Supporting Postsecondary Educators to Develop Assessments for Student Learning Based on Backward Design

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ABSTRACT
Assessment of student learning is crucial to capture accurately student understanding of core concepts and competencies as well as to provide relevant feedback for informing teaching and learning. Yet, many instructors in two-year and four-year undergraduate institutions rarely have pedagogical training to design fair instruction and assessments. This qualitative study describes changes occurring in the perspectives and practices of two postsecondary educators teaching introductory biology courses after participating in a one-day workshop on assessments and applying their new knowledge during course implementations. The assessment workshop emphasized the use of “backward design” for course planning and alignment. Learnings particularly focused on using Bloom’s taxonomy and best practices in assessment design. Data from educators’ interviews and samples of their course documents revealed encouraging findings. Even after a short intervention, the educators took initiatives to align course objectives, learning activities, and assessments. And notwithstanding the challenges arising from the COVID-19 pandemic, they also made some changes in formulating and communicating objectives with students, introduced relevant learning activities, and revised assessment questions to reflect best practices. The article discusses these findings and offers the next steps for research on supporting educators to design fair assessments and courses for undergraduate instruction.

Key Words: assessment; professional development; backward design; case study; qualitative research.

Introductory biology courses in two-year and four-year undergraduate institutions are crucial in the education of both major and nonmajor students. The courses are especially vital to prepare the latter for engaging with key issues, such as those related to climate change and public health. Well-designed courses in the first two years of college can inspire students to pursue degrees in science while also helping all students to understand fundamental disciplinary concepts and practices and develop scientific literacy, regardless of their academic and vocational interests (Alberts, 2005; President’s Council of Advisors on Science and Technology, 2012). In designing high-quality courses, sound assessments play a pivotal role; when used formatively to adapt teaching based on identified student needs, assessments support the learning of a broad range of populations, including undergraduate students (Black et al., 2003).

While postsecondary educators have subject matter expertise, they may have limited pedagogical training to support effective design and facilitation of introductory courses (Beaumont, 2018; Eddy, 2007; Hativa et al., 2001). Also, many biology teachers are unaware of literature supporting research-based instructional strategies (Addis et al., 2013) and show limited effective adoption of best practices in instruction (Stains et al., 2018). Therefore, many college educators struggle to craft assessments that effectively reveal students’ depth of understanding and that provide feedback to guide teaching and learning. As Brownell and Tanner explained in their 2017 study, graduate schools spend a lot of time training students to be researchers, where they adopt the “values, attitudes, and professional identities of the scientist that trained them.” However, “faculty positions at most colleges and universities are primarily teaching positions, and even faculty positions at research institutions require some teaching, but the majority of graduate students in the sciences are only taught how to do research.” Thus, the authors argue, sets up a fundamental disconnect between the training graduate students receive and the types of jobs they will have (Brownell & Tanner, 2017). Hence, faculty expectations of how student understanding develops are more likely to be based on the organizing principles of their discipline instead of on students’ actual learning processes and performance (Nathan & Petrosino, 2003).

Furthermore, research has shown that the learning objectives of introductory biology courses are not always transparent to students, the alignment of activities to assessments may not be present, and the assessments do not always fully uncover student thinking and misconceptions (Minbiole, 2016). The objectives and assessment questions also tend to stress lower-level cognitive skills, such as recall and comprehension of facts (Momsen et al., 2010). Finally, studies show a disparity in academic achievement, with certain formats and cognitive levels of test questions typically favoring male students and students from middle or higher socioeconomic status over female students and students of lower socioeconomic status (Stanger-Hall, 2017; Wright et al., 2017).
These studies suggest that college educators would benefit from exposure and access to principles and approaches for creating fair and effective assessments aligned with the course objectives and activities. One such approach is “backward design,” a conceptual framework for curriculum and assessment design to promote student understanding (Wiggins & McTighe, 1998). This framework proposes a proactive, three-stage planning sequence that focuses on alignment across course goals, assessments, and learning experiences. In contrast to traditional course design, in which instructors begin with preferred or long-standing materials and activities and plan assessments subsequently, the backward design sequence begins with identifying desired student understandings based on the content goals and standards. The second stage defines acceptable evidence of students’ attainment of the desired understandings, thus prompting instructors to consider appropriate assessment methods and evidence before planning specific lessons. Finally, guided by the desired results and assessments, the third stage involves intentional development of lessons and activities, course materials, and instructional strategies to provide students with the requisite learning experiences.

