

E-learning design for higher skill acquisition in the biomedical sciences



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Abstract

Adapting higher education to modern practices such as e-Learning is becoming increasingly important, as technology gains traction and provides novel alternatives to traditional instruction. Experts have studied the elements contributing to well-designed e-Learning resources and offered insight as to which are most crucial for instructional design practitioners. The goal of this project is to apply the most relevant e-Learning success factors discovered in the literature to the context of an intermediate-level undergraduate biochemistry class at McGill University through the development of academic resources. A backward design approach was used to develop five useful e-Learning activities that aim at higher skills in students (e.g. 'Apply', 'Analyze', and 'Evaluate' from Bloom's Taxonomy) and that incorporate the most relevant parameters for successful e-Learning. This iterative design task involved careful metacognition along the way to ensure that no aspect was left behind so that the activities truly reflect the state of modern educational research as it pertains to e-Learning. The final products took the form of five activities: **1) Answering a student email**, **2) Creating concept maps**, **3) Applying knowledge to another context**, **4) Refuting pseudo-science claims**, and **5) Audience-dependent scientific communication**. They were all tested for compliance to the success factors and desired learning objectives before being finalized. An interesting aspect of this project is that it can be transposed to biomedical disciplines beyond biochemistry rather easily, since similar activities can be created for other courses and the model relies on meeting strict criteria. In the Fall 2020 semester, the developed activities were used as models for course TAs, as they developed ~50 sample problems for use in BIOC311 - Metabolic Biochemistry.

Introduction

Many undergraduate biomedical science courses are lower skill-intensive (focus on memorization). As we adapt to implement e-Learning, it is key that we also foster the acquisition of higher skills by students. The term 'higher skills' here refers to *Apply*, *Analyze*, and *Evaluate* from Bloom's Taxonomy (see ★ in Figure 1).

