2018

Using a Logic Model to Direct Backward Design of Curriculum

Aria Mia Loberti

Bryan M. Dewsbury
University of Rhode Island, dewsbury@uri.edu

Citation/Publisher Attribution

Loberti, A. M., Dewsbury, Bryan M. Using a Logic Model to Direct Backward Design of Curriculum (2018) *Journal of Microbiology and Biology Education* 19(3):1-4 doi: 10.1128/jmbe.v19i3.1638

Perspectives
DOI: https://doi.org/10.1128/jmbe.v19i3.1638

JMBE Journal of Microbiology & Biology Education

Using a Logic Model to Direct Backward Design of Curriculum †

Aria Mia Loberti[1] and Bryan M. Dewsbury[2]*
[1]*Department of Political Science, University of Rhode Island, Kingston, RI 02881;*
[2]*Department of Biological Sciences, University of Rhode Island, Kingston, RI 02881*

Contemporary approaches to STEM course design typically encourage the backward design of curricula. This is to say that the learning activities and assessments of the course are explicitly guided by the learning outcomes of the course. Less discussed is the fact that this paradigm is also used in nonacademic settings. From this perspective, drawing from the nonacademic world, we discuss the use of a logic model approach as a structured, orderly way to implement backward design. We use the design and implementation of an introductory biology class to illustrate how a logic model template helped frame our inclusive, Freirean approach to teaching and learning.

INTRODUCTION

National calls for a transformation in STEM pedagogy have forced a re-examination of how practitioners approach curriculum design and instruction (1). A large body of literature has demonstrated the effectiveness of backward design in carefully aligning measurable learning outcomes with activities and assessments (2). Approaches that follow this model may differ in nuance, but generally overlap in asking the instructor to consider the outcomes they want to achieve before designing specific activities and assessments for the course (3). Outcomes-based approaches, however, are not a new phenomenon. There is a long history of design thinking in other fields, and its use in nonacademic contexts create opportunities for academics to understand its applicability (4).

While current course-design approaches incorporate a degree of design thinking, there are a few inherent challenges associated with traditional approaches. First, good course design can be time consuming. The investment needed to align every component of the course with learning outcomes while accounting for logistical restrictions does not often match the available time instructors have to do so. Second, transferability and thus replicability of the course can be problematic. Documentation of specific courses can be a compendium of various documents, whose relevance instructors in new contexts may have trouble determining. Examining design thinking from project management in the nonacademic world may elucidate strategies to simplify the application of the process in higher education (5).

Logic models are one frequently used approach to project design (6). They are structured outlines used to identify and monitor goals and necessities, design comprehensive initiatives, and foster collaboration (7). They demonstrate a clear relationship between a program's purpose and its results by identifying the means needed to reach situation-specific ends while mapping out a clear path to success (8). Typically using a flowchart style, the model is often also used to measure and evaluate program efficacy (8). Current course-design approaches emphasize the fidelity of assessments with other aspects of the course structure. While worthwhile, these approaches may not fully capture the scope of what each learning component (formative and summative assessments, learning activities, etc.) requires. Current approaches also do not lay out, as an explicit part of the process, the contextual factors of the course. For example, what assumptions are being made about the nature of the incoming students? How is the instructor's social positioning and sense of otherness affecting the personal interactions in the classroom? In this way, logic models can be thought of as the junction where backward course design can intersect with inclusive teaching (9). It also gives the instructor a means to more clearly tie together the long-term, future goals for their students, the mechanics of the course experience, and the situational context of the course.

In this manuscript, we describe how we used a logic model approach to design and implement several iterations of an introductory biology course in a large, public research

---

*Corresponding author. Mailing address: 120 Flagg Road, CBLS 483, Kingston, RI 02881. Phone: 401-874-2248. Fax: 401-874-9107. E-mail: dewsbury@uri.edu.

Received: 12 June 2018, Accepted: 4 September 2018, Published: 14 December 2018.

†Supplemental materials available at http://asmscience.org/jmbe

university (Appendix 1). We describe aspects of our template as they pertain to our situation. Our goal is for instructors to draw useful lessons applicable to their own courses from how we used the logic model as a design-thinking tool.