As we have published elsewhere, many educators attending our workshop on assessment design believed that writing effective learning objectives had little or nothing to do with writing effective assessments (Chmiel et al., in press). Educators did not see the relevance of developing learning objectives, despite reporting that they were somewhat familiar with backward design. This in turn emphasizes the importance of linking action-oriented objectives to matching classroom activities and assessment tasks. Furthermore, establishing clear connections between course learning objectives and assessments is a matter of fairness, which is particularly crucial in introductory biology courses because instructor-developed tests are often used to evaluate student performance, assign grades, and thus shape their trajectories in STEM education. Although studies show a positive impact of using curriculum design frameworks—such as Bloom’s taxonomy (Bloom et al., 1956) and backward design (Wiggins & McTighe, 1998)—on student retention (Long et al., 2020), engagement (Minbiole, 2016), and academic performance (Stanger-Hall, 2017) for biology majors and nonmajors, our review of the literature revealed little about how educators can be systematically supported to incorporate the frameworks and design meaningful courses and assessments.

To address this gap, we designed a professional development workshop, informed by the backward design framework described earlier, to aid postsecondary educators who teach life science courses, and we studied the shifts in educators’ perspectives and practices about assessment and course design. We focused on understanding how this professional learning informed changes in crafting and aligning course objectives, student learning activities, and assessment items. While there are numerous professional development opportunities for postsecondary educators, little is known about how these professional development opportunities might translate into practical and systemic change. As Borrego and Henderson (2014) noted,

> It has become painfully clear that higher education change processes are at least as complex as the pedagogies and learning processes they seek to promote. STEM education change agents, leaders, and researchers are just beginning to view change as a scholarly endeavor that can and should be informed by the research literature. While fields such as management, higher education, and communication have developed a wealth of literature to inform such change efforts, this knowledge remains largely inaccessible to STEM education leaders and researchers.

Thus, our study focused on how this professional learning experience of two educators influenced their thinking about assessment as well as changes in instructional design and enactment. In-depth, qualitative investigations provide an opportunity to examine these irreducible complexities from the viewpoint of educators undergoing change efforts.

The following questions guided the study:

- **Question 1:** How does professional learning based on the backward design approach support postsecondary educators to change their perspectives on assessing student learning?
- **Question 2:** What changes do the educators make in the learning objectives of their courses?
- **Question 3:** What changes do they make in the design of their course assessments?
- **Question 4:** What changes do they make in the course learning activities for their students?

### Method

#### Study Setting: Assessment Workshop

A one-day (i.e., six-and-a-half instructional hours) workshop was offered at a national professional conference for all attendees (teaching courses in life sciences), drawing heavily from the Great Lakes region, as it took place in person in Chicago in November of 2019. It was designed and facilitated by two college biology instructors and program staff with expertise in design and facilitation, and it was reviewed by assessment experts. The overall aims of the workshop were to help educators develop their skills in formulating high-quality learning objectives, in using evidence-based practices to develop and align assessment items with those learning objectives, and in analyzing students’ performance on the items and mastery of the learning objectives. An interpretive qualitative study approach (Creswell & Creswell, 2018; Merriam, 2002) was followed to understand and describe how postsecondary educators who participated in this workshop applied strategies and resources from the workshop to improve assessments and measure and nurture student understanding.

