance of cellular respiration in the body. However, only two students completed the questionnaires, one of whom gave extensive detailed written feedback. The reason given for others not providing written feedback varied from 'not knowing what to write' to 'not having enough time due to family, work and college course commitments'. This is unfortunate as it makes reporting the results from a student feedback perspective challenging to almost impossible. That said, the oral student feedback supports the use of case studies to help consolidate the theory and relevance of cellular respiration, develop critical thinking skills and prepare for HE through tutor-taught theory and student autonomy and was given ten out of a possible ten stars.

But while the observer said there was 'good reinforcement of subject terminology' and that 'the case study was a creative activity... Students were engaged with it...' there were many areas that needed improvement and thus it was graded a 3.

On reading the observer's feedback and my reflection on this lesson I felt the grade 3 was 'deserved' and much work was needed to improve this to ensure positive and more accurate conclusions to the hypothesis and aim of this action research for the future.

DISCUSSION OF RESULTS

It is difficult to come to a direct conclusion as to whether the results fully answer the hypothesis and aim of this action research project. This is primarily because only one student provided detailed written feedback and oral feedback was difficult to record. However, in this discussion I am going to try to interpret the results with respect to engagement, relevance, teaching of theory and development of critical thinking skills. I will also describe the use of case studies in facilitating transition from FE to HE.

We are all familiar with the term engagement when couples become betrothed, but recently it has become another buzzword in education. More worrying is the idea that 'engagement appears to be a false prophet of education increasingly seen as the goal itself' (Muijs 2016). In particular it can be a defining factor in determining observation grades, possibly because 'it is easier to observe than learning' (Muijs 2016).

So does student engagement equate to being busy or is there more to it than this? Can we use case studies to enhance engagement? Finally how do we know students are engaged?

It is easy to define engagement as an activity where students are occupied throughout a lesson. However, that is an oversimplification and I agree with the recent views of @DrR Lofthouse (2016) who states that 'we need to improve our definition of engagement as it's not the same as keep busy or show an interest'. So how do we prove this?

There is much debate as to how we define student engagement and its importance in HE). Ofsted discusses the necessity of engagement in FE, saying 'that learners benefit from high expectations, engagement... from staff'

(Ofsted, 2015). Astin (1999) defined student engagement as 'the amount of physical and psychological energy

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a student devotes to their academic experience'. However, being directly linked to institutional quality, student engagement needs to also include 'approaches to learning to allow both surface and deep' (Holmes 2017).

So how can we do this? I have always followed the ARCS principle (Graeme Blench, personal communication, 2011) when trying to encourage student engagement:

A – Attention

R – Relevance

C – Confidence and autonomy

S – Satisfaction/feedback

Similar strategies are also supported by Pino-James (2014) in addition to embracing collaborative learning and establishing positive student–teacher relationships. However, the idea of social/collaborative learning is not new as it reflects the ideologies of social development theory. The real impact of this has recently been shown by Kalinithi (2016) who states that 'human knowledge is never contained in one person, it grows from relationships' (p. 172). His book also highlights how much he values social learning and the power of language in building trust. Trust, like respect, is earned and its focus in leadership and education is well documented by Myatt (2016).

If this can be part of a student's learning journey then we as educators are engaging both academically and pastorally and preparing them for employability and leadership roles in society. The use of case scenarios enhances this journey through better student engagement problem-solving skills, autonomy and critical thinking skills, all essential qualities for employers and leaders, in addition, it facilitates teamwork and peer engagement, also important for employability and leadership.

However, student engagement is also linked to 'two important metrics in learning: student satisfaction and the

quality of the student experience' (Holmes, 2017). This can be achieved through 'careful curriculum design'. I have found that using 'real-time' case studies like MTME to help teach carbohydrate metabolism is effective in engaging and motivating students. My mentor's feedback comments included 'Good engaging activities planned to motivate learners', while my observer's comments included 'The learners quickly became engaged with the case study.'