DISCUSSION

The logic model can be used to chart a course's learning goals and how specific objectives can be attained throughout the course's duration (10). Main components of the model include *Inputs* (resources needed for program implementation), *Outputs* (specific actions expected of the stakeholders in the process), and *Outcomes* (specific overall learning goals and changes expected to occur as a function of the generated activities) (8). Outputs can be broken down further to identify the specific activities expected of the stakeholders and the ways in which stakeholders will be expected to participate in the course. A useful mnemonic device for the appropriate elements to include was suggested by Porteous et al. (11): the acronym CATSOLO stands for **c**omponents, **a**ctivities, **t**arget group, **s**hort-term goals and their **o**utcomes, and **l**ong-term goals and their **o**utcomes.

The course discussed here is a high-enrollment introductory biology course taught at a large, public research institution in the northeastern United States. Students in this course are a mix of biology majors and students from other departments who require a biology course to fulfill the requirements of their STEM major. Biology majors take this course as the first in a two-part sequence. Below, we discuss our model following the backward design mindset.

Outcomes

We began our logic model (see Appendix 1) for this course by first considering our semester-long learning goals—the broader set of skills we ultimately hope students take from the course. The backward design used here is informed by Fink's taxonomy, which gives equal primacy to the human dimension of the learning process (12). Our course design thus incorporates goals that are both content-related and cognizant of the human dimension of learning. We categorized our outcomes as short-term, medium-term, and long-term according to the timeframes in which we envisioned learning outcomes being attained. Long-term outcomes refer to our view of what students will become in the future, and the ways in which skills developed in our course will impact that. These outcomes are meant to address the question, Who do we want students to be? When practitioners are challenged with this question, most quickly identify that they wish for critical thinking skills and social maturation to catalyze the evolution of a civically engaged adult. Long-term outcomes serve as the philosophical guide for the adjudication of the course.

Medium-term outcomes focus on the skills that we would like the students to leave with immediately upon completion of our course. We used Fink's taxonomy to develop these learning outcomes and categorized them in accordance with predetermined topics used for introductory biology content. In addition to content-specific learning outcomes, we also included skills related to teamwork, reflection, and community-building. The logic model only lists the unit-level learning as discussion of the full suite of specific outcomes is beyond the scope of this manuscript. These are, however, listed in detail in the course's syllabus (Appendix 2).

Short-term outcomes refer to skills we would like to see demonstrated within the period of a day's class or a week of instruction. The taxonomy used here does overlap some with that used in the medium-term category, but we find it important to the evolution of a strong course dynamic to continuously monitor the degree to which students are engaging in the experience. For this reason, short-term outcomes are not necessarily *learning* outcomes. They include our assessment that students are in fact completing given assignments, engaging fully in the team projects, and confident enough to articulate to us any difficulties they may be experiencing. A culture of monitoring such outcomes creates a more explicit angle for early intervention with students who exhibit early struggles in the course.

Outputs

Outputs in the logic model are the specific activities generated by the ways in which the situation-specific inputs apply to a course (see below). In other words, outputs is an amalgamation of everything that happens during the semester. Robust STEM course designs typically contain a healthy mix of learning activities based on (a) course outcomes and (b) assessments (formative and summative) that measure the degree to which those outcomes were met. The output component of the logic model is a listing of both learning activities and assessments. We use a Deep Teaching approach (13) to our course design. This pedagogy is rooted in the teachings of Paolo Freire (14) who emphasized the need to build relationships and engage students' cultural histories to enhance the learning process. This means that the instructor is also a key (but not necessarily central) stakeholder in the outputs of the experience.

For our course, we chose to divide the outputs into activities and participation. We define activities here as the suite of tasks students are required to do as members of the community of learners. These include the various assignments associated with the Web-enhanced pedagogical model we employ and the associated assessments of students' competencies. For example, students are asked to complete pre-class readings, watch pre-recorded lectures, and read assigned chapters before the face-to-face part of the class. In the physical classroom, there are additional required tasks related to the learning outcomes of the day.