To achieve these aims and to promote a culture of transparent and fair instruction, the workshop facilitators introduced the backward design framework, which provides tools and templates to create and align learning objectives, learning activities to achieve those objectives, and appropriate assessments that can reveal students’ mastery of the objectives. The workshop stressed crafting increasingly rigorous, higher-order learning objectives based on a taxonomy initially presented by Bloom and colleagues (1956). Specifically, four components of assessment design were emphasized: writing clear, concise, and measurable statements of learning objectives related to disciplinary concepts and skills; using a test blueprint, which is a systematic map to align test items with the learning objectives and to gather evidence of students’ mastery of the objectives; writing test items that are aligned with the learning objectives based on best practices; and analyzing assessment items to determine their usefulness, identify possible revisions to the items, and revisit instructional content as needed.
The facilitators provided a print-based workbook containing background information on the components and opportunities to practice the components with fellow participants during the session.

Participants

To gauge the effectiveness of the workshop, mixed methods evaluation studies were conducted by TERC, a nonprofit educational research and development organization in the United States, with a sample of 67 educators attending the workshop.

The program evaluators designed a few studies (Chmiel et al., in press), with the present study designed to illuminate how the educators applied new learning to improve and align their course objectives, assessments, and learning activities. The focus of this study was on two educators, Rita and Amy, who were part of the broader sample of 67 educators participating in the workshop. The two educators spoke about their efforts at change with eloquence, providing insights into the complexity of change in postsecondary teaching and learning.

At the time of this study, Rita had five years of teaching experience and taught an introductory course on human biology for non-majors at a two-year community college. Amy had seven years of teaching experience and taught an introductory course on plant and animal biology for first-year students, built toward upper-level biology courses at a four-year liberal arts college. These two educators were selected for the study to help us understand patterns in their perspectives and practices as they applied the workshop learning in different courses to support students with diverse inclinations in pursuing biology education. Although they taught in different institutions where high-quality assessments were valued, neither had access to specific training or resources to guide them in designing and aligning course objectives and assessments. At the same time, the relative similarity of the length of their teaching experience allowed us to explore the impact of the assessment workshop on early-career educators. The educators were also selected because they provided clear descriptions of their attempts to try out new assessment and teaching practices, despite disruptions due to the COVID-19 pandemic.

Data Sources & Analysis

Following the assessment workshop, we conducted (and transcribed) in-depth interviews of approximately 45 minutes with the educators in March 2021. A semistructured protocol guided the interviews to probe specific changes in their thinking about assessments, especially about the backward design framework, their course learning objectives, the assessment items, the learning activities for the students, and the rationale behind changes made. Additionally, samples of course documents, such as syllabi, exam questions, lesson plans, and assignments were collected from these educators before the interview to understand better their changes to course design. The documents were referenced during the interview, prompting the educators to illustrate and explain changes made in their instructional practice.

The interview data were analyzed qualitatively based on a coding scheme derived from the broader evaluation study. Table 1 presents a set of codes relevant for this study (see Supplemental Material available with the online version of this article). The codes emerged from a review of the interview transcripts and were also informed by the study questions described earlier. Furthermore, multiple codes were found applicable for each question and point to several types of change in educators’ perspectives on course objectives, assessments, and activities. The course documents were used to confirm and elaborate the interview findings as appropriate.

Questions

Changes in Educators’ Perspectives about Assessing Student Learning

Two main changes occurred in the educators’ perspectives about assessing student learning after participating in the assessment workshop and applying their new knowledge in the classroom (see Table 1 in the Supplemental Material for codes associated with Question 1). First, Amy developed a clearer understanding of the underlying logic of the backward design approach, connecting the dots among objectives, learning activities, and assessments. Specifically, she appreciated the importance of writing clear and concise course objectives, enabling lessons to help students achieve those objectives, and crafting assessment questions to measure student mastery of the objectives. She felt “completely convinced” that instructors must first confirm, for themselves, that there is alignment among objectives, lessons, and assessment items before helping students to make those connections.

