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## Engaging Student Stakeholders in Developing a Learning Outcomes Assessment Framework

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### Abstract

Learning outcomes assessment and alignment contribute to the transparency, quality, and progression of a program. We set forth a learning outcomes framework that aligns learning outcomes at the course, major, program, and university levels. Senior undergraduate students were recruited to analyze assessments from eight core courses required for Molecular and Cellular Biology (MCB) majors at the University of Guelph. This analysis was conducted to achieve two goals: (a) to develop tools to assess learning outcomes in the MCB Department, and (b) to incorporate insights shared by the student perspective. Almost 1,600 Individual questions and their attributes were coded, compiled, and linked into the learning outcomes framework. The students then connected the questions to course concepts and assigned a cognitive domain indicated by Bloom's Taxonomy level. After training and calibration, two undergraduate students evaluated all questions in the eight core courses with an average of  $93.2\% \pm 1.6\%$  ( $n=8$ ) agreement between evaluators. These data were used to generate assessment profiles for individual courses and as an aggregate to provide insights regarding the program. This work makes constructive use the learning outcomes framework and illustrates the importance of leveraging undergraduate student perspectives in discussions of learning outcomes in higher education.

**Keywords:** learning outcomes assessment, Bloom's taxonomy, student engagement

Learning outcomes (LOs) are statements of what a learner is expected to know, understand, and be able to demonstrate at the end of a learning experience (Harden, 1999). Assessing LOs is important for all stakeholders in higher education: students, instructors, administrators, and the public and governments.

In 2012, the University of Guelph was the first university in Canada to approve institution-specific undergraduate learning outcomes ("University of Guelph 2012 Learning Outcomes Undergraduate Degree," 2012). Guelph's Institutional Quality Assurance Framework requires that every program define LOs and provide evidence of assessing those outcomes (University of Guelph Institutional Quality Assurance Process, n.d.). During the 2011/12 academic year, program LOs were approved for the Bachelor of Science (B.Sc.) program. At the same time, the Molecular and Cellular Biology (MCB) Department developed major LOs for its majors that align with the B.Sc. program LOs and university LOs. Beginning with the 2014/15 academic year, all courses administered by MCB included course learning outcomes (CLOs) in course outlines.

LO achievement is often inferred through assessment; students who correctly answer questions targeting a particular LO are assumed to have mastered said LO (Marton & Booth,

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1997). Ideally, all levels of LOs, from the course level to the university level, should be aligned in a LO framework (Figure 1), such that assessment information gathered in a course can be translated to the university level.

In this report, we had two aims. Our first aim was to apply the LO framework to the MCB core courses: a collection of eight courses ranging from first year to third year required for all majors in the MCB Department and for the vast majority of biology-related majors at the University of Guelph (Table 1).

Table 1  
*Bloom's Level Assignment Agreement*

Course Number	Course Level	Questions Analyzed	Agreement (%)
1	2	311	83.9
2	3	198	92.9
3	1	238	95.8
4	2	129	90.7
5	2	199	98.0
6	2	170	94.0
7	2	228	93.0
8	3	161	96.9
Total		1634	92.6
Average of 8 courses			93.2 ± 1.6

*Note.* The number of questions analyzed from each of the 8 MCB core courses is shown, along with the percentage of questions in each course for which the student analysts agreed on the Bloom's level assignment. Course level corresponds to the year of undergraduate studies that a course is typically taken. Course 1 had the lowest agreement rate; this is likely a consequence of using Course 1 to calibrate our Bloom's level assignment process.

These eight courses had a total enrolment of approximately 8,000 students each year (almost half of the approximately 18,000 undergraduate students at the university). Given the breadth of programs requiring these courses, assessing CLOs for the MCB Core Courses using the LO framework informs the progression of learning in MCB and non-MCB majors, impacting a large segment of the university.