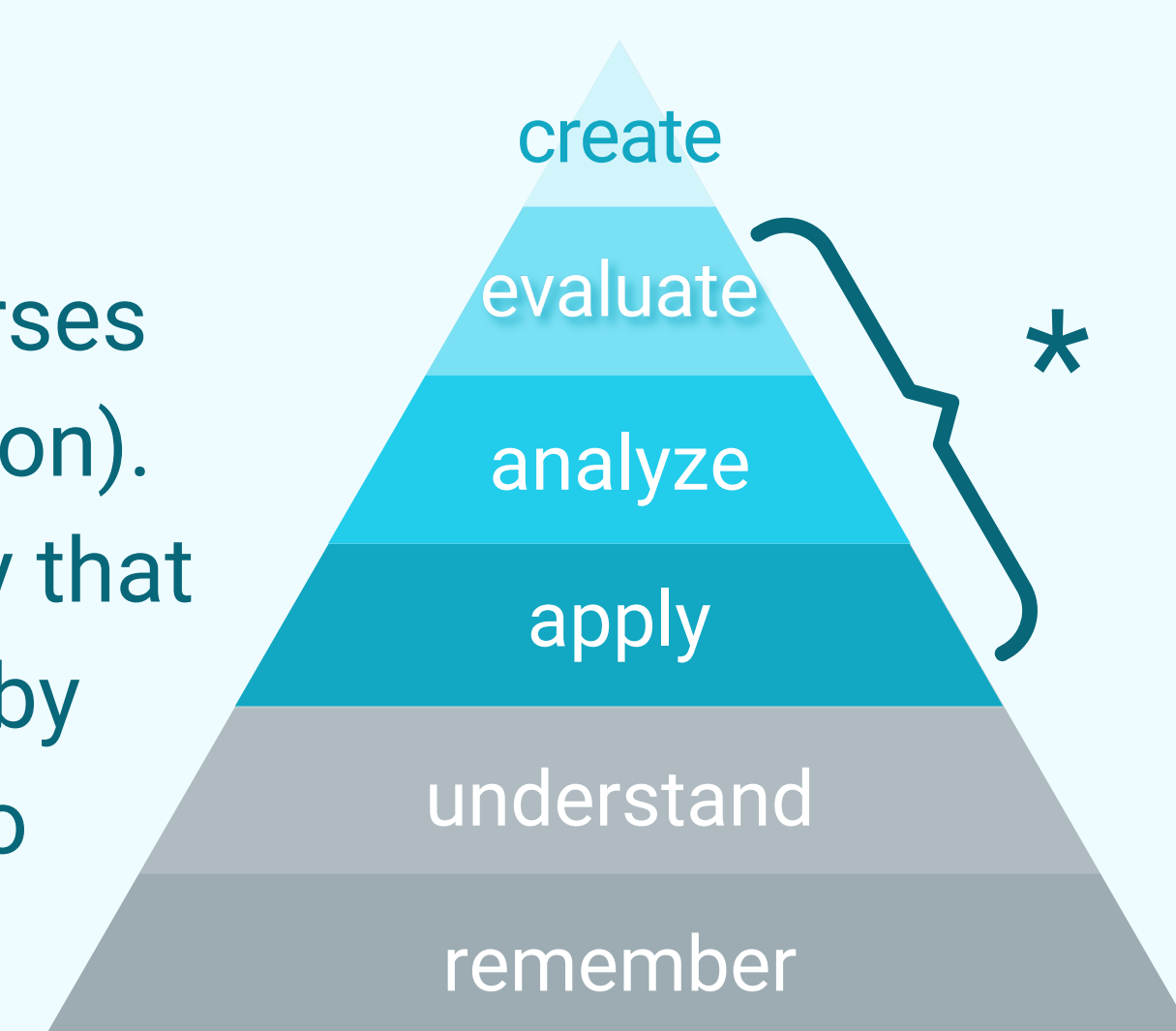


Figure 1. Bloom's Taxonomy

The notion of **e-Learning** relates to the delivery of education (instruction, learning or teaching) via the use of electronic media (Koohang and Harman, 2005). More specifically, this project focused on web-based tools (such as McGill's learning management system, *myCourses*).
≠ 'distance learning'
≠ 'online learning'

Goals:

1. Identify the most important scholarly parameters contributing to well-designed e-Learning material.
2. Design five useful e-Learning activities fostering higher skills in students that are adapted for implementation in BIOC311.

References

1. Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain. New York, USA: David McKay.
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Methods

Step 1: Identifying success factors

Factors to optimize e-Learning in students vary with context; no clear comprehensive model available.

Identified ten most common and relevant from a literature search of recent peer-reviewed articles from reputable journals; divided them into three categories (Table I).