Definitely making those connections between objectives, lessons, and exams. I think about [that] all the time now, even outside of that class. Even if it’s in a course that I’m not ready yet to jump in and do that, I’m starting to think about individual activities. What did I want them to get out of this activity? And I wasn’t doing that as explicitly before I took the course. But I’m completely convinced it makes things so much more effective when I connect the dots before I try to make the students connect the dots.

While initial alignment work was done globally at the course level, Amy also looked within each area, “connecting the dots” across objectives, activities, and assessment questions for individual lessons. Here is an example of how she did this:

[The co-instructor for this course and I] started implementing pre-class assignments, and it made them much more clear because we were still giving [students] reading assignments, but then we were saying, for today’s lesson, you should read these pages, but these are the objectives. We started with kind of an overall “what you should get out of today” and then some specific learning lessons. And then, we would tie these to objectives. And so then, anything we were assigning, we were much more deliberate now about taking our online homework system and saying not just “that’s a good question” but also “that’s a good question that fits this objective.” And so that question will help. So, if I want them to explain photosynthesis, this is the homework that’s going to help them do that, and then I can ask about it on the exam. And so we were much more connecting the dots. So definitely in that individual lesson plans is where it becomes most evident.

Second, there was a “ripple effect” of the learning, revealing a willingness to continue applying the backward design logic in teaching subsequent courses. Both educators were eager to extend this approach to other disciplinary or cross-disciplinary courses they teach, despite challenges arising from the COVID-19 pandemic. For example, after teaching a course on human biology, Rita began attending carefully to the objectives, activities, and assessments. She discussed these with a co-instructor to pilot a
cross-disciplinary honors course (in English literature) on humans, science, and medicine.

I think it's a ripple effect of what I'm learning. So, I'm thinking about these objectives because when you design a course, it's backward design, right? And so, I want students to have that scientific literacy. And so, now everything I want to think about how am I assessing them, what they're writing about, and then activities we're incorporating into that. I share that with my peer, and she's been very interested in this. I think it's going to keep going. It hasn't stopped, just in COVID. I think it's actually going to move on to other courses beyond biology, which I think is great.

Changes in Course Learning Objectives

There were four ways educators addressed their course learning objectives (see Table 1 in the Supplemental Material for codes associated with Question 2).

First, inspired by the backward design approach, the value of designing learning objectives intentionally came to be recognized. As Rita explained, she began attending to the objectives and interpreting student performance on tests accordingly. This change marked a shift away from her previous practice involving predesigned exam questions with a limited focus on the objectives being assessed and on relating students' performance to specific objectives.

When you're teaching early on in your career, you're given content, and you have these examples from resources. And when the exam time comes, you use the pool of questions, and you do your exam. What I really like now about the backward design is you have to think of the objective being assessed on the exams and what you're doing. So now I am more conscious about it. Before, I would do the questions and give it to my students, but I wasn't really conscious about it. The other thing is thinking about reviewing the outcomes because [the assessment workshop facilitators] mentioned there are different ways you can look at things. Before it was just giving the students the grades, and sometimes you notice when you are grading that students are stuck on something. And it didn't always click that, oh, it's related to an objective or not. Now I'm more aware of that, so I'm being more reflective about what am I measuring.

Second, both educators communicated course objectives to students, thus working toward transparency in instruction. Rita organized and aligned the individual lessons to the objectives and shared this documentation with her students. By focusing on course objectives and making them explicit to students, she created a roadmap to make instructional decisions. The objectives also provided students with a concrete reference to guide their learning.