Among higher education stakeholders, the primary relationship is between instructors and students. However, the student voice in developing and assessing LOs is often muted or missing even though the undergraduate student perspective is central to the mission of universities (Trowler & Trowler, 2010). The Critical Evaluation Mode approach of curricular analysis is aimed at revealing assumptions through critical reflection (Aoki, 1991), including incorrect assumptions about student understanding and application of LOs in their assessments. In the work described here, our second aim was to leverage undergraduate student analysts' first-hand experiences with MCB core courses to evaluate assessments and their relationships to LOs and to include the student perspective in curricular renewal discussions.

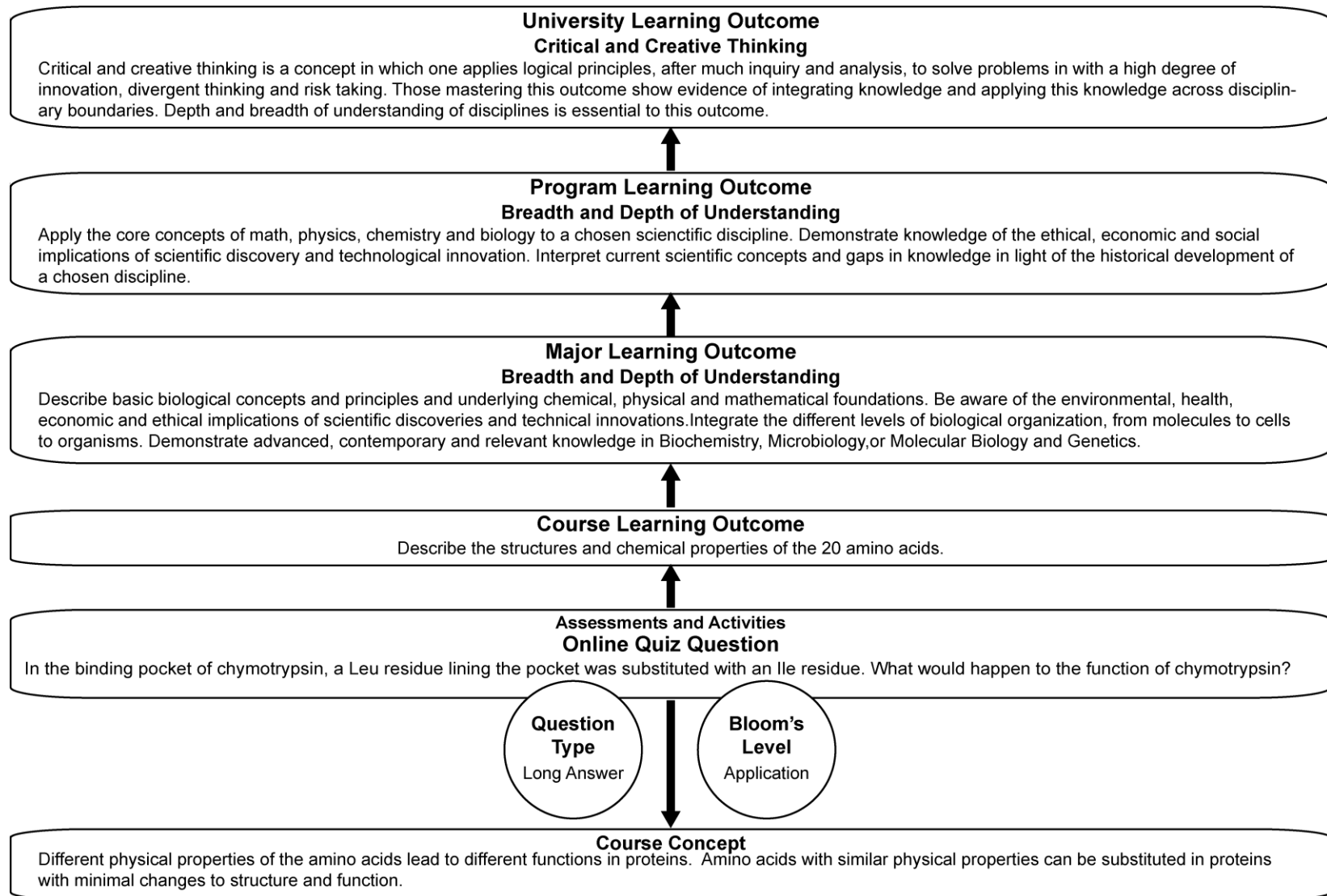


Figure 1. A learning outcomes framework. For each level, the example given relates to a question from an Introductory Biochemistry course. LO achievement can be inferred at various levels of the learning outcome framework by collecting student performance data at the “Assessments and Activities” level.

