Exploring Two-Year College Biology Instructors' Preferences around Teaching Strategies and Professional Development

Sarah B. Wise,†* Tim Archie,‡ and Sandra Laursen‡
†Center for STEM Learning and ‡Ethnography & Evaluation Research, University of Colorado Boulder, Boulder, CO 80309

ABSTRACT
Nearly half of all college students and the majority of college students of color begin their studies at 2-year colleges. The educational quality that these students experience will affect future success, but little research to date has focused on the professional development (PD) of their instructors. We offer an exploratory study on PD needs and preferences of ten 2-year college biology instructors who have experience with evidence-based instructional practices. Using a literature review and interview data, we address four research questions. We contextualize the interview results by describing interviewee teaching styles and their teaching and inclusion strategies, drawing on categorizations from education research literatures in and beyond biology. We then summarize interviewee experiences, preferences, and recommendations for PD. Most interviewees preferred PD that could be readily applied to their courses and included follow-up community support. While our purposive sample is limited, we note high levels of interest in PD supporting inclusive pedagogy and non-biology learning goals, such as study skills, metacognition, and quantitative skills. We describe implications for inclusive design of biology instructor PD.

INTRODUCTION
Two-year colleges (2YCs) play a crucial role in higher education in the United States and serve highly diverse students. Two-year college instructors are also highly diverse in many dimensions, including educational background (Willie and Stecklein, 1982), their part- or full-time work status (Akroyd *et al.*, 2011), number of classes to prepare (Belfield, 2015), outside employment, and salary (Cataldi *et al.*, 2005). As a group, they have different characteristics and work experiences than four-year college (4YC) instructors (Cataldi *et al.*, 2005; Reece, 2021). In this paper, we document a diverse range of teaching styles, teaching strategies, and professional development (PD) preferences as reported among a group of ten 2YC biology instructors. We embarked on this study to support a proposed PD project, recognizing that little research to date has focused on characterizing 2YC biology instructors or their instruction (Schinske *et al.*, 2017; Lo *et al.*, 2019). PD providers can use the data presented here to better prepare learning experiences for 2YC biology instructors.

Our collective lack of investigation of 2YC contexts comes at a cost. More than half of all 4YC students begin their studies in a 2YC, where they may develop fundamental study skills (Windham *et al.*, 2014) and attitudes toward engaging in scientific research (Nerio *et al.*, 2019). Their experiences in 2YCs may variously lead them to resist evidence-based instructional practices (EBIPs) or to demand them (Mohamed, 2008) and affect their ability to transfer and succeed at 4YCs (Eagan and Jaeger, 2009). However, student success and teaching reform movements have largely focused on instructors and students at 4YCs (Edenfield and McBrayer, 2020; Jensen *et al.*, 2020). In a review of biology education research, only 3% of all papers between 2012 and 2015 focused on the 2YC context (Schinske *et al.*, 2017). If

Kimberly Tanner, *Monitoring Editor*
Submitted Sep 15, 2021; Revised Mar 17, 2022; Accepted Mar 28, 2022
CBE Life Sci Educ June 1, 2022 21:ar39
DOI:10.1187/cbe.21-09-0250
*Address correspondence to: Sarah B. Wise (sarah.wise@colorado.edu).

biology education research aims to equitably support students in higher education, we must apply more attention to this context.

PROJECT ORIGIN AND RESEARCH QUESTIONS

This project was initiated to support the design of new PD workshops by leaders of the Howard Hughes Medical Institute's (HHMI) BioInteractive project. BioInteractive classroom resources include interactive lessons, videos, lesson sequences, and planning resources. HHMI leaders seek to help 2YC instructors make effective use of this material to improve 2YC biology education. To support them and other PD providers in planning effective experiences for 2YC biology instructors, we addressed four research questions (RQ). The first two are broad questions to identify what is already known about the use of EBIPs and PD in the specific context of 2YCs, and thus were addressed by summarizing science, technology, engineering, and mathematics (STEM) education literature:

RQ1. Which EBIPs and course structures benefit 2YC students?
RQ2. What is known about 2YC instructor use of EBIPs and PD?

a. What barriers and supports affect 2YC instructor use of EBIPs?
b. How do 2YC instructors engage in PD?
c. What PD structures are effective for 2YC instructors?

For a closer look at faculty perspectives on these topics, we interviewed ten 2YC biology instructors who had some experience with HHMI BioInteractive resources. These interviews provided the basis for addressing the last two research questions and their associated subquestions:

RQ3. What supports and barriers do 2YC biology instructors encounter around teaching?

a. What teaching strategies do interviewees use?
b. What are barriers and supports affect interviewees' use of EBIPs?

RQ4. What experiences and preferences do 2YC biology instructors have around PD?

a. What kinds of PD have interviewees experienced?
b. What barriers and supports do interviewees encounter around PD?
c. What preferences do interviewees have for teaching-related PD?

We developed these questions because we did not find a strong 2YC literature base in these areas and found value in integrating relevant literature across K–12 and higher education (Boyer, 1990). In approaching the interview study, we thought that existing teaching strategies might influence the barriers, supports, and preferences that interviewees might have. Understanding linkages between existing teaching strategies and factors that affect the use of EBIPs, as well as PD preferences that affect whether and how faculty participate, could shed light on ways to design effective PD for 2YC biology instructors.

LITERATURE REVIEW ADDRESSING RQ1 AND RQ2

Research-based instructional strategies (Dean and Hubbell, 2012), EBIPs (Stains and Vickrey, 2017), active learning (Bonwell and Eisen, 1991), scientific teaching (Handelsman *et al.*, 2007), and student-centered learning (Beach *et al.*, 2012) are all similar labels for teaching practices that differ from didactic lecture and are based on education research. In this paper, we collectively refer to all of these terms as EBIPs, and we included all variations in our review of literature addressing RQ1 and RQ2. Missett and Foster (2015) characterize EBIPs as "clearly described curricular interventions, programs, and instructional techniques with methodologically rigorous research bases supporting their effectiveness" (p. 97).