I tell my students—some of them want a study guide. I tell them “just look at our objectives.” So I’ve been more organized in this sense so I actually have now a document, where I can align the course objective. And then, I have for each of the chapters a list of what I want them to know, so I find that helpful. There's so much content to teach and so little time. One of the important things I have to come to realize is you can't teach students everything. You have to teach them how to learn. And so, what these objectives do is, what do you master by the end of this course as a basis for them to continue their learning? And they are actually a reference for me to think about, and for them to know, so if I say you have to pass your final exam, at least they know that “OK, I have to know this, I need to know about cellular processes, I need to know about structure function, I need to know about scientific method.” It's just giving me and the students a connection, something that we actually have that is solid, that to them makes sense, and it's more fair. Rather than “I have to cover this content in 16 weeks, and I might cover this, I might not cover this.” So at least I know now, and I'm covering things I'm giving the priority, to the objectives I'm putting in. So, there's a roadmap for my teaching. I'm not just going in and following slides or just having discussions that are pointless with the students.

Similarly, Amy improved her communication of course objectives in her first-semester course, which served students coming from diverse precollege academic experiences. Whereas she had earlier relied on communicating course content generally through slide presentations, Amy began making individual lesson objectives explicit to students after the workshop, helping students understand what they needed to learn from each lesson. She believed this was important to organize the content and support students who came to class with different levels of preparation, especially to help them develop a solid foundational knowledge of biology for pursuing more advanced courses subsequently.

In the past, we'd relied a lot on communicating through PowerPoint. So now we have a Canvas page for every day of the class, and then it gives the objectives. This course is very difficult for us to teach because it's the freshman first semester. It's our largest course. But also, the students coming into it have such diverse backgrounds and experiences that they've had from their high school. I find it really hard to organize, to hit everyone, to make sure [they're] getting what they need to out of the course. And so we thought, clear communication about objectives is not going to hurt anybody. Even the students who feel like they're pretty prepared to come to class are going to benefit from that.

And we would plan these lectures, and we were doing mostly lecture-based, and we would give these lectures. We weren't communicating what we wanted them to get out of each lecture; instead of just, “here's 50 PowerPoint slides, just match them up with the textbook reading, and that's how you should study,” we really made a focus on specific learning. What do we actually need them to learn out of this class period? And it's a course that builds. Obviously, it's a freshman first semester, so then when they get to the second semester, they're building on not only their learning skills but some of their biology.

Third, Amy recognized the importance of beginning with clear learning objectives to improve student performance. As Amy elaborated in the quote below, she understood that simply altering individual questions on a course's final examination was insufficient. She drew on the guidelines and workbook materials provided by the assessment workshop to formulate clearer objectives. This toolkit helped Amy specify objectives based on Bloom's taxonomy and highlight those objectives to her students.

For our final exams, we pretty much end up using the same exam every year. And so, it was very easy for me to pull up an exam and not have to start from scratch, but then revise questions to try to make the questions clearer. So it was kind of just coming at it as a minor tweak at the end of the process. But it felt pretty productive to do, so that was the first step. But then, I didn't see that big of a difference in their performance on that exam. And so that really just gave me more evidence to realize that we needed to start at the beginning, and start with writing objectives clearer. We had been talking kind of informally over the years about making things more clear, but then this workshop gave us like a toolkit or a set of instructions for how to do it.
Finally, Amy became aware of revising objectives at different granularity. She understood that objectives could be developed for individual lessons and broader program-level or course-level objectives.

To me, before that workshop, objectives were mostly something that you wrote for your undergraduate program, like for the whole biology major or for a course, and not necessarily for a lesson. I always had a goal for each lecture period, but not formal objectives, and I’d never thought about it that way.

**Changes in Assessment Design**

There were three main ways in which the assessment workshop inspired the educators in various ways to craft assessments (see Table 1 in the Supplemental Material for codes associated with Question 3). First, assessments came to be related more carefully to the learning objectives. Responding to her institution’s emphasis during the two years preceding this interview on systematically assessing and formally documenting student learning outcomes, Rita created a plan to interpret and document student performance on her course assessments. She focused on questions aligned with a specific learning objective of correlating structure and function at different biological levels of organization, which is a core concept in biology. She gauged student mastery based on the number of questions they answered. This feedback, in turn, helped her reflect on her teaching. She believed the alignment of assessment questions to specific objectives was essential to ensure that nonmajor students would develop an understanding of key concepts in biology that were relevant to their lives. As reported in an official course assessment record submitted to her institution, Rita indicated that students demonstrating low skills when assessed on their ability to relate this core concept might need additional support to master the concept.