However, my grade 3 and personal reflection dictate that there are areas which need improving to support the hypothesis and aim of this AR. When the students were just starting to become engaged, the deep learning and critical thinking skills that this task should have facilitated were starkly shut down because I had allowed insufficient time for the task to be completed. This really should not have happened as when I had tried this out initially in 2015 I had allowed a full session for this activity, to excellent mentor feedback:– 'Engaging activities ("Mr Terrified's Molar Extraction") to motivate pupils with good context/scenario.' The reason for this was to ensure the students had a better understanding, as the previous session had been fraught with confusion. A total of 11 minutes as stated by my observer as just not enough to fully allow students to critically think and ensure evidence of deep learning.

Another area for improvement is questioning technique. I need to develop more probing questions to allow the more able students to extend and differentiate their learning opportunities (Taylor 2016), [Laidlaw, L. (1989). Subsequently this would better facilitate the freedom to develop higher-order thinking skills and better prepare students for HE.

Further, one of the learning outcomes (LO) of the lesson was to evaluate, and the short time frame meant that this LO was not achieved.

I also need to ensure that, when I

am designing LO, these are actively embedded in the session, particularly the higher Bloom's Taxonomy scale, eg evaluate and analyse. This was also picked up in my observation, and again is also in part the result of my not having allowed the students the time to engage in these tasks, something I need to ensure in the future.

The advantage of the effective use of case scenarios to enhance engagement is that they 'encourage students to think and take a position' <http://www.hawaii.edu/intlrel/pols382/Reflective%20Thinking%20-%20UH/reflection.html> through promoting higher-order, deep thinking, autonomy and discussions embracing social learning. They also provide an easy and enjoyable way of creating a relevant and appropriate 'real-time' activity as well as a means of ensuring understanding and assessment of theory through formative assessment, as evidenced at Sunderland College. This success of formative assessment can then, as I found out at both Newcastle and Northumbria, lead to improved summative assessment achievement in some students of cellular metabolism.

So how do we know students are engaged? Johnson (2012) gives us some indicators including 'reading critically, planning & debating', certainly not just keeping busy or showing an interest. There was evidence from my observations that the students were busily engaged in reading and looking up notes as well as researching on their phones. However, the engagement time could have been longer if I had dedicated the whole session time to this task.

Does the use of case studies help L3 students develop critical thinking skills and, more importantly, help L3 students' progress from FE to HE? While the one detailed feedback did appear to support the use of case scenarios to promote engagement, whether it has developed critical thinking skills is unclear. While the students said that it had helped higher-order thinking, and although I have spoken

to them about this in previous sessions, I would find it difficult to determine if critical thinking had actually taken place as a result of using a case scenario. What is clear is that in this case the observer disagreed. In particular she states a need to 'provide learners with the opportunity to develop higher order thinking skills'. The main reason for this feedback is twofold: the lack of time given to allow the students to do the case scenario, and the absence of probing questions to extend and explore deeper knowledge.

There has been much discussion of the importance of questioning because 'Education is a process of inquiry.' Morgan & Saxton (2006) state that 'being able to ask a perceptive question, follow it up with one that probes deeper and that gets to the heart of the matter, while at the same time bringing students along without feeling anxious or interrogated is the art of great teaching' (p. 127). Taylor (2016) further advises that questions should have a purpose, shape and understanding and allow reflection. He also provides

a detailed taxonomy of questions to transform different depths and levels of knowledge. These are ideas and suggestions which I am currently using in my teaching practice to enhance deeper thinking and stretch more able students. The use of questioning techniques and case scenarios would allow greater critical thinking, and undoubtedly improved the outcome of this action research proposal. [Laidlaw, L. (1989), Swanson, T. A., Kim, S. I. & Glucksman, M. J. (2009) and Wood, P. & Smith, J. (2016)..

In previous years, HE was considered a route for the privileged middle and upper classes, thereby failing candidates/students from 'socio-economically disadvantaged groups and mature learners who had been out of education' (Burnell 2013). However, the development of Access L3 courses at FE colleges has enabled the entry of these students to HE through 'widening participation' (Burnell 2013). While most of these students are successful in HE, mainly 'through renegotiating their

identity and perceptions of themselves in relation to their class and educational experiences', the initial jump from L3 at FE to L4 at HE can be 'accompanied by significant anxieties and worries' (Roffey-Barentsen 2015).