Best Practices for 2YC STEM Students

Which EBIPs and course structures benefit 2YC students? In examining RQ1, we found that literature from investigations of active learning involving 2YC STEM students is largely consistent with the 4YC literature. Two-year college biology students struggle to engage effectively with lecture-based teaching (Lysne *et al.*, 2013). Two-year college STEM students show attitudinal, performance, or retention gains with a wide variety of EBIPs (Lloyd and Eckhardt, 2010; Hawkins, 2011; Smith *et al.*, 2012; Paige, 2013; Bonney, 2015; Tamari *et al.*, 2015; Pape-Lindstrom *et al.*, 2018), transformed course structures (Lloyd and Eckhardt, 2010; Huang, 2018), and research experiences (Prunuske *et al.*, 2016; Nerio *et al.*, 2019).

As in 4YC settings, the impacts of EBIPs on 2YC student outcomes appear related to the extent of change from traditional instruction. Small reforms such as reading quizzes, demonstrations involving props, and case studies are associated with improvements in student attitudes and perceptions of learning (Bonney, 2015), and increased performance on questions (Tamari *et al.*, 2015) or exams (Pape-Lindstrom *et al.*, 2018). Clicker questions are associated with increased retention within individual courses (Hawkins, 2011).

More extensive instructional reforms are associated with more profound outcomes for 2YC students. For example, transforming a sequence of three chemistry courses such that students experienced an inquiry-based class, then a flipped class, and finally a project-based learning class increased student course performance and persistence across the sequence, with the largest gains found among Hispanic students (Burke, 2020). In another study of an immersive introductory chemistry class, in which students take a reduced course load to accommodate an intensive course structure, students showed increased course performance in the reformed course itself and a subsequent organic chemistry course and were more likely to graduate (Lloyd and Eckhardt, 2010). Two-year college students taking a set of Carnegie Math Pathways courses, which provide a transformed developmental math curriculum, instructor support, and institutional support, had much higher course completion than peers who took traditional developmental math (Huang, 2018).

In line with this trend, strong impacts were found for 2YC students engaging in 1- or 2-year-long mentored research experiences. These students experienced a stronger sense of connection to college, were more likely to graduate and remain in STEM fields, and were more likely to transfer to a university compared with peers (Prunuske *et al.*, 2016; Nerio *et al.*, 2019).

In sum, EBIPs involving structural changes to courses, course sequences, and cocurricular experiences appear most likely to improve 2YC student persistence, graduation, and transfer rates and to narrow equity gaps. Smaller, classroom-level interventions can improve student success in a particular course and thereby assist students' persistence through a program. While the literature for 2YC students is neither expansive nor detailed, it confirms that EBIPs benefit these students, in response to RQ1.

Two-Year College Instructor Use of EBIPs and PD

Barriers and Supports for Use of EBIPs. Despite the proven effectiveness of EBIPs in STEM disciplines, their use is not widespread among instructors at 4YCs (Henderson and Dancy, 2007; Stains *et al.*, 2018) and has not been measured among 2YC biology instructors. What do we know about barriers and supports that affect 2YC instructor use of EBIPs? These are also not well documented, but a significant body of more general literature helps us to answer RQ2A. Across this literature, some of the most commonly reported barriers to the use of EBIPs include: the need to cover a specified body of course content (Henderson and Dancy, 2007; Bathgate *et al.*, 2019; Sturtevant and Wheeler, 2019), instructor time constraints (Michael, 2007; Brownell and Tanner, 2012; Hora *et al.*, 2012), student resistance (Michael, 2007; Herreid and Schiller, 2013; Bathgate *et al.*, 2019; Apkarian *et al.*, 2021), unsupportive departmental culture (Henderson and Dancy, 2007; Hora *et al.*, 2012; Bradforth *et al.*, 2015; Corbo *et al.*, 2016; Shadle *et al.*, 2017; Wieman, 2017; Bathgate *et al.*, 2019), instructors' own lack of confidence in or negative attitude toward EBIPs (Shadle *et al.*, 2017; Sturtevant and Wheeler, 2019), classroom layouts not set up for group work (Sturtevant and Wheeler, 2019; Apkarian *et al.*, 2021), and lack of resources to acquire new materials or support new implementations (Elrod and Kezar, 2017).

Recently, Bathgate and colleagues (2019) found that perceived supports were more influential than barriers in relation to 4YC instructors' use of EBIPs. Thus, instead of focusing on eliminating barriers, supporting EBIP use may be more effective. Identified supports for using EBIPs are generally the opposite of barriers (Bathgate *et al.*, 2019), and they include academic receptivity (departmental support for research-based methods, positive department culture); logistic support (resources, time, agreements about course content coverage, classroom spaces conducive to group work); student receptivity toward EBIPs; instructors' personal comfort, confidence, and ability to use EBIPs; and prior experience with EBIPs (Apkarian *et al.*, 2021), including engaging with educational research around EBIPs (Hyson *et al.*, 2021). Other research has found that faculty beliefs regarding the positive results of EBIPs are the best predictor of their use (Madson *et al.*, 2017).

One study did examine 2YC biology in particular and reported similar barriers and supports to those seen in the wider literature. Corwin *et al.* (2019) identified several barriers to teaching quantitative biology using EBIPs, including perceptions of student deficits, tension between time to teach quantitative skills and cover biology content, and gaps in content and pedagogical content knowledge. They identified supports to implementation, including PD, use of previously developed curricular resources, collegial and peer support, course-level autonomy to use EBIPs, explicit course learning goals, student supports such as developmental courses and tutoring, and instructional grants (Corwin *et al.*, 2019).

Engagement in PD. Similar to the research on teaching practices in 2YC settings, there is limited research on PD for 2YC instructors (RQ2B). However, 2YC biology instructors identified PD as most influential in changing teaching practice (Corwin *et al.*, 2019), consistent with other literature (Laursen *et al.*, 2019). Further, 2YC instructors prioritized spending time on PD over conducting teaching research and basic research (Hardré, 2012). Instructors in the Corwin *et al.* (2019) valued PD workshops that taught them new skills and how to apply these skills to biology content.

Not all 2YC instructors engage in PD, however. They encounter barriers in finding time and funding (Hardré, 2012). Two-year college instructors are more likely to be motivated to participate in PD when they perceive the department, chair, and institution are supportive of it (Hardré, 2012; Diegel, 2013).