I had three questions that I chose for my students. They were related to an objective for structure and function. And I had a plan where, if my students answer all three questions, I would say they mastered that objective at some level. If they answered only two, there is some performance that’s going on, they’re progressing. And if they didn’t answer anything, or only one, then those are really low skills. And so, I actually had some data to see that 75 percent of my students are meeting this [objective], but there’s 25 percent that are at low skills. Because this is the first time that we actually saw that, we didn’t have something to tell us how are these students performing on specific questions that align with these objectives. So, I think that’s important in teaching and learning because you usually have your average of the class at the end of the semester, but we never think about what did they get. So specifically for nonmajors and these students that are going to be making decisions about citizenship, and about vaccines and things like that, you want to make sure that there are specific things they know.

Second, Rita was willing to revise assessments and activities based on student performance. As expressed below, she proposed reviewing the item analysis data about student performance to tailor her instructional decisions to those students’ needs.

To me as an instructor, now I know 25% of my students don’t really meet the mastery that I was looking for, so that’s important to me. Why? How can we enforce this? Maybe we need to think about increasing learning activities that are related to those three questions.

Third, Amy used strategies to incorporate best practices in developing assessments by revising question format and organization. She drew on exemplar questions from the workshop and the accompanying workbook. Although multiple-choice questions requiring the selection of a single alternative were part of the final examination for an introductory biology course taught pre- and post-workshop, she introduced new types of questions—the multiple true-false—on the assessment designed post-workshop (see also Figure 1 in the Supplemental Material). Further, on the assessment post-workshop, she grouped multiple-choice questions based on content topics, such as photosynthesis and animal diversity, and labeled sections of the exam according to the topics and chapter numbers to help students activate their thinking about different topics. In contrast, the questions on the pre-workshop assessment were not identified according to chapter topics. Finally, she ordered questions on the assessment post-workshop according to the difficulty level, with the more difficult questions presented earlier in the test to account for possible student fatigue that generally sets in toward the end of a test.

I had never learned this before, this multiple true-false. And [the workshop facilitators] pointed out to us that when you’re asking a multiple-choice question, you’re not just asking them to choose one answer. You’re asking them to eliminate the other two or three. And so then I looked at this question. This is going to make much more sense. They’re pretty complex ideas, and it would make a lot more sense for them to take each one individually and have them think about each one, “is this false, is this true.” So that’s definitely a new change.

**Changes in Student Learning Activities**

There were two salient ways in which the course learning activities were revised to promote student learning (see Table 1 for codes associated with Question 4). First, Rita intentionally selected activities to achieve the learning objectives and to promote fairness in instruction. Due to the backward design framework, she became more cognizant of providing opportunities for students to engage in specific activities that align with course objectives and, subsequently, will be assessed. This acknowledgment marked a significant shift away from a limited focus on objectives and assessments and towards including carefully designed activities. Specifically, she added an outlining activity to support the content understanding aligned with chapter and course objectives and changed the presentation of objectives and grading policy in the course syllabus to incorporate this new activity. Compared to the syllabus for this course taught preworkshop prior to introducing this activity, the revised syllabus for the course taught postworkshop clearly indicated that completing outline notes consisting of questions and activities related to the chapter content was a key component of each chapter assignment.

For example, in a chapter about the skeletal system, the outline notes asked students to list the functions of the skeletal system and the types of bone cells and their functions in the remodeling of bone. These content ideas were also indicated as specific objectives on the chapter checklist, thus showing how the activity was aligned with those objectives. The quote below elaborates this point (see Figure 2 in Supplemental Material, showing how a laboratory-based activity was aligned with a specific objective of the overall course).