The importance of involving students in curricular analysis has been discussed (Danaher, 1994; Rudduck, Chaplain, & Wallace, 1996; Stenhouse, 1975, 1983). Involving students increases their sense of value and engagement in the classroom and enhances communication, while listening to students can improve teaching practice, be transformative, and overcome exclusionary biases in education (reviewed in Cook-Sather, 2006). Students at Sharnbrook Upper School in the UK, for example, analyzed several aspects of their education experience over a 3-year directed-research program, inspiring organizational change based on insights that were not obvious to instructors (Fielding, 2001). In a second study, students in the final year of a B.Sc. physiotherapy course at University College Dublin reflected on the curriculum and developed curricular improvement plans through group dialogue with a neutral facilitator, leading to some curricular change (O'Neill & McMahon, 2012). Finally, the Western Conference on Science Education recognized the importance of the undergraduate student voice by introducing student ambassadors in 2015 to provide undergraduate student input in and outside of the conference presentations.

In the MCB Department at Guelph, student opinions are collected through questionnaires administered at the end of a course and used to evaluate individual instructors and courses. Student representatives are on the MCB curriculum committee, but they have not actively engaged in analyzing the curriculum they experience. To acquire and actively use student perspectives, we recruited undergraduate students to develop tools to evaluate assessments and relate them to LOs in the MCB core courses. To our knowledge, no one in Ontario has reported the direct involvement of undergraduate students in the development and application of methods to evaluate assessments related to LOs along the progression of course concept through to university LOs.

In this report, we describe our strategy for building the LO framework at the level of individual assessments and activities in the MCB core courses in which undergraduate student analysts developed evaluation methods and used their first-hand experience with the MCB core courses to connect course assessments with concepts and LOs, performing the majority of the work described below. Through open discussions between students and instructors, underlying factors affecting course assessments and LOs were realized, explored, and respected while navigating the analysis. The student evaluations were used to revise MCB core course LOs in the summer of 2015, incorporating student interpretation of LOs as they related to course assessments. The LO framework we have developed can now be populated with student performance data to assess learning outcomes achievement at the course level and then translate those measures through to the level of the university.

### **Data Collection and Storage**

The student analysts signed a confidentiality agreement to protect both the students and the confidential data with which they worked. A secure server held digital copies of each course's assessment activities administered in 2013 and 2014, referred to as course embedded assessments. The questions were compiled into a master list for each course. Duplicate questions were noted, but each question was still assigned its own code for sake of convenience. Questions with multiple parts were separated into individual questions with unique codes if the parts were considered independent of each other. However, if the answer to a previous part of a question was required to solve the next part, the components of the

question were considered dependent and left together. The original grouping was noted for questions that were broken up.

A question metadata Excel spreadsheet was developed for each course and included the objective qualities, or attributes, of each question (Table 2). Unattainable or otherwise missing data were noted. Also included in the question metadata spreadsheets were the subjective, or evaluative, qualities of each question, including the assignment of a Bloom's Taxonomy Level and links to CLOs, major LOs, program LOs, and course concept inventories.

Table 2  
*Categories of Metadata Compiled for Each MCB Core Course*

Category	Definition
Source	the name of the document that originally contained the question
Semester	the specific semester that the question was used
Date	the date of the exam, the due date, or the latest possible day to complete the assignment
Year of study	the intended year-level of the course
CEA type	the format of the overall CEA from which the question came
Question type	the physical format of the question as it appears on the CEA
Marks allotted	the number of points rewarded for the correct solution
Professor	the instructor who taught the course when this question was used
Question author	the individual who wrote the question
Bloom's Taxonomy Level	the cognitive skill level required to solve the question, informed by a modified version of Bloom's Taxonomy (Krathwohl, 2002).
Course learning outcomes (CLOs)	Course Learning Outcomes aligned with each question. Codes were employed to avoid copying the entire CLO into the Excel sheet
Major Learning Outcomes (major LOs)	Major Learning Outcomes were aligned with CLOs in a separate spreadsheet. The major LOs were numbered to avoid copying the entire MLOs and CLOs in the excel sheet
Program Learning Outcomes (program LOs)	Program Learning Outcomes were aligned with major LOs in a separate spreadsheet
Concepts	a reference to the concept covered by the question when concept inventories existed
Notes	any additional relevant information