Effective PD. What does research on PD suggest about the design of effective learning experiences? We again must go beyond 2YC literature to infer answers to RQ2C. Among professional developers, conventional wisdom favors experiences that are substantially long. The "one-shot workshop" has been roundly criticized (Kennedy, 1999). In K–12 education, effective programs using both discrete and sustained formats have been reported (Kennedy, 1999), though some authors suggest that programs must have a sustained component and be at least 20 hours in length (Desimone, 2009). Some reviews of programs (Kennedy, 1999; Gonzalez *et al.*, 2022) found no relationship between contact time and effects, while another review noted that a 15-hour experience (Allen *et al.*, 2011) had a higher effect size than a different experience three times as long (Kennedy, 2016). That is, while very short PD experiences clearly do not provide sufficient time to support most practitioners in implementing an EBIP (Daly *et al.*, 2021), long durations do not guarantee effectiveness either. Such findings have led to a call for researchers to focus more on the underlying theory and content that drive PD design (Kennedy, 2016; Gonzalez *et al.*, 2022).

Recently, Kennedy noted that, although PD is valued, "there is little consensus about how PD works, that is, about what happens in PD, how it fosters teacher learning, and how it is expected to alter teaching practice" (Kennedy, 2016, p. 945). By classifying the underlying theory of action for different K–12 PD programs, Kennedy found that programs prescribing specific practices to teachers had low effect sizes, while others that focused on teaching strategies and developing insight had relatively high effect sizes. Within the strategy- and insight-focused modes of action, the most effective programs were presented by coaches or facilitators who adopted a collaborative approach with participants. Kennedy's findings emphasize the importance of the theory of change embedded in the PD, while also echoing some elements identified in an earlier review of PD design features. That review found that effective K–12 PD programs include follow-up steps in teachers' schools, active-learning methods, collective participation, and substantive attention to how students learn specific content (Blank and De Las Alas, 2009).

Kennedy (2016) also categorized what primary type of teaching challenge was targeted by the PD: conveying content, managing a classroom, engaging students, or understanding student thinking. She found that a focus on any of these areas can be beneficial to student learning. However, looking closely at programs focused on conveying content, she found that, in the most successful programs, "content was subsumed under a broader goal, such as helping teachers learn to expose student thinking" (Kennedy, 2016, p. 971). Likewise, a focus on understanding student thinking is also supported by a recent meta-analysis (Gonzales *et al.*, 2022)

What can we learn from the literature about PD supporting faculty use of EBIPs? A recent American Association for the Advancement of Science (AAAS) report summarized STEM PD in higher ed aimed at developing EBIP use (Laursen *et al.*, 2019). These opportunities have varied from shorter, 12-hour workshops (Stains *et al.*, 2015), to weeklong intensive experiences (Yoshinobu and Jones, 2012; Yoshinobu *et al.*, 2021), to graduate student training, faculty learning communities, and new faculty co-teaching experiences lasting a semester or more (Finelli *et al.*, 2014; Seidel *et al.*, 2017; Stang *et al.*, 2017; Corrales *et al.*, 2020). The opportunities are most frequently designed to raise awareness of EBIPs (Brawner *et al.*, 2002; Dokter, 2008; Henderson, 2008; Felder and Brent, 2010), help faculty create community around implementing EBIPs (Finelli *et al.*, 2014; Seidel *et al.*, 2017), develop courses and curricula that use such practices (Pelch and McConnell, 2016), or support new and future faculty (learning assistants, graduate teaching assistants, and postdocs) in planning for and implementing these practices (Otero *et al.*, 2010; Pfund *et al.*, 2012; Yoshinobu and Jones, 2012; Ebert-May *et al.*, 2015; Prevost *et al.*, 2018; Connolly *et al.*, 2018; Chasteen and Chattergoon, 2020). Several PD opportunities have resulted in at least half of faculty participants adopting or persisting in using EBIPs (Brawner *et al.*, 2002; Henderson, 2008; Felder and Brent, 2010; Yoshinobu and Jones, 2012; Wieman *et al.*, 2013; Stang *et al.*, 2017; DeMonbrun *et al.*, 2018; Archie *et al.*, 2021); however, there are some concerns that the reported gains may not be sustained over time (Wieman *et al.*, 2013; Chasteen *et al.*, 2015; Stains *et al.*, 2015). Other initiatives have sought to support PD providers in structuring and assessing impact of their offerings (Prather and Brissenden, 2008; Olmstead and Turpen, 2016). Laursen and colleagues (2019) note that these STEM PD opportunities have offered a strong focus on EBIPs, but less emphasis around shaping instructor beliefs and attitudes or helping them implement approaches that advance equity in the classroom.

To address RQ2C, our review suggests that PD can be effective in promoting EBIPs, but also points to an overemphasis on prescriptive structures for teaching-related PD. Providing PD that focuses on providing supports and developing teaching insights and strategies may be more productive. For all college instructors, new models for PD and instructor supports promoting EBIPs warrant attention.

STUDY METHODS

Interviews

We chose to interview 2YC biology instructors to illustrate the variety of their PD needs and interests and to contextualize these needs and interests by individuals' professional experiences, strategies, and styles. Interviews provide particular value for exploratory investigations where the literature base is not deep (Miles and Huberman, 1994), as in this case (Schinske *et al.*, 2017). Interviews are well suited for exploring a real-world phenomenon in depth in a natural context; they emphasize participants' lived experiences and the meaning people make of these experiences (Miles and Huberman, 1994). The resulting rich description may be used in developing hypotheses and instruments for other types of studies, such as surveys. In the context of the overall project, these interviews provided guidance to professional developers planning a program and a basis for developing a survey that will characterize 2YC biology instructor professional needs and interests from a larger sample.

Following project Institutional Review Board approval (protocol 20-0721, University of Colorado Boulder), we recruited ten 2YC biology instructor interviewees with some active-learning experience, using a list of contacts from HHMI and additional suggestions provided by Dr. Lisa Corwin, a biology education researcher. Interviews with consenting participants were semistructured, with probes related to our research questions, especially teaching strategies, PD experiences, and PD needs and preferences (see Supplemental Material). Interviews were conducted and recorded using Zoom online conferencing and lasted about 1 hour. We stopped recruiting interviewees once we had a pool that was diverse with respect to gender, race, ethnicity, geographic location, teaching style, and full-time/part-time teaching status and after we noticed patterns emerging in interviewee responses. Following the interviews, interviewees completed a brief survey to confirm demographic and contextual information that was not collected systematically in the interview.

