

Two-Tier Multiple Choice Questions:

An Alternative Method of Formative Assessment for First Year Undergraduate Biology Students.

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Abstract

Formative assessment is a very appropriate and practical method of monitoring student progress, which has shown to significantly improve student learning by allowing them the opportunity to gain a better understanding, and therefore promoting Assessment for Learning (Black & Wiliam 1998; OECD 2005). However research has reported that formative assessment methods are rarely used in both second and third level classrooms (Angelo & Cross 1993; Keeley 2008).

A method of formative assessment called Two-Tier Multiple Choice Questions (MCQs) in Photosynthesis and Respiration were designed, developed and evaluated by First Year Undergraduate Students of Biology at the University of Limerick, Ireland. Two-Tier MCQs have proven to be very successful in educational settings (Williams, 2006) and research has shown that not only do they (1) help to test student understanding, but they also (2) aim to test student higher level of cognitive thinking and (3) help to identify misconceptions students may have (Haladyna & Downing 1989; Treagust 2006).

Two-Tier MCQs - What are they and how do they work?

Two-Tier MCQs are a *more sophisticated form* of multiple choice question. The first tier resembles a traditional MCQ, which usually pertains to a knowledge statement. The second tier resembles the format of a traditional multiple choice question but aim to promote higher thinking and reasoning skills. The questions also aim to identify misconceptions held by students as many of the distracters are based misconceptions held by students which were identified by other studies (Mann & Treagust 1998; Haslam & Treagust 1987). **12 questions** in total were finalised for the project. **6 on the topic of Photosynthesis and 6 on the topic of Respiration.** The format of a Two-Tier MCQs can be seen below:

Example Respiration Questions:

Respiration occurs in both animal cells and plant cells

- A. *True
B. False

The reason for my answer is because :

- Green plant cells respire when there is no light energy and carry out the process of photosynthesis when there is light energy.
- Respiration only occurs in animal cells and not in plant cells. Plant cells only photosynthesise.
- *Both plant and animal cells respire all the time. Plant cell respiration takes place during the day while photosynthesis is occurring
- Respiration only takes place during the night time hours in plant cells.

Figure 1: Example Two-Tier MCQ on the Topic of Respiration Developed for the Study. * Indicates the correct answer

Methodology

The study was carried out in three distinct phases.

Phase 1

The first phase involved the development of the Two-Tier MCQs. The questions were developed specifically for the Irish Biology Senior Cycle Syllabus. Some question were adapted from work previously carried out by Mann & Treagust (1998) and also Haslam & Treagust (1987).

Phase 2

The second phase involve the questions being evaluated by an academic member of Life Science Department at the University of Limerick to ensure the questions were correct and proper.

Phase 3

The third phase involved the questions being undertaken by the BSc. Ed students (n=17). The questions were then evaluated by the student. This sought their opinion on the tool as a method of formative assessment.

Results of the Two-Tier MCQs

A high percentage of the BSc. Ed students answered the first tier of the question correctly. But when asked to show a more in-depth understanding and higher thinking in the second tier, the students found it more difficult and were failing to get the full question correct.