### **Blooming**

The cognitive skill level required by each question was assigned, using a modified Bloom's Taxonomy (Krathwohl, 2002), hereafter referred to as Bloom's. With the help of a Bloom's expert at the University ("Dr. C"), two student analysts collaborated with one MCB professor and two staff members from the Office of Open Education and Educational Support to define each Bloom's level for this work (Table 3). A calibration activity was then performed where the student analysts each wrote new questions about a common topic that targeted each specific Bloom's level.

Table 3

*Bloom's Taxonomy Level Working Definitions and Student Analysts' Thoughts*

<b>Term</b>	<b>Working Definition</b>	<b>Student Analysts' Thoughts</b>
<b>Remember</b>	<ul style="list-style-type: none"> <li>• What does the student remember?</li> <li>• tested using language very similar to that in class</li> <li>• multiple choice questions did not include significant distractors</li> </ul>	<ul style="list-style-type: none"> <li>• facts, or concepts taught for students to memorize.</li> <li>• examples provided in class and questions using those examples have been gone over</li> </ul>
<b>Understand</b>	<ul style="list-style-type: none"> <li>• What does the student understand?</li> <li>• tested using language different from what was given in class, or by giving examples using thinking on what is given</li> <li>• answers includes significant distractors (ones that test common misconceptions) (We don't usually teach wrong answers so distractors are "different from what is taught in class". Plausible distractors. Make a new association.)</li> </ul>	<ul style="list-style-type: none"> <li>• examples are familiar but asked to think about them in a different way</li> <li>• memorization alone is not enough to answer these questions</li> </ul>
<b>Apply</b>	<ul style="list-style-type: none"> <li>• Can a student apply what they know?</li> <li>• tested by using examples and having students use principles and information not given in the example.</li> <li>• question required prediction of a new situation</li> <li>• Calculations: solve word problems by selecting correct formula and identifying answer.</li> </ul>	<ul style="list-style-type: none"> <li>• new examples students have never seen in class</li> </ul>
<b>Analyze</b>	<ul style="list-style-type: none"> <li>• student must be able to deconstruct examples and see the individual parts, see relationships</li> <li>• interpret data and select the best solution. Recognize and explain patterns and meaning. See parts and wholes. Identify how parts relate to one another, can explain why. Are the conclusions supported by sound reasoning? What are the causal relationships between the parts? What are the unstated assumptions?</li> </ul>	<ul style="list-style-type: none"> <li>• none</li> </ul>
<b>Create</b>	<ul style="list-style-type: none"> <li>• student must be able to put elements or parts together to create something that</li> </ul>	<ul style="list-style-type: none"> <li>• a multiple choice question cannot be in</li> </ul>

	was not there before	this category, because the options are provided
<b>Evaluate</b>	<ul style="list-style-type: none"> <li>students must be able to have opinions, make judgments, or appraise ideas, solutions, methods, etc.</li> </ul>	<ul style="list-style-type: none"> <li>in distinguishing Analyzing from Evaluating, evaluation takes analysis one step further and asks students to form an opinion about or judge their own or another's analysis of something, or both. Multiple choice questions can be ranked as evaluation.</li> </ul>

*Note.* This table lists Bloom's cognitive levels in order of increasing sophistication (Krathwohl, 2002). As described, a Blooming expert guided the initial definitions of Bloom's levels. After the student analysts processed those recommendations and formed their own opinions, they expanded the definitions to enhance the understanding of each level.