The interview sample included full-time biology instructors, each with more than 4 years of teaching experience. They worked at 10 different 2YCs located in the southeastern, northeastern, and western United States. About three-quarters worked in a multi-campus system, rather than on a stand-alone campus. Two interviewees were part-time adjuncts; those teaching full-time had a variety of titles, including instructor, associate professor, and professor. One interviewee was also the department chair. Two interviewees taught occasionally at a second 2YC campus, and two taught at another 2YC regularly. All interviewees taught class sizes of 15–60 students; only one taught a class of more than 100 students. The interviewee sample included individuals identifying as men and women and as Black, Hispanic, and white.

Data Analysis

Interview analysis began immediately after the interviews, by writing analytic memos that noted emergent themes and patterns in the data. The memos and automatically generated Zoom transcripts provided the basis for a thematic analysis (Saldaña, 2016), which was guided by the literature review and research questions. This analysis included compiling tables of teaching and inclusion strategies, levels of collegial and administrator support, and PD experiences reported by each individual. A theme emerged related to whether instructors engaged students in group work, and we began to look at whether this related to their other teaching, collegial, and PD experiences. Difficulty in comparing collegial and PD experiences across interviewees led us to request additional information systematically, using a short questionnaire.

Finally, we went back to the original interview topics to classify individual teaching styles, reported teaching strategies, and

TABLE 1. Interviewee teaching styles, example teaching strategies, example inclusion strategies, and relative amount of PD experiences over the last 5 years

Pseudonym	Teaching style[a]	Teaching strategies	Inclusion strategies	PD experiences[b]
Mel	Didactic	Lecture, no group work	Avoiding bias; 1:1 emails	Few
Gina	Didactic	Lecture, no group work	Brain breaks; scientist spotlights	Few
Jen	Interactive lecture	Whole-class discussion, adaptive technology	Community builder questions; offers flexibility and support resources	Some
Margot	Student centered	Metacognition, inclusion, skills	Growth mindset, metacognition activities	Many
Ronnie	Student centered	Flipped, process-oriented guided-inquiry learning (POGIL), think-pair-share (TPS)	Intro module to address hidden curriculum	Some
Sonia	Student centered	Metacognition, inclusion, cases, random call	Random call; replace office hour with interactive practice session	Many
Pieter	Student centered	Flipped, cases, inquiry based learning, skills	Synthesizes peer-review feedback	Many
Viktor	Student centered	Flipped, daily assessment, skills	Offers flexibility; works to understand student backgrounds	Many
Liana	Student centered	Flipped, competency-based assessment; skills	Rewriting OpenStax text to improve scientist representation	Many
Terra	Student centered	Flipped, cases, community science inquiry	Anxiety-reduction strategies; offering resources	Many

[a]Based on Stains *et al.* (2018).
[b]Few = 1–4; some = 5–9; many = 10 or more.

inclusion strategies based on existing frameworks. To describe the range of teaching activities across the sample in ways that are aligned with other studies, we classified the reported teaching strategies according to types of active learning in biology developed by Driessen and colleagues (2020). We used these data, along with transcripts and survey results, to further classify individuals' overall teaching styles as didactic, interactive, or student centered, in parallel with categories derived from observation work of Stains and colleagues (2018). In addition, we categorized interviewee-reported strategies for advancing equity and inclusion in the classroom according to five principles summarized by Draffan and colleagues (2017). Descriptions of these categorization schemes are presented alongside the results in the next section. Categorizations are based on the entirety of the interview transcript; not every piece of evidence supporting the category is presented in the *Results* section.

RESULTS

We first present an overview table referencing interviewees by their pseudonyms and describing their teaching styles, specific examples of their teaching and inclusion strategies, and an estimate of their relative amounts of PD experience (Table 1).

To address RQ3, we then explore and explain the classification of interviewee-reported teaching strategies, teaching style, and inclusion strategies, using illustrative quotes. These provide important context for results related to RQ4 about experiences around and preferences for PD. Addressing that question, we describe interviewee perceptions of collegial support, reported PD experiences, barriers to and supports for PD, and PD preferences. We explore the preferences of both the group as a whole and within the subgroup of interviewees who had few experiences with PD.

Teaching Strategies

The teaching strategies discussed by the interviewees were highly variable, with almost 40 unique strategies described across the group. Most of these strategies are described in the education literature, but one strategy of using student notes and formative assessment to support the development of transferable study skills was previously unknown to us and was described as self-developed. As a group, the reported strategies align well with categories generated by Driessen and colleagues (2020) in a review of active learning in biology education research (Table 2). Among the interviewees, all nine strategy categories were reported, but Practicing Core Competencies (as defined by *Vision and Change*, AAAS, 2009) and Assessment strategies were the most frequently reported. On average, each interviewee reported about five specific strategies from about four categories. The number of strategies reported by individuals ranged from two to eight, and the number of categories that individual strategies fell into ranged from two to six. As we only asked interviewees to describe "favorite" strategies, these numbers are underestimates of their full range of teaching practices.

Teaching Styles

The pedagogical foci of interviewees ranged from presenting entertaining, student-relevant lectures to engaging students in analyzing biology data sets. Most interviewees involved students in some kind of group work in at least some classes. Based on their reported teaching strategies, we categorized each interviewee's overall teaching style as didactic, interactive, or student-centered, following the categories derived from classroom observation work by Stains and colleagues (2018). In this characterization, a "didactic" style refers to lecture with occasional questions, an "interactive" style includes lecture with frequent teacher questions and occasional student group work, and a "student-centered" style has frequent student group work and reduced time lecturing.

We classified seven of the 10 interviewees as having a student-centered teaching style; one was classified as interactive and two as didactic (Table 2). To illustrate how we arrived at these categorizations, we provide quotations from instructors classified into each style, along with some of their statements about why they chose this style of teaching.