Participation is the degree to which students physically engage in the various elements of the course that were designed to meet the learning outcomes. Unlike activities, participation is not mandatory, but it is hoped that the structure of the course as determined by the learning outcomes encourages students to dialogue with their colleagues and the instructor in meaningful ways. Attendance at office hours, engaging team members inside and outside the classroom, and interactions with the instructor during class sessions are all examples of participation.

Inputs

Inputs are the conditions required for the successful attainment of the learning outcomes of a course. Regardless of course type, some of these conditions need to be determined before the first day of instruction. In accordance with Freirean philosophy, our course is built on an explicit need to have *awareness of self* as it pertains to social positioning, and a deep understanding of the broader and specific social realities of the students who will take the course (15). Therefore, activities that assist instructors in understanding their potential implicit biases (for example the Implicit Association Test [16]) and privilege are critical to the preparation process. Additionally, creating a dataset on the attributes of the students by sending out pre-class surveys is useful for getting a sense of the students' academic and social profile and developing empathy for them before the course begins. The nature of the incoming students and the social goals of the instructor then determine the other inputs of how the classroom climate is created, and the specific nature of the content-related pedagogies used.

We use a Web-enhanced pedagogy for this course. Students are required to complete online assignments, view video lectures, and complete textbook readings at home. Face-to-face time is used to engage in deconstruction of concepts students still find confusing after completing the preparation work. Deconstruction may entail interrupted lectures or additional problem sets with guidance on solution approaches. The choice of method depends on our determination of the best means to meet the learning outcomes of the day. Classroom climate is defined as the general temperament created in the course as a function of a number of factors including the physical layout of the classroom, the nature of the verbal interaction with students, and the structure of the interactions between the students. Time is spent before the course begins to work on the instructor's delivery style, fine-tune the mechanics of group-work support from the course's learning assistants, and update activities that facilitate the development of respectful feedback.

Assumptions

The implementation of our introductory biology course is predicated on some assumptions which we accept the responsibility of ensuring during the delivery of the course. First, we assume that the course is implemented in a space that is somewhat conducive to active learning. In a perfect world, this space would contain movable tables and chairs to ensure seamless collaboration, but we have been able to facilitate small-group work in classrooms with conventional lecture seating as well. Second, we assume that students are willing to engage in this style of pedagogy. Given the reality that many students may come in to the course expecting a didactic experience, we understand the need to intentionally communicate the value and expectations around our particular style of course. Third, we assume that the technology (Wi-Fi strength, courseware functionality, etc.) we rely on for much of our pedagogy will remain glitch-free throughout the semester.

External factors

The implementation of the course each semester is affected by a number of external factors both specific to our location and as a function of more general identity-related psychologies. The academic context of students matters. Students who are taking the course as a service to their nonbiology-major curriculum may desire different outcomes than do students who are expecting this course to lay the foundation of biology-specific contexts later on in their major's curriculum. Social contexts of the course may have profound impacts on the process. The instructor's self-awareness of implicit bias and worldview of pedagogy is likely to affect the ways their teaching is operationalized. At a predominantly white institution, such as the one where this course is taught, there is the likelihood that historically minoritized students may endure identity contingencies such as stereotype threat (17) and reduced sense of belonging (18). Consideration of these and other socioeconomic factors is crucial to the nature of the inputs to the model. The college transition process can also impact the ways in which students engage in the course. For our population, based on prior experience, we always anticipate spending time on facilitating good habits related to studying and time management. Additionally, we recognize that the transition into the college environment likely represents a critical stage in the development of students' science identity (19). The pedagogy of our course needs to facilitate and nurture this development. Lastly, we understand that the pedagogical style of other courses (especially STEM courses) matters. A course designed to be student-centered will resonate differently with students if it is the only such course they are taking, or if it is one of many guided by that approach.

CONCLUSION

A completed logic model should be read from start to finish like a chain of interconnected "if, then" statements (8). By applying a backward-design approach using the logic model to our course, we were continuously cognizant of applying our overall mission—the goals of the course—to the specific daily strategies that promote student success (20). Working from the macro to the micro level allows for thoroughness and the development of a purposeful action-based classroom experience. It clarifies what we need to do ourselves and what we need to seek from our institution in order to create a structured environment that fosters students' understanding of course material and impact.