Before, I never gave too much thought to the learning activities. It was more of your syllabus has the objectives, and then you have an assessment. With that backward design, just thinking that your learning activities actually have to reinforce what you’re trying to...
assess that’s based on the objectives, that made it very interesting. So, now I have activity sheets that I give students. But I’m mindful to think, “How does it meet those objectives? Is there always a question that aligns with these objectives?” So, if a student uses it as a study guide, I know for sure they have had some engagement with what I’m going to assess them on later on, so that fairness—it is really important. Just giving students information and telling them this is my objective and then just giving them the preaching part of the teaching is not enough. So, the learning activities are really important. And so now, when I design my online courses, I usually have an information page that will have the objectives, and for my lab specifically, I always note on the top which course objective it relates to. So, I hope that’s more solid ground for my students.

Second, Rita began incorporating learning activities to promote real-world relevance and help students connect important concepts, such as the organismal, cellular, and molecular levels.

When we’re looking at protein functions, when we talk about the cell and protein functions, there’s one of the little animations on HHMI, which is about cystic fibrosis and other protein channels. Then there’s this movie trailer that’s [called] “Six Feet Apart.” And it talks about—before COVID—about this romantic relationship between two people, and they have to keep a distance of six feet apart because of cystic fibrosis and the bacterial infection transmission. So, I would first show them the video, and I would tell them, “OK, so this is at the organismal level.” And then, we could make the connection to the cellular level and the molecular level, and we could talk about proteins. So, my activities now are a little different. They relate more to life rather than if I tell them the protein does so and so, and they go and look up something, and I don’t know if they’re going to make the connection or not. I tried to make those connections because if I really want them to know the biological molecules and what they do, it has to make sense, it has to click, and so that’s a little bit easier for me.

Discussion

This interpretive qualitative study describes changes in the perspectives and practices of two postsecondary educators as they began redesigning assessments and instruction to support student learning in undergraduate introductory biology courses. After participating in a workshop focused on creating fair assessments, the educators appreciated the backward design logic behind aligning learning objectives, activities, and assessments. They were enthusiastic about applying their new knowledge in the classroom and using this logic in designing other courses within and beyond biology.

These positive shifts are consistent with calls for reforms envisioning course design that focuses on student learning and foregrounds planning of high-quality assessments to promote integrated and meaningful learning (American Association for the Advancement of Science [AAAS], 2011; Fink, 2007). The changes in perspectives are crucial because, typically, undergraduate instructors have subject-matter expertise but may have a limited background in learning theory and might be less aware of novice students’ actual needs and processes for learning the subject (Nathan & Petrosino, 2003). Hence, crafting and implementing well-designed assessments aligned with the learning objectives and activities can reveal student progress and difficulties in attaining the objectives and provide vital insights to reorganize course content. The study findings also showed that educators became cognizant of connecting key components of their instruction—objectives, activities, and assessments—at a more global level, across an entire course, and at a focused level within lessons or chapters. This is a promising finding because in applying the backward design logic on a more granular level, educators can strive consistently to gain crucial feedback and support their students’ learning based on and through individual lesson-level assessments and activities.

The educators’ approach in working with course objectives also changed. They became more intentional in planning and specifying objectives, aided by tools based on backward design and Bloom’s taxonomy introduced in the assessment workshop. They also communicated the objectives more clearly to students and considered the objectives as a starting point for revising assessments and instruction. These changes are especially promising as we consider some serious concerns about undergraduate introductory biology courses. Prior research shows that learning objectives are not always clear to students when courses are designed in a traditional linear manner and that instructors often lack the tools to establish and fine-tune goals and organize content around the goals (Minbiole, 2016). As evidenced in this study, the educators’ desire to make their course objectives explicit to students is a positive step toward designing fair and transparent instruction. Clarifying course objectives is likely to aid students in engaging purposefully with course content and in preparing for examinations and aid the educators in delivering the content with a clear roadmap to make suitable instructional choices.