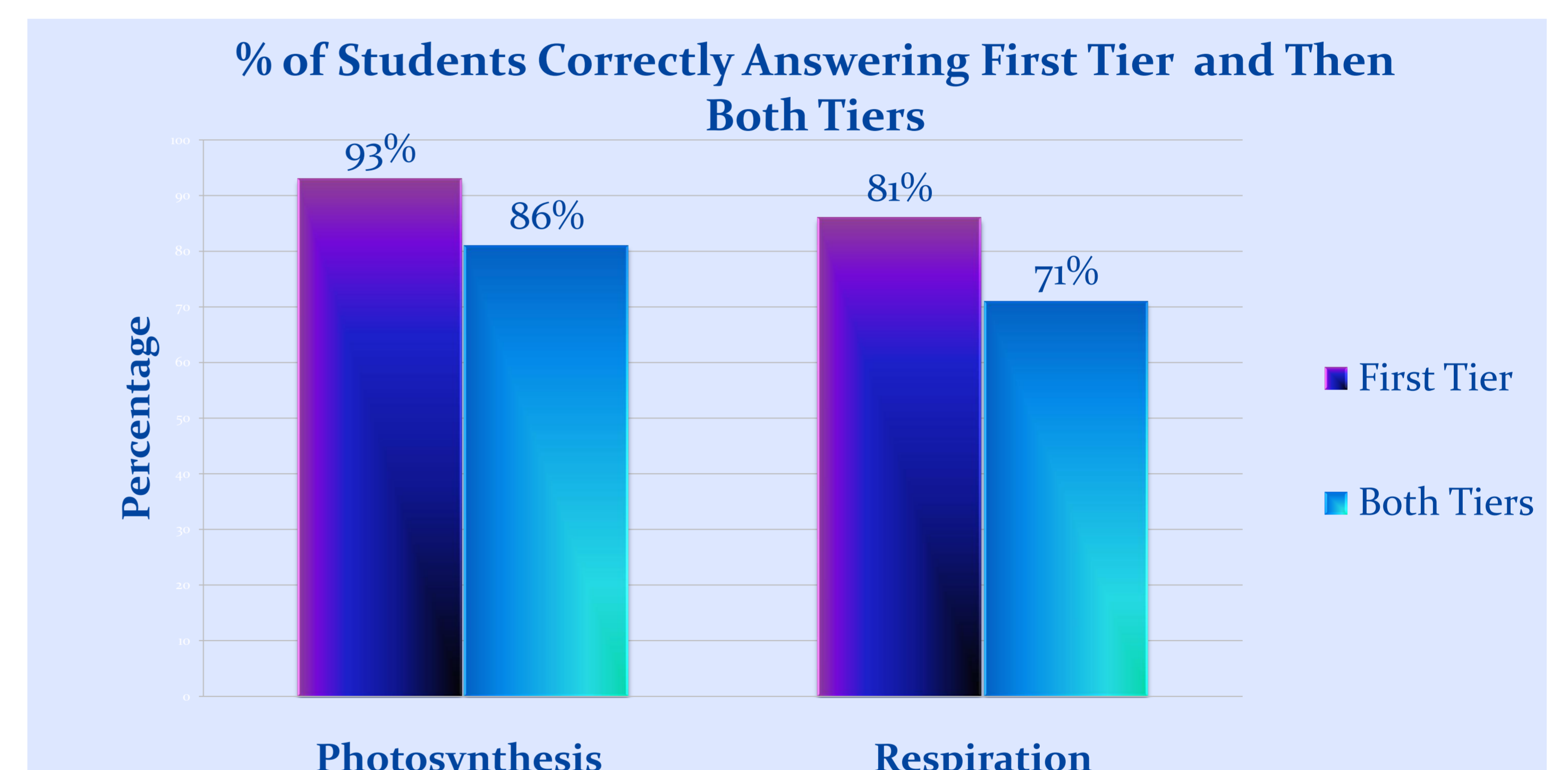


Figure 2: The percentage of students getting the first and then both tiers of the questions correct

Student Opinion on the Instrument

The results from these evaluations are very positive as can be seen in Table 1 below and the students own comments below.

Table 1: Students Evaluation of the Two-Tier MCQs

1. Have you ever encountered two-tier MCQs before?	
Yes: 17.6%	No: 82.4%
2. Did you feel the two-tier MCQs challenged you more than traditional single tier MCQs?	
Yes: 100%	No: 0%
3. Do you feel the two-tier MCQs assess and promote higher levels of thinking more than traditional MCQs?	
Yes: 100%	No: 0%
4. Do you feel the two-tier MCQs are a good method of assessment to diagnose misunderstandings and misconceptions students may have on a topic in Biology?	
Yes: 100%	No: 0%
5. As a student-teacher, do you feel you would you use the two-tier MCQs in the future in your classes?	
Yes: 93.8%	No: 6.2%

Student Comments

- "Would help to give a better understanding"
- "Make you fully understand the topic"
- "They are quiet enjoyable to figure out"
- "promote higher thinking and understanding"
- "one is forced to think more about the question and topic"

References:

- Angelo, T. and Cross, K. P. (1993) *Classroom Assessment Techniques: A Handbook for College Teachers*. 2nd ed., San Francisco Jossey-Bass Publishers
- Black, P. and Wiliam, D. (1998) 'Assessment and Classroom Learning', *Assessment in Education: Principles, Policy & Practice*, 5(1), 7-74.
- Haladyna, T. M. and Downing, S. M. (1989) 'A Taxonomy of Multiple-Choice Item-Writing Rules', *Applied Measurements in Education*, 2(1), 37-50.
- Haslam and Treagust (1987) 'Diagnosing secondary students' misconceptions of Photosynthesis and Respiration in plants using a two-tier multiple choice instrument', *Journal of Biological Education*, 21(3), 203-211.
- Mann, M. and Treagust, D. F. (2000) 'An instrument to diagnose conceptions of breathing, gas exchange and Respiration', in *Paper presented at the annual meeting of the National Association for Research in Science Teaching*, New Orleans, L April 28 - May 1, 2000, 18
- OECD (2005) 'Formative Assessment: Improving Learning in Secondary Classrooms', November [online], available: <http://www.oecd.org/dataoecd/19/31/35661078.pdf> [accessed 10/11/2009].
- Treagust, D. (2006) 'Diagnostic assessment in science as a means to improving teaching, learning and retention', in *UniServe Science*, The University of Sydney, 28 September 2006.
- Williams, J. B. (2006) 'Assertion-reason multiple-choice testing as a tool for deep learning and understanding', *Assessment & Evaluation in Higher Education*, 31(3), 287-301.