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Reflections on the Value of Mapping the Final Theory Examination in a Molecular Biochemistry Unit †

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INTRODUCTION

Intended learning outcomes (ILOs) are an integral part of teaching and learning at the university level (8), and consist of a set of statements that describe in unambiguous terms what the students are expected to be able to achieve after the completion of a particular unit. Because of this, the ILOs should lead into the assessment tasks and, in turn, contribute to the ILOs and broader student outcomes for the overall degree (4, 5). Hussey and Smith (8) have highlighted the significance of ILOs in aiding theoretical discussions about learning and teaching as well as for better course design. The key concept for designing curriculum is that all forms of assessment should reflect the ILOs (7). As a key assessment method, examinations therefore should also be designed to address the ILOs. Examination mapping is a process whereby allocation of marks to different sections of an examination can be related to the ILOs. This can inform the instructor as to how well the design of the exam fits the stated ILOs. We hypothesized that applying examination mapping to a second year unit in cellular and molecular biochemistry would illuminate how the design of the final written examination reflects the ILOs for this unit.

PROCEDURE

Assessment in the second year cellular and molecular biochemistry unit consists of five assessment tasks, including an end-of-semester written theory examination, the assessment task used for the mapping exercise. This examination consisted of 13 questions, each composed of specific sub-sections that assessed related aspects of a single topic. The unit had five ILOs, three of which ("conducting of experiments," "laboratory record keeping," and "ethical frameworks") were not assessed in the written exam (Appendix 1, Table 1). The two ILOs that were assessed in the final examination ("explain the molecular basis and co-ordination of cell biology processes in healthy cells and tissues, and in contrast to diseased states" and "interpret, evaluate, and communicate molecular and biochemical data") were structured into three task-specific criteria: "knowledge," "interpretation," and "application," according to Bloom's taxonomy (1). The marks allocated to each of these criteria over the whole of the examination were then mapped (Appendix 1, Table 2).

DISCUSSION

Of the three task-specific criteria, "knowledge" accounted for 49% of available marks in the final examination, followed by "interpretation" (34%), and "application" (17%) (Appendix 1, Table 2). To determine how each question was to be allocated to one of the three task-specific criteria, we defined the characteristics of the examination questions and tabulated their link to the relevant ILO. Table 1 illustrates a specific example of this process (second example in Appendix 1, Table 3). We found there were fewer marks than expected allotted to the "application" aspect of ILOs. This suggests that future examination questions should be designed to specifically address the reduced "application" facet. Our findings indicate that examination mapping has the potential to identify over-assessment (or under-assessment) of a particular ILO and hence lead to a balance of questions that address relevant student learning outcomes. This approach is similar to blueprinting in medical education, where learning objectives are mapped against test content. Hamdy (6) reported that blueprinting adds value in the avoidance of under-sampling or biased sampling in addition to reducing the exclusive focus on certain sets of skills through examination assessments. Examination mapping has already helped us identify a change of strategy and future direction in preparing examinations.

An important insight gained through examination mapping was that a rubric may help students to prepare effectively for written examinations. We reached this conclusion when defining question characteristics as they connect to each ILO as shown in Table 1. It is clear that students generally are less confident about preparing for exams compared to coursework (3, 10). Several studies have shown that

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TABLE 1.
Example of delineation of intended learning outcomes through examination mapping.

Task-Specific Criteria	Question Characteristic	Example Question	How the Question Relates to the Intended Learning Outcome
Knowledge	Is the student knowledgeable about the topic?	What is the purpose of the lane marked "negative control"?	Assesses knowledge of PCR. It is not necessary to interpret the data in order for the student to answer this question correctly.
Interpretation	Can relevant information be identified?	What is the size of the male-specific PCR product?	Assesses ability to use knowledge of PCR to determine which product is the male-specific product, and how to interpret the gel with respect to the size of the PCR product.
Application	Can the student use the information to reach and justify a conclusion?	What is the likely gender of the person from whom the "unknown sample" of DNA was obtained?	Assesses ability to apply knowledge of PCR by interpreting a result from an unknown sample. The student is required to interpret the results obtained for all DNA samples used in the experiment, and to reach a conclusion regarding an unknown sample.

although rubrics assist students in both learning and module coursework (9, 2), there is a dearth of research into the effectiveness of rubrics for written examinations. However, a recent report concluded that students were "confident" and "in-control" of final examinations when the rubric was communicated to those students (10). We envisage a rubric for the final examination that will explain to students the characteristics of the question, along with how to approach answering different questions to assessor's expectations.

CONCLUSION

In summary, final theory examination mapping allowed us to (i) understand the distribution of marks to different ILOs, (ii) devise strategies for designing future examinations, and (iii) obtain vital clues to aid rubric design for final examinations that may assist students to prepare efficiently for the final examination. We propose that this examination mapping can be readily adapted to other units and will help improve teaching quality, and in turn, student engagement and achievement.

SUPPLEMENTAL MATERIALS

Appendix 1: Table 1. Match between learning outcomes/objectives and criteria for the task; Table 2. Examination map; Table 3. Additional example for delineation of ILOs through examination mapping

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