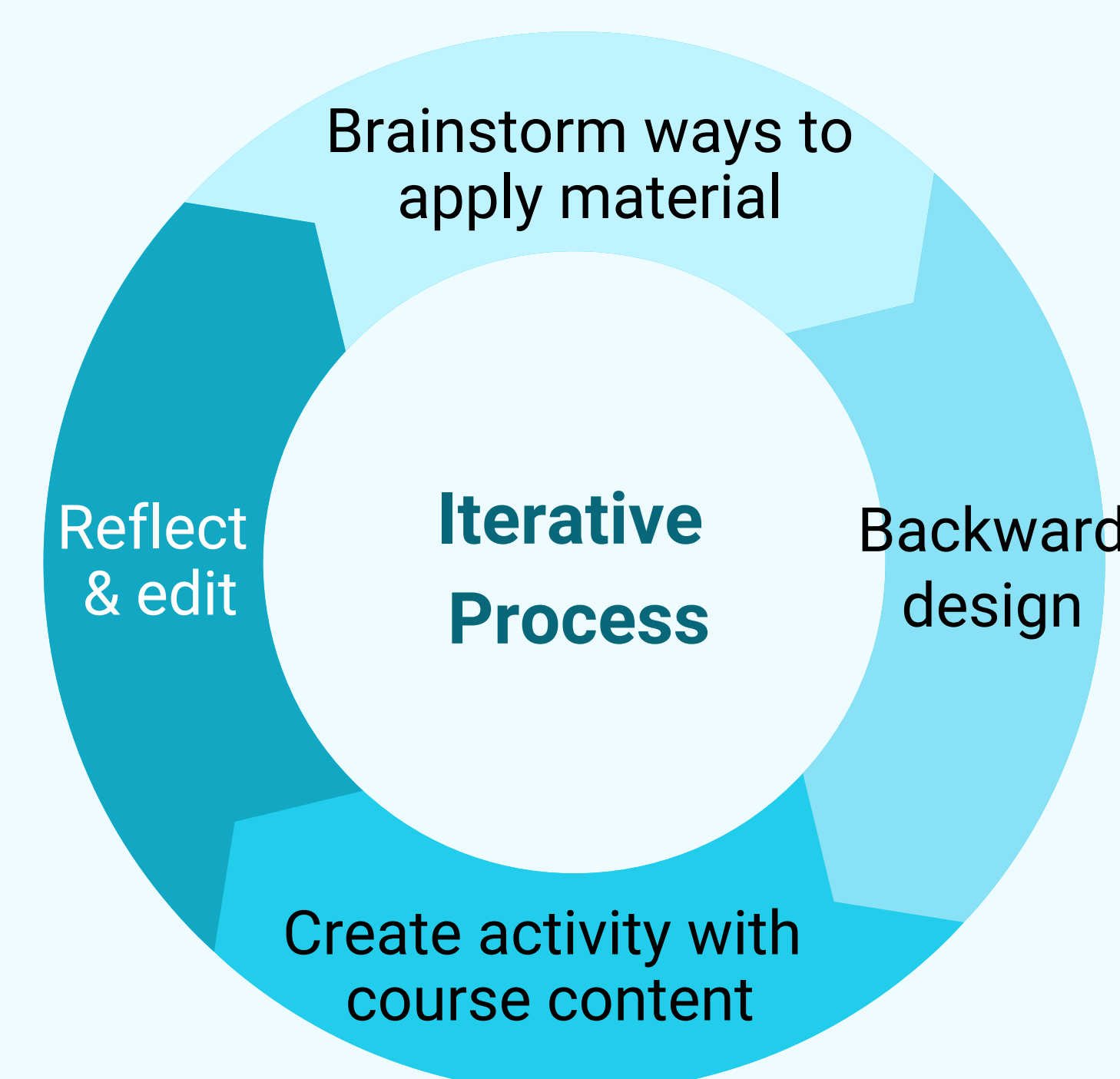
Table I. Relevant Factors Contributing to Successful e-Learning

Category	Factor
Instructional Design	Student-centeredness
	Perceived usefulness
	Clear instructions
	Varied material
Pedagogy	Adequate conditions
	Interactivity
	Fair assessment
	Coherent alignment
Technology	Proper IT infrastructure
	Available technical support

Steps 2 and 3:

Activity Design

Metacognition



Results

Five activities, including learning outcomes, instructions, rubrics, & grading instructions:

1. Answering a student email (*APPLY, EVALUATE*)
2. Creating concept maps (*APPLY, EVALUATE*)
3. Applying knowledge to another context (*APPLY, ANALYZE*)
4. Refuting pseudo-science claims (*APPLY, EVALUATE*)
5. Audience-dependent scientific communication (*ANALYZE, EVALUATE*)

myCourses

Learning course material while developing key skills (e.g. adaptability, teamwork, communication, critical thinking, problem-solving, and professionalism).

Interaction: student-student (collaboration) & student-grader (feedback).

Retroactive assessment: all activities met 9/10 of identified parameters ('Adequate Learning Conditions' cannot be evaluated for each activity in isolation).

Conclusion

Activities implemented successfully in BIOC311 in Fall 2020, serving as models for the course TAs to develop ~50 sample problems. Contributed to course redesign (from memorization focus towards higher skill development approach).

This can be mimicked in other biomedical disciplines, by implementing the successful e-Learning parameters and following an iterative design methodology.

Limitations:

- Activities were well-designed theoretically, but no testing of whether they truly helped students gain higher skills & whether implemented factors were relevant.
- Improvement in class average from Fall 2019 to Fall 2020 not necessarily related to this (other factors: remote delivery, different student cohort, instructor change, etc.).
- Learning curve (no rapid results post-implementation) & potential student pushback.

Avenues for Future Work:

- Analyzing student perceptions of the developed activities, as well as studying their skills before & after the course to see if the activities were beneficial to them.
- Studying which of the identified parameters had the greatest impact on student learning in undergraduate biomedical science courses to develop a reliable model.

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