TABLE 2. Teaching strategies reported by interviewees

Category[a]	Teaching strategy as described by interviewee(s)[b]	Individual teaching styles[c]
Games	Gamified activities (3)	D, S, S
Paper Work	In class activities–unspecified (4)	S, S, S, S
Conceptual Class Design	Flipped/Web enhanced (3)	S, S, S
	Backward design	S
Live-action visuals	Using Prezi	S
	Presents HHMI activities as a part of lecture	D
Practice Core Competencies	Skill-based learning outcomes (3)	S, S, S
	Case studies (2)	S, S
	Lectures with engaging, relevant examples	D
	Lectures with scaffolded diagramming and note-taking	D
	Working with data sets	S
	Encouraging revision of work	S
	Community science projects	S
	Virtual labs	I
Assessment	Very frequent formative assessment (3)	S, S, S
	Card-based "clicker"; Zoom polling; Mentimeter (3)	S, S, S
	Two-part assessment, using IF-AT scratch cards	S
	Competency-based assessment	S
	Required practice exams	I
	Prior knowledge assessment with optional practice modules	S
	Point-less grading scheme	S
	"Mastering Biology" activities	I
	HHMI Biointeractive activities (3)	I, S, S
Group Work	Project-based learning, team-based learning (2)	S, S
	Process-oriented guided-inquiry learning (POGIL)	S
	Collaborative review activities (whiteboard or Google Doc)	I
Discussion	Draw out student connections, expertise (3)	I, S, S
	Think–pair–share	S
	Random call	S
	Online discussion boards	D
Metacognition	Reading notes/worksheets (2)	S, S
	Activities drawn from contemplative pedagogy	S
	Learning journals	S

[a]Categorized according to Driessen *et al.* (2020).
[b]If more than one interviewee reported a strategy, the number is reported in parentheses.
[c]From Stains *et al.* (2018). The teaching styles of the interviewees reporting each strategy: D, didactic; I, interactive; S, student-centered.

Didactic Style of Instruction. Mel was one of two instructors whose teaching we classified as didactic, based on her emphasis on presenting information and because she does not involve students in group work. Her teaching strategies were classified as falling into Discussion and Games (Table 2). Her comments emphasized developing individual relationships with students and presenting material in a variety of ways.

> Mel: I started off a long time ago teaching junior high school. That taught me that everybody can learn something, you just have to find a way to project that information to those individuals…. So I found different methods to help all of my students. I like to use gamification in my classes … and like to use small incentives for the gaming…. I like to use Jeopardy with my classes… with music and everything. I love to see them get excited about the bonus points…. I try to build a relationship with them… building a rapport with the students, I think, is the number one thing to get them interested…. What I believe is that… if you establish a relationship with students, then they feel… obligated to do what [they] are supposed to do. So they feel a sense of obligation to you. I want that… because I know it's going to keep them accountable.
>
> Interviewer: Do you have students work in pairs or small groups at any point in your classes?
>
> Mel: Not in the online [environment]. I've never preferred working in groups…. I'm very much an introvert. I've never liked working in groups; …the other reason is that not every one carries their weight.

Interactive Style of Instruction. Like Mel, Jen sought to include lecture material that connected to diverse student experiences. She also described a passion for leveraging academic technologies to support student learning. In this passage, for example, she describes strategies that we categorized as Paper Work and Discussion (Table 2). Based on the fact that Jen described using group work on occasion and integrated a variety of ways to learn, review, and practice material in class, we classified her style as interactive (Stains *et al.*, 2018).

> Jen: I like to use a lot of variety, because I know there's different learners in the class. So, in the past I've used things like Edpuzzles, which … has a short video and there are questions that you can embed within the video.… So I've assigned that in the past, thinking "that's going to be the game changer!" It helped, but you know, students get out of it what they put into it. I've consistently used Pearson's product, "Mastering A&P" or "Mastering Biology" to assign … Dynamic Biology tutorials where students get feedback about how they answer things. Students report that they like it,… they find it helpful.
>
> Interviewer: Do you have things you like to do to get them engaged with you, or with each other?
>
> Jen: Less so … getting students to connect with each other… that's kind of up to them … I try to start off with something … to try to get them hooked into the subject. I'll put up an interesting picture and ask what they see, what connections do they see, to see if they will respond. Mostly they are silent, they don't want to say anything or participate.… I just think they're just used to being very passive. Just sitting there and receiving all the answers and receiving all the notes and assignments.

Student-Centered Style of Instruction. Finally, Liana is an example of an instructor classified as student centered. In this passage, she describes her use of Conceptual Course Design, Group Work, Practicing Core Competencies, and Assessment (Table 2). Like other student-centered instructors in this data set, she described using formative assessment to understand student thinking and tailor her teaching to support efficient learning.

> Liana: My biggest thing is trying to figure out … particularly with two year college … particularly working as an adjunct, I can give it all and my students really, really can't. They have so many demands on their time. So when I have their time and attention, [I want to] engage them, be as efficient as possible with their learning, … working on things that are high retention, high recall. Allowing them to trip on the big misconceptions when I have them in front of me, so I can catch it and get them over those big spots … [We] do a lot of active learning—particularly now that we are fully on Zoom, I wander somewhere near flipped. We have reading guides beforehand,… [then] two to three activities per three hour class, usually in small group. Right now I'm teaching competency-based, which I'm absolutely loving … so they have all semester to show grasp of the core concepts and … show skill in eight scientific skills.… Since we are assessing skill, we have to practice skill in class, I can't just talk at them.

The instructors using a student-centered style reported a wide variety of pedagogical foci. Three student-centered instructors had flipped their classes, while two focused on involving students in investigations using real data. Another used daily formative assessment to support students in developing study and note-taking skills, and another applied contemplative pedagogy techniques (Zajonc, 2014) to help students make connections between the course material and their lived experiences. All of these instructors involved students in extensive group work and described working to reduce the time they spent lecturing in class (Stains *et al.*, 2018).