Furthermore, the educators developed learning activities that explicitly targeted objectives and provided meaningful experiences. They also made initial attempts to align assessment questions with specific objectives and to reflect on student performance in considering revisions to activities and assessments. These efforts mark the beginning of a shift toward using assessments formatively to support student learning (Black et al., 2003). The measures align with key recommendations as called for by the AAAS (2011), namely, multiple modes of instruction (in this case, videos and discussions) and relating abstract concepts to real-world problems and scenarios. Additionally, the attempts at revising the format and organization of assessment questions based on best practices are important because instructor-designed examinations often become the basis on which to assess student performance and influence their academic pathways into STEM higher education.

Finally, it is important to underscore that these two educators implemented changes in courses for different student audiences and at different institutions. One course was aimed at nonmajor students at a two-year community college. In contrast, the other course was aimed at first-year students and provided a foundation for upper-level biology courses at a four-year undergraduate institution. Both educators came to understand the backward design logic, recognize its importance, and incorporate some of the tools and insights from the workshop into their course design, indicating the potential and value of such opportunities and structures for professional learning to refine instruction for supporting students with diverse academic inclinations. It is also worth noting that although the institutional contexts were different, a key similarity was that neither institution offered specific training or resources to help the educators craft and align learning objectives and high-quality assessments. We suspect that limited institutional support for assessment design is not uncommon in other community and liberal arts colleges and thus may pose barriers. Hence, professional development workshops are all the more vital in guiding the thinking and practices of college faculty to enact specific changes in course design.

Offering professional learning that helps educators improve instructional and assessment practices represents a necessary step
toward moving undergraduate biology courses from teaching-centered to learning-centered, prioritizing the intended student understanding to be achieved, and planning assessments and learning activities to reflect and reinforce those objectives. While these changes in introductory undergraduate science courses may help attract and retain students in STEM academic pathways, the changes are equally important for making science ideas meaningful and accessible for all students.

○ Limitations & Next Steps

This study sheds light on how professional learning experiences for postsecondary educators can improve instruction and assessments to enhance student learning. The findings suggest that even a one-day professional development program focused on assessment design can help educators incorporate new perspectives and practices that emphasize a strong alignment among course objectives, learning activities, and assessments. Nonetheless, the data captured changes from one unusual semester, in which there were temporary closures and shifts toward online learning due to the COVID-19 pandemic. Therefore, data from a larger sample of postsecondary educators are needed to better understand variations, over time, in applying their professional learning to revise assessments and teaching for in-person, online, and/or hybrid courses.

Relatedly, both educators in this study were early in their teaching careers. It is possible they were more open to adapting their instructional approach and incorporating insights and tools gained from the assessment workshop compared to more experienced college faculty who may be more firmly set in their instructional approaches. Therefore, to strengthen the generalizability of the findings, it would be important to investigate the professional learning of educators who are more advanced in their career trajectories. A more extensive study with educators in two-year and four-year institutions would help bring to light specific challenges and strategies for aiding college instructors with varying levels of prior instructional experience.

Further, this study did not address the cognitive level of the learning objectives designed by the educators. This is an important issue because there can be an overemphasis on lower-order cognitive skills focused on recalling scientific facts while attending teaching for in-person, online, and/or hybrid courses. Relatedly, both educators in this study were early in their teaching careers. It is possible they were more open to adapting their instructional approach and incorporating insights and tools gained from the assessment workshop compared to more experienced college faculty who may be more firmly set in their instructional approaches. Therefore, to strengthen the generalizability of the findings, it would be important to investigate the professional learning of educators who are more advanced in their career trajectories. A more extensive study with educators in two-year and four-year institutions would help bring to light specific challenges and strategies for aiding college instructors with varying levels of prior instructional experience.

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