We consider the logic model a companion to a syllabus, expounding upon that document in such a way that we can better elucidate the means necessary to achieve the aims outlined within it. The logic model provides a framework and catalogue of what we need to implement and achieve on a daily basis, and a structure to assess the success of our efforts. The logic model can be applied to different types of course design as well, but its attentiveness to both long- and short-term goals makes it particularly useful for a backward-designed course.

We hope to provide an experiential and discovery-based approach to learning fundamentals of biology for all of our students. To be truly student-centered, it is important to distinguish between the set goals of a curriculum and the process by which we can aid students in achieving those goals. The minimalist structure of the logic model allows these complex interactions to be simplified and clarified in a more attainable format, which we can then reference throughout the semester as a means of assessment. We suggest using the logic model approach to guide backward design and lay groundwork for a curriculum using its most essential and foundational components.

SUPPLEMENTAL MATERIALS

Appendix 1: Introductory biology logic model
Appendix 2: Principles of Biology I syllabus

ACKNOWLEDGMENTS

The authors declare that there are no conflicts of interest.

REFERENCES

1. American Association for the Advancement of Science. 2011. Vision and change in undergraduate biology education: a call to action: a summary of recommendations made at a national conference organized by the American Association for the Advancement of Science, July 15–17, 2009. Washington, DC.
2. Daugherty KK. 2006. Backward course design: making the end the beginning. Am J Pharm Educ 70(6):135.
3. Richards JC. 2003. Curriculum approaches in language teaching: forward, central, and backward design. RELC J 44(1):5–33.
4. Dym CL, Agogino AM, Eris O, Frey DD, Leifer LJ. 2005. Engineering design thinking, teaching, and learning. J Engineer Educ 94(1):103–120.
5. Dunne D, Martin R. 2006. Design thinking and how it will change management education: an interview and discussion. Acad Mgmt Learn Educ 5(4):512–523.
6 Goeschel CA, Weiss WM, Pronovost PJ. 2012. Using a logic model to design and evaluate quality and patient safety improvement programs. Int J Qual Health Care 24(4):330–337.
7. Knowlton LW, Phillips CC. 2012. The logic model guidebook: better strategies for great results. Sage Publications Inc, Thousand Oaks, CA.
8. Roberts A. 2013. Logic models: charting a course for success. NTEN: Nonprofit Technology Network. Retrieved from https://www.nten.org/article/logic-models-charting-a-course-for-success/
9. Dewsbury BM. 2017. Context determines strategies for "activating" the inclusive classroom. J Microbiol Biol Educ, 18(3). doi:10.1128/jmbe.v18i3.1347.
10. Kaplan SA, Garrett KE. 2005. The use of logic models by community-based initiatives. Eval Prog Plan 28(2):167–172. Retrieved from http://www.sciencedirect.com/science/article/pii/S0149718905000066
11. Porteous NL, Sheldrick BJ, Stewart PJ. 2002. Introducing program teams to logic models: facilitating the learning process. Can J Prog Eval 17(3):113–141.
12. Fink LD. 2013. Creating significant learning experiences: an integrated approach to designing college courses. John Wiley & Sons, Hoboken, NJ.
13. Dewsbury BM, in press. Deep teaching in a college STEM classroom. Cultural Stud Sci Educ.
14. Freire P. 1972. Education: domestication or liberation? Prospects 2(2):173–181.
15. Freire P. 1985. The politics of education: culture, power, and liberation. Greenwood Publishing Group, Westport, CT.
16. Greenwald AG, McGhee DE, Schwartz JL. 1998. Measuring individual differences in implicit cognition: the implicit association test. J Personal Soc Psychol 74(6):1464.
17. Steele CM, Aronson J. 1995. Stereotype threat and the intellectual test performance of African Americans. J Personal Soc Psychol 69(5):797.
18. Johnson DR, 2012. Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors. J Coll Student Dev 53(2):336–346.
19. Wilkins AC. 2014. Race, age, and identity transformations in the transition from high school to college for Black and first-generation White men. Sociol Educ 87(3):171–187.
20. Armbruster P, Patel M, Johnson E, Weiss M. 2008. Active learning and student-centered pedagogy improves student attitudes and performance in introductory biology. CBE Life Sci Educ 8(3):203–213.