These interviewee statements reflect that instructors using different teaching styles have different explicit and implicit beliefs about their students' learning, and the teacher's role in motivating and supporting students. Mel states that student learning is aided when students feel a sense of obligation; a need to please her, as the instructor, can hold students accountable to accomplish the course learning objectives. Jen describes students as primarily learning individually and somewhat passively. Like Mel, Jen portrays her role as coaxing them to develop the interest to learn on their own. In contrast, Liana appears to believe that group work helps time-constrained 2YC students learn efficiently. In describing EBIPs such as flipping, focusing on misconceptions, and competency-based assessments, she centers opportunities for students to grapple with difficult material in her presence and thus puts students in charge of their learning while supporting them in this process: "We have to practice;… I can't just talk at them."

Strategies to Advance Equity and Inclusion

All interviewees reported using strategies to promote equity and inclusion in their classrooms, and the numbers of strategies they reported were not noticeably connected to teaching style. The most frequently described strategies were developing one-on-one relationships with students, flexibly responding to student needs, taking steps to reduce student anxiety, and increasing visibility of people from underrepresented groups in the curriculum (Table 3). Many interviewees also connected specific teaching strategies to equity and inclusion goals. For example, Sonia described using random call to promote equitable participation in the classroom:

> Sonia: Doing the random call method, … that makes sure that we're not having one voice in the discussion. I'm actually doing a study right now with colleagues … [about] how does getting called on in class benefit, how does it interfere? … We were concerned about the anxiety and what that might be doing. The biggest response we got was that it does not interfere with their learning. There are some with high anxiety, but they do pass. Some of them like hearing other people's perspectives; … [some] like practicing articulating their thoughts. The people in a random call classroom are saying they hear more voices than in a non-random call classroom.… Students said they were more likely to not skip class, if they thought they might get called on.

Interviewees varied in their levels of experience with equity and inclusion strategies. At least one had been active in national conversations on these issues, and several described multiple strategies to address equity, while others described fewer strategies. Many of the instructors reporting fewer strategies also indicated they would like to learn or do more around equity and inclusion, including Jen:

> Jen: When I teach about the reproductive system, I try to use gender-neutral terminology, like "a person with ovaries"… I'm happy to make that change. [My county] is mostly white and middle-aged… most of my classes are white and female, but we do have Black and Latino students, and there are probably LGBTQ students. I don't ask students about [that].… One of the first assignments is to introduce themselves, it's online, and one of the things I aim to do [in the future] is ask them their pronouns.

TABLE 3. Strategies for advancing equity and inclusion reported by interviewees

Principle[a]	Strategy reported by interviewees[b]	Individual teaching styles[c]
Being Flexible	Willing to alter class structures or policies to meet student needs	D, S
	Flexible access to materials/providing Zoom recordings (2)	I, S
	Online classes are largely asynchronous (2)	I, S
Being Equitable	Not using anti-cheating software (2)	S, S
	First-week "hidden curriculum" class module	S
	Structures intended to reduce student anxiety (4)	D, S, S, S
	Wait time after asking a question	I
	Combat impostor syndrome	S
	OpenStax textbook, to reduce costs	S
	Reduce bias by sticking to written policies/syllabus	D
	Random call to allow all voices to be heard	S
Working Collaboratively	Community-building question to start lesson	I
	Former students explain class to new students	S
	Stable group assignments	S
	Instructor synthesizes feedback from group peer review and communicates to individuals	S
	Replace office hour with optional interactive practice session	S
Supporting Personalization	1:1 conversations/emails (3)	D, D, S
	Gender-neutral language and/or pronouns (2)	D, I
	Memorize names (2)	D, S
	Collect information to understand student backgrounds (2)	I, S
	Growth mindset and metacognitive activities (2)	S, S
	Explain "I'm here to help" and provide support resources (3)	D, I, S
	In-class brain break	D
Embracing Diversity	Real scientist spotlights (3)	D, S, S

[a]Organized according to principles of inclusive teaching summarized by Draffan and colleagues (2017).
[b]If more than one interviewee reported a strategy, the number is reported in parentheses.
[c]From Stains *et al.* (2018). The teaching styles of the interviewees reporting each strategy: D, didactic; I, interactive; S, student-centered.

Interviewer: Is there anything you do in the hopes to make it more comfortable for students, given there is one dominant category?

Jen: I'm not sure. I tell students I'm here to help and there's more than one answer. If they have trouble with Internet access … and miss a class, I have video recordings that they can have. But I don't have any [strategies] specific to … race or gender…. I feel like this is more pertaining to learning issues and ADA accommodations…. I teach 4–5 students and maybe 3 students have accommodations. If we could capture more of them, that number could go up.

Gina described a growing awareness around inclusion, leading her to check on individual students more frequently:

Gina: Staff members … have made us really aware that there's a large subset of our population that's food insecure, and I had no idea…. So I come off as really strict and then, if a student approaches me and says, "Look I missed this," or "I couldn't take my kids to daycare" … then behind the scenes, I will help them out. When students don't show up, I've been sending them an email, like, "Hey, are you okay?" and then I have some language that I've been given to have them reach out to resources they need…. Maybe I have always had transgender students and I never realized it, but I finally started getting students who asked me to use certain pronouns … Of course I did what they asked me to and respected that, but I was still confused. Now I kind of get it more, and I understand…. The last two years, between the MeToo movement, … Black Lives Matter, food insecurity … like, where was I four years ago? I have no idea … [but] it's a part of our growth. It's a seed that's planted [now] when I deal with students.

We classified interviewee-reported equity and inclusion strategies using five principles of inclusive teaching summarized by Draffan and colleagues (2017). For example, in the passages quoted previously, we identify Gina's strategies as specific examples of Supporting Personalization. The full list of strategies is shown in Table 3, and the teaching style for each interviewee who noted a particular strategy is shown in the third column.

The reported strategies most frequently aligned with the principles of Being Equitable, Working Collaboratively, and Supporting Personalization. Strategies aligning with the principles of Being Flexible and Embracing Diversity were relatively less common. On average, interviewees reported about four specific equity and inclusion strategies from about two categories. The number of strategies reported by individuals ranged from one to seven, and the number of categories for those strategies ranged from one to five. As we only asked for strategies that interviewees "typically use," these numbers should be taken as underestimates of instructors' full ranges of inclusive strategies.

