A METACOGNITIVE ACTIVITY TO ENHANCE STUDENT UNDERSTANDING OF COMPLEXITY OF A THRESHOLD CONCEPT IN BIOLOGY

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BACKGROUND, AIMS AND METHODS

Threshold concepts are transformative, but also likely to be troublesome, for undergraduate students. Metacognitive activities that expose students to the structural complexity of a threshold concept and are organized in terms of the Structure of Observed Learning Outcomes (SOLO) taxonomy have been shown to improve student learning outcomes in a third year engineering course (Meyer, Knight, Callaghan & Baldock**,** 2015). The current study aimed to emphasise the structural complexity of the concept of 'cell membrane transfer' to a large cohort of first year biology students and improve their understanding of this concept.

The metacognitive activity was divided into several parts. In the first stage, students were asked to answer an open-ended question related to how transfer of substances occurs across the cell membrane. Following this, the students were asked to mark their own answer on a scale of 1-10 and provide justification of their marking by selecting one of five statements, which were ascending in complexity based on the SOLO taxonomy. Subsequently, students were provided with 9 model answers to the question, which varied in structural complexity, and were asked to mark the answers out of 10. This was followed by an instructor explaining their marking of the 9 answers and justification of the marks. Lastly, students were asked to revisit their own answer and re-mark their answer out of 10 and provide justification. After the class, the instructor marked each student response, providing a score and justification, which could be compared to students' pre- and post-scores and justification.

RESULTS AND DISCUSSION

In our study, it was evident that students find it difficult to identify the variation in complexity of a threshold concept. More than 50% of students were unable to match the instructor score for each model answer, with the exception of only the least complex, and hence lowest scored, answer. The self-assigned student post-score of their own answers was marginally greater than the instructor's score (p<0.05, n=312). Those students who assigned themselves a higher score than that of the instructor (46% of the cohort) deviated to the same extent as those who assigned a lower score (32%). As expected, the students with a lower instructor score overestimated the complexity of their answers and *vice versa*. Values for student post-justification of their score were compared to the instructor's justification. This showed that those students who scored themselves the same or a higher score for their answers in comparison to the instructor significantly aligned the justification of their mark to a higher order statement, while those that scored lower than the instructor aligned the justification to a lower order statement (p<0.01). In addition, students' understanding of the complexity of the concept was enhanced by introduction of the metacognitive activity, as shown by a significant difference in the self-assigned pre- (median 5) and post- (median 3) scores (p<0.001; n=195). First year biology students seem to benefit from being exposed to the variation in structural complexity of threshold concepts, while instructors benefit from exposure to common student misconceptions.

REFERENCES

Meyer, J. H., Knight, D. B., Callaghan, D. P., & Baldock, T. E. (2015). An empirical exploration of metacognitive assessment activities in a third-year civil engineering hydraulics course. *European Journal of Engineering Education*, *40*(3), 309-327.

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