JLD Journal of Learning Design
DESIGNING FOR EFFECTIVE LEARNING

EDITORIAL

Volume 7 No. 2

SPECIAL ISSUE: Assessment of Learning Outcomes in Science Education

Welcome to this special issue of the *Journal of Learning Design*, focussing on the assessment of learning outcomes in undergraduate science. We are delighted to present nine papers from a variety of scientific disciplines, including chemistry, biology, and agriculture, as well as the fundamental science in nursing degrees. The release of this issue coincides with the 2014 Australian Conference on Science and Mathematics Education, September 29 - October 1 in Sydney. The structure of the special issue is loosely based on the structure of the Australian Threshold Learning Outcomes for Science.[1]

TLO development

In the first paper in this issue, Botwright Acuña and her colleagues share their work on the development of a set of Threshold Learning Outcomes for Australian agriculture degrees in a project funded by the Office for Learning and Teaching. In this report, they describe an exhaustive process of consultation around the possible inclusion of vocational knowledge in their TLOs, with the conclusion that this should not be included. Their process will be of interest to other disciplines seeking to refine the Science Threshold Learning Outcomes.

Science TLO 2 - Content

Second, Jones summarises the current literature around assessment of science content knowledge pointing out that an excessive focus on traditional content delivery and assessment does not optimise student learning. She recommends a revamp of both delivery and assessment, noting that assessment tasks other than examinations, designed for example to teach science communication, have been shown to lead to improved student learning of content.

In spite of such long-standing criticisms of examinations, at most institutions these form a major part of assessment in undergraduate science. The following two papers - the third and fourth in this issue - describe detailed statistical analyses of results of multiple-choice examinations in chemistry in the United States. Despite their location outside of Australia, their focus aligns with TLO2 which is concerned with the depth and breadth of students' scientific knowledge.

Murphy and Holme have used a two-pronged expert analysis of multiple choice items, by complexity and content area, to allow sophisticated investigation of student performance

[1] The TLOs can be seen in full at: http://www.olt.gov.au/system/files/altc_standards_SCIENCE_240811_v3.pdf

within content areas, corrected for difficulty of questions. Such data can inform instructional design by clarifying which concepts are poorly understood. Through standardised examinations published by the American Chemical Society's Examination Institute, they have access to very large data sets of student performance on the items analysed. Their analytical method is applicable to any assessment item, not only examination questions and not only multiple choice, and offers all instructors a way to check their assessments.

Bowman, Gulacar and King review the literature on study habits and student use of time, and they present a detailed analysis of data obtained through a publisher's online homework system correlated with student performance on mid-term and final exams. Interestingly, they found that the best predictor of student success in the final exam and overall in their course was the number of attempts on each homework question where a strong negative correlation was observed. Total time spent on homework questions was not correlated with performance while average time per question had a positive correlation. The authors offer helpful suggestions as to how this data, which is collected automatically, can be used to improve teaching and learning for students. One important finding was that student performance is related to the type of question, with conceptual word problems being consistently more difficult than surface questions. This ties in with Jones' comments (this issue) about restructuring assessment using knowledge of such challenges for students.

In the fifth paper, Logan and Angel have analysed website information and confidential curriculum documents to determine the extent and method of incorporation of basic science in nursing degrees in Australia. Different institutions rely on different educational philosophies and nursing theories as they determine what science their students require for their future practice. Their comprehensive literature review explains the potential pitfalls of service teaching and the data show a trend to better integration of science within nursing subjects over the past eight years. This paper should be food for thought for anyone involved in the service teaching of basic sciences which are important to many health science professionals but present a challenge to many students.

Science TLO 4 – Communication

The following three papers - the sixth, seventh and eighth in this issue respectively - have a shared interest in TLO4: Communication. This learning outcome requires graduates to effectively communicate scientific results, information and arguments to a range of audiences, for a range of purposes, and using a variety of modes.

Glaser presents a mature curriculum design for a science communication course in which students are scaffolded through learning the process of scientific writing including peer review. The course has been running for five years and a new, current topic that involves chemistry is selected each year. Students learn about the publication process and perform a task very similar to that of a journal peer reviewer, while also learning chemistry. For their final submission, students must respond to their peer reviewers' comments. Glaser demonstrates in this paper that both performing peer review and responding to the comments can lead to improved learning outcomes for students, consistent with Jones' comments (this issue). The curriculum design presented is applicable to any discipline and is highly recommended for broad adoption.

Colthorpe, Chen and Zimbardi report the use of a "journal club" in which students are guided in giving oral presentations to develop and assess their science communication skills.

Addition of a peer feedback component to this process, similar to the Glaser paper (this issue), improved not only their performance on the assessment task but also their critical analysis skills and their perception of the task. In addition, greater feedback was obtained by students with less input from academic staff. Analysis of the feedback provided revealed some interesting features in terms of the voice used by students and what aspects of the presentation they addressed in their feedback.

Lawrie and her colleagues present the development of a technology tool that supports the use of small-group collaborative learning tasks in extremely large first year classes. The bespoke tool facilitates group formation, discussions, file sharing and peer assessment and, importantly, provides the instructor with immediate feedback about student engagement during the staged task. Evaluation of the tool indicated that, for many students, positive interdependence and genuine collaborative learning was achieved. Challenges included lack of IT capabilities of some students and changes in enrolment over the semester.

Science TLO 5 - Personal and professional responsibility

In the ninth (and final) paper, Schultz, one of the issue's Guest Editors, presents a case for the inclusion of macroethics in undergraduate science education. By this she means discussing controversial topics and not limiting ethical teaching to issues of plagiarism and academic integrity. She argues strongly that this approach is necessary to ensure that trained scientists have the tools to manage ethical issues that will arise in their work. The paper also reports on the outcomes of a workshop for chemistry academic staff on this topic. Assessment options such as debates and essays are presented along with a marking rubric to ensure impartiality.

While from diverse disciplines, each paper in this issue has significant and transferable understandings to share regarding the assessment of student learning outcomes. We commend the issue to you and hope that enjoy reading it.

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