Structural and Collegial Support

Because collegial support may affect implementation of EBIPs (Bathgate *et al.*, 2019; c.f. Archie *et al.*, 2021), we asked interviewees to report their sense of support from their colleagues and college administrators for their teaching. Six of the 10 interviewees reported that their colleagues were very supportive of their teaching. Five of these six also reported feeling somewhat or very supported by their administrators. One interviewee who uses a didactic style said, “There are colleagues that I can share ideas with and get feedback. They are very resourceful and are willing to help as well.” Two of the student-centered interviewees cited administrative initiatives around integrating research in the classroom and around competency-based assessment as providing strong support for their use of EBIPs.

However, feelings of general support did not mean an absence of collegial tensions for these instructors. An instructor who focused on engaging students with real data sets commented,

> Pieter: The whole time I’ve been there, our administration has been nothing but … helpful and on board with looking at new strategies in the classroom, even this “point-less” [grading] approach…. Any sort of supplies that we ever need[ed], I’ve never been told, “No.”…The only problem is… I mean, my colleagues are great, but maybe this is a common thread [in] most places—we have some instructors who are just satisfied with … lecturing and then being done with it…. They’re very satisfied with just using publisher-based PowerPoints to teach from…. So it’s hard to get … the perspective [across] that maybe, maybe we can still hit … certain concepts really deep … but let’s train the students to be scientists, rather than train them to be students.

Three other interviewees reported that collegial support for their work was mixed, and one felt unsupported by colleagues. Among this group, three interviewees (two with a student-centered style and one with a didactic style) also felt mixed or limited support from their administrators. Gina recounted some negative collegial interactions.

> Gina: So I’ve been feeling more and more, as the years go on, that I am considered maybe old-fashioned. The new trend at my school is student-based research … even in the non-science majors’ [classes], they’re doing labs that have been flipped to more of an inquiry-type thing…. Everybody used to be like me. And now everybody’s doing something different … I support my colleagues who teach differently, but I don’t feel they support me.… You know, I have been called uninvolved by a teacher, and I have been told by another colleague that she does “real science” [but I don’t].

Margot, the student-centered instructor who draws many techniques from contemplative pedagogy, also related a feeling of being judged.

> Margot: [When I saw] the impact on the students, I couldn’t go back. In a way, it helped me get to a point where I thought, … “It’s OK if my colleagues in the department say that I’m ’not rigorous enough,’ or ’not traditional.’” [pause] So more recently I’ve been looking at … what grades mean, and the … way they perpetuate gaps and inequities and racism,… and I’ve been looking at alternative ways of evaluating…. And that’s really tough, for STEM faculty. And so, I have noticed that in department meetings, I tend to be quiet … when it comes to this topic. And … feeling … really vulnerable…. Yeah, there are days when it’s more difficult.… and I have kindness toward [my colleagues], and compassion, and empathy, I know why, they’re probably scared, they’ve probably bought into a racist system. They aren’t bad people. It’s just, the judgment is so harsh.

Several interviewees also mentioned feeling stigmatized by colleagues from other institutions. For example, Terra described feeling looked down upon by both 4YC faculty and high school counselors:

> Terra: I will be in a meeting with four-year colleagues … [and] once they hear you work at a community college, whatever you have to say is not important…. And you know, we educate half of the students in this country … for their first two years…. But there’s still that stigma…. We actually hear this in our region, [that] high school counselors put us as last resort [in advising students].

Overall, while respondents’ experiences of support from colleagues and administrative initiatives varied, many interviewees experienced ongoing collegial tension related to their styles of teaching and the fact that they work in a 2YC. For one interviewee who taught in a student-centered style, this kind of tension led them to move to another campus, “specifically because my current campus has strong support for active learning, formative assessment, and … mastery grading.”

PD Experiences

Interviewees uniformly valued PD, and all reported having had some supportive PD experiences. Some noted barriers to engagement, and some expressed disappointment with prior PD experiences. Viktor, who is chair of his department and engaged on a committee to reform PD at his college, voiced a call to action for PD providers:

> Viktor: There is a real need for professional development at the two-year college…. At a national level, we just haven’t really focused on the two-year college. And it’d be great if somebody can pull together something … that we can all participate in. You know most of folks of color from low-income backgrounds start at the community college. So, we can’t close this equity gap until we address this.… Where a lot of professional development falls short is, you do onetime seminars and then it’s like, “Okay, go forth.” And nobody follows up to say, “Does this really work?” Yeah, they may find … this is not working for any of our participants, so maybe we should rethink what we are presenting.

All but three interviewees attended at least one PD event a year, and five had attended more than 10 events in the last 5 years (Table 1). Most had had a wide variety of PD experiences through a number of providers, including their graduate training institutions, their colleges and colleagues, local and state-level organizations, national professional societies, publishers, and also social media groups. A few interviewees drew strategies from non-STEM books and non-STEM education conferences.

Several student-centered interviewees spoke of learning EBIP strategies and developing support networks for their teaching through their PD experiences. Ronnie, a student-centered instructor, described her network as filling an unmet need.

TABLE 4. PD structures preferred by interviewees

Structures	No. of interviewees preferring this (out of 10)
PD with a follow-up support or a community network component	8
PD about non-biology goals (such as: science skills, quantitative skills, mindset, metacognition, study skills, getting students involved in research or other opportunities, avoiding microaggressions, inclusion, peer review, effective group collaboration, etc.)	7
PD that gives participants time to work on aspects of their own courses	5
PD in which two or more people from the same department participate together	5
PD scheduled over semester/summer breaks	5
PD in which small groups plan and practice implementing a teaching strategy of common interest	4
PD with a component where participants later teach colleagues about what they learned or have become skilled at implementing	4
PD specific to a subdiscipline of biology offered	3
Fully online PD	2
PD that brings people from different STEM disciplines together	1
PD around collaborating in biology education research (focused on 2YC context)	0

> Ronnie: Even having been involved in the HHMI BioInteractive Academy, for this short period of time, it's given me a network that I feel is lacking at my current job…. I am able to interact with all these people that have similar teaching philosophies to mine, and are as enthusiastic as I am.

Pieter, another student-centered instructor, spoke about having a variety of people outside of his department to bounce ideas off.