After establishing a common understanding of each Bloom's level, questions from Course 1 were assigned a Bloom's Taxonomy Level. Two 3<sup>rd</sup> year undergraduate student analysts assessed each question individually, confirming assignments with each other in blocks of 50 questions. Since each question can only be assigned to one Bloom's category, the assignment had to be unanimous. We developed a "25C" process to handle discrepancies and uncertainties: first, two (2) student analysts discussed the rationale behind each Bloom's assignment. If agreement was not reached, the question was brought to the larger group of five (5) people (the student analysts plus the professor and two staff). If four of these five members did not agree on an assignment, the question was presented to the Blooming expert, "Dr. C" (C). For calibration purposes, "Dr. C" reviewed each Course 1 question with the main group of five (5).

After discussing the discrepancies in Course 1 first, Bloom's levels were assigned to the other course questions, settling discrepancies according to the 25C process. All questions in the MCB core courses were evaluated this way with the exception of Course 8 that the two 3<sup>rd</sup> undergraduate students had not completed previously. For Course 8, the questions were initially assessed by one 4<sup>th</sup> year undergraduate student who had completed the course and one lab demonstrator (the "2" level), and any discrepancies were discussed with the analysts, the professor, and two staff (the "5" level).

All final Bloom's level assignments were recorded in each course's question metadata spreadsheet. In our work, agreement at the "2" level ranged from 83.9 to 98.0 % of the questions within each course; the average agreement rate between the eight was  $93.2 \pm 1.6\%$  (Table 1). Course 1 had the lowest agreement at the "2" stage, likely because this was the first course evaluated when the analysts were calibrating their Bloom's level definitions. All



discrepancies were settled at the “5” level and we never went to the “C” level, reflecting the robust nature of the definitions and calibrations.

The direct experience of the student analysts with the MCB core courses was essential to the assignment of Bloom’s levels to the questions. How concepts were presented, discussed, and emphasized in the classroom provided students with a critical context for the Bloom’s level assignment. For example, students discerned whether questions included specific examples discussed in class requiring recall or new situations requiring application or analysis. Throughout the process, the student analysts regularly met with the professor-supervisor to discuss the work, their perspectives, and issues to overcome.

### **CLO and Concept Assignments**

Based on their experience as students in the courses being evaluated, the student analysts assigned a CLO code to each question. The process of assigning CLOs to questions was similar to the Blooming process: the student analysts assigned CLO codes individually and confirmed assignments in blocks of 50 questions. Each question may be associated with one CLO, multiple CLOs, or no CLOs. Disagreements were resolved if an analyst could make a compelling argument to link the CLO to the question. In addition, the CLOs of each course were mapped to one, multiple, or none of the 6 MLOs defined by the MCB Department. The MCB MLOs were previously aligned to the B.Sc. PLOs.

For those MCB core courses with a concept inventory, concepts were numbered and linked to questions if the student analysts considered the concept to be relevant to the question based on their experience as students in the course. As with CLOs and major LOs, each question was associated with one, multiple, or no concepts. The methodology employed by the two analysts was identical to the protocol used to link CLOs to questions.

### **Summary and Next Steps**

Through this work, undergraduate students carried out complex pedagogical analyses on a large set of data about courses they had completed and provided the student perspective on the connections between how they were assessed and the stated learning outcomes of the course. Their involvement in this work highlights the need and importance of including the student’s voice and experience in curricular and learning outcomes assessment discussions to overcome instructor-centred assumptions or biases in developing and assessing learning outcomes. The student analysts brought context for the assignment of Bloom’s levels to the questions and identified gaps in question-CLO relationships based on their experience in the courses and interpretation of questions and CLOs.

The results and recommendations from the student evaluations were presented to faculty at annual course-specific review sessions. Instructor-authored learning outcomes were then revised to account for student perspective and interpretation. These changes highlight increased communication and mutual respect between instructors and students leading to constructive improvement.

Moving forward, we can now gather student performance data for the questions in our LO framework to report out student achievement of LOs from the course through the major, program, and university perspectives. These data will further inform continuous improvement

of our courses and programs to meet learning outcomes. We believe this framework can be applied to other programs and universities.

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