Case studies have been 'used most extensively in the teaching of medicine, law and business',

Swanson, T. A., Kim, S. I. & Glucksman, M. J. (2009). and I have found them a way to enhance engagement of students as shown here.

In summary, while this action research project shows that use of a case study can enhance engagement, relevance and teaching of theory, more work including the use of other case studies, greater student feedback and example assessment grades, along with greater time given and deeper questioning techniques, Morgan, N. & Saxton, N. (2006) would be required to prove this conclusively. ■

REFERENCES

- Astin, A. W. (1999). 'Student involvement: a developmental theory for higher education'. *Journal of College Student Development*, 40(5): 518–29.
- Burnell, I. (2013). 'Investigating the transition from FE to HE: what are the lived experiences and perspectives of non-traditional learners?' White Rose eThesis online, University of Leeds, University of Sheffield and University of York. Online: <http://etheses.whiterose.ac.uk/4832/> [accessed March 2016]
- Cook, T. (2009). 'The purpose of mess in action research; building vigour through a messy turn'. *Educational Action Research*, 17: 277–329.
- Davis, B. & Sumara, D. (2005). 'Complexity science and educational action research: toward pragmatics of transformation'. *Educational Action Research*, 13: 453–65
- Holmes, N. (2017). 'Engaging with assessment: increasing student engagement through continuous assessment'. *Active Learning in Higher Education*, 11(1): 167–76.
- Johnson, B. (2012). 'How do we know when students are engaged?' Online: <http://www.edutopia.org/blog/student-engagement-definition-ben-johnson> [accessed December 2015]
- Kalinithi, P. (2016). *When breath becomes air*. London: Penguin Random House.
- Laidlaw, L. (1989). 'Some further thoughts on questioning' (unpublished), Toronto.
- McNiff, J. (2011). Action research and professional learning. Online: http://www.sagepub.com/sites/default/files/upm-binaries/39884_9780857025838.pdf Mc Niff 2011 [accessed February 2016]
- Morgan, N. & Saxton, N. (2006). *Asking better questions*. Markham, Ontario: Pembroke Publishers.
- Muijs, D. (2016). Online tweets (@profDanielMuijs). Online: <http://twitter.com/profdanielmuijs?lang=en>
- Myatt, M. (2016). *High challenge, low threat: how the best leaders find a balance*. Woodbridge: John Catt Educational Ltd.
- Ofsted (2015). 'Further Education and skills inspection June 2015'. Online: <https://reports.ofsted.gov.uk/provider/files/2497140/urn/130551.pdf> [accessed March 2016].
- Pino-James, N. (2014). 'Golden Rules for engaging students in learning activities'. Online: <http://www.edutopia.org/blog/golden-rules-for-engaging-students-nicolas-pino-james> [accessed December 2015]
- Polson, Cheryl, J (1993) Teaching Adult Students <https://files.eric.ed.gov/fulltext/ED395136.pdf> [accessed December 2015]
- Promising EFA practices (2015). 'Literacy for life skills and entrepreneurship'. Online: <http://unesdoc.unesco.org/images/0023/002339/233991e.pdf> [accessed June 2016]
- Roffey-Barentsen, J. (2015). 'Smoothing the ride'. *Research in Teacher Education*, 5(2): 12–16.
- Skills Funding Agency (2016). 'Advanced Learner Loans funding and performance-management rules'. Online: www.gov.uk [accessed September 2016]
- Somekh, B. & Zeichner, K. (2009). 'Action research for educational reform: remodelling action research theories and practices in local contexts', *Educational Action Research*, 17: 5–21.
- Swanson, T. A., Kim, S. I. & Glucksman, M. J. (2009). *Biochemistry, molecular biology and genetics*. Philadelphia, PA: Lippincott Williams & Wilkins.
- Taylor, T. (2016). *A beginners guide to the mantle of the expert: a transformative approach to education*. Norwich: Singular Publishing Ltd.
- Wood, P. & Smith, J. (2016). *Educational research: taking the plunge*. Camarthen: Independent Thinking Press.