> Pieter: We are in the same building … as the nursing school. The nursing instructors, I can bounce ideas off them…. And SEA-PHAGES [an HHMI initiative: see https://seaphages.org], they … have people in cohorts,… there are message boards and forums, and those folks you can contact anytime, bounce ideas off any of them … and all of them are in research-based practices for students. And so, it's helpful.

Four interviewees described primarily inventing their own teaching techniques or learning from colleagues, as opposed to learning techniques from education classes or PD experiences. These four included the two didactic instructors, the single interactive instructor, and one student-centered instructor. One of the didactic instructors, Mel, had only two PD experiences outside the college across her career, despite expressing high value for such experiences.

> Mel: A lot of stuff has been trial and error for me. Then I find later that I'm not the only one doing this stuff; … other people through time have found that this is what helps…. After I get talking to people—since once again I'm an introvert—[I discover] I do things the hard way a lot of times, when I could have just asked the more experienced person, but I just…. I know everyone is busy, and we haven't had a lot of professional development opportunities that were specific to my area. Even before COVID, they didn't want to send us anywhere—I guess the funding wasn't there.

Barriers to Engaging in PD

As documented in the literature (Bathgate *et al.*, 2019; Sturtevant and Wheeler, 2019), the primary difficulties interviewees cited around engaging in PD were getting released from teaching duties and a lack of funding. One interviewee was allocated funding only to attend within-state PD. Another noted that opportunities requiring instructional teams to attend PD together can be a barrier, because many 2YC faculty are the only representatives of their disciplines in their colleges. Several noted that online PD can ease some of these barriers.

Several interviewees described difficulty in implementing what they were presented during PD. Interviewees recommended that curricula provided take a "plug-and-play" form, because they lack time to make extensive modifications. They also noted that any recommended student materials need to be free and open access.

Preferred PD Structures

The K–12 literature contains recommendations for the ways that PD should be structured (Desimone, 2009), but we do not know whether such structures are compatible with the needs of 2YC biology instructors. Interviewees were asked to read a noncomprehensive list of structural options and identify those they thought would be most beneficial for PD providers to offer. Table 4 lists these structures in order of most to least popular.

Nearly all interviewees noted community support as a desirable structure within PD, echoing the needs described earlier. This structure was also noted by many to align well with structures that gave participants time to generate a product. Several interviewees suggested PD would ideally involve a cycle wherein instructors generate a product, try it in class, and then return to their PD communities to discuss it.

Interviewees also expressed strong interest in PD that would allow them to advance non-biology learning goals; one characterized this structure as "crucial." Interviewees wanted to learn more about many topics outside biology, including diversity and inclusion, science and quantitative skills, study skills, metacognition, growth mindset, and collaboration. This finding may be related to a greater focus by 2YC instructors on transferable skills, given the importance of 2YC preparation to the success of their students in subsequent jobs and transfer institutions (Reece, 2021). Of relevance to PD design is the fact that skill-related learning outcomes for 2YC students are enhanced within classes taught with a student-centered teaching style (Haukoos and Penick, 1983; Hora *et al.*, 2020).

Within discussions of PD for non-biology learning goals, interviewees highlighted the need for PD around incorporating inclusion and social justice into biology classes. Sonia suggested that PD with a theme of inclusion should "bombard with facts about what works" while also giving participants enough time and space to practice effective techniques. She also mentioned that faculty mentoring or community support is particularly important for learning to be more inclusive and equitable: "Walk with them as they slowly reinvent the wheel."

Two of the interviewees had few PD experiences, and both teach in a didactic style. Both of these instructors teach in a didactic style. Compared with others, these interviewees expressed more interest in content-specific PD, for example, focused on anatomy and physiology or ecology and evolution. One noted that the general PD experiences offered by her college made it hard for her to apply new ideas to her courses.

In line with these patterns, interviewees more experienced with PD speculated that subdiscipline-specific offerings "might bring new people in" to the EBIP fold. One warned PD providers to not "assume [participants] are teaching in their area of expertise." On the other hand, another interviewee argued that didactic-style instructors especially need PD related to the skills 2YC students need to be successful in transferring to 4YCs.

DISCUSSION

Limitations

In this study, the majority of interviewees were classified as student-centered instructors, in contrast with national samples that document higher proportions of didactic and interactive instructors (Stains *et al.*, 2018). Moreover, several individuals were engaged in biology education research and national education initiatives, and as a group they were active in pursuing PD. The interviewee sample in this study was not intended to represent all 2YC biology instructors: These instructors had used HHMI educational resources and elected to engage in an interview about instruction. Therefore, our sample should not be considered to represent the broader population of 2YC biology instructors; in particular, it lacks depth in didactic, interactive, and adjunct teaching perspectives. Nonetheless, speakers offer valuable insights relevant to the design of PD and may represent those who would elect to participate in biology teaching PD. It also produced themes about the use of EBIPs and PD preferences, and those themes were used to develop a generalizable survey of 2YC biology instructors. Results of that survey are the subject of a future paper.

Ramifications for Design of PD for 2YC Biology Instructors

At the broadest level, these findings from both our review of literature and our qualitative study should give confidence to professional developers that EBIPs are applicable and relevant to 2YC settings. Because the supports and challenges to instructors in adopting EBIPs are comparable across 2YC and 4YC settings, much of what is known about PD is likely to apply to 2YC instructors as well as to their 4YC counterparts. At the same time, the study highlights how the context for 2YC instructors' work shapes their teaching needs, interests, and opportunities in ways that should in turn shape the design and conduct of teaching-related PD for these faculty.

As in our sample, people with all three teaching styles—didactic, interactive, and student-centered—may be present in any 2YC PD setting, and their interests and needs likewise vary. For example, interviewees with didactic teaching style desired more focus on subdiscipline-specific content, while interviewees with student-centered styles were interested in topics that may not be familiar to those with didactic styles, such as "pointless" grading (grading approaches that emphasize feedback over assigning points; Zerwin, 2020) and contemplative pedagogy (approaches that emphasize reflection and awareness to generate deeper learning; Barbezat and Bush, 2014). Therefore, PD participants with different teaching styles may respond to different PD approaches and content. To inform design that meets participant needs and also advances the use of EBIPs, PD providers will need to plan for a varied audience. They may wish to use pre-workshop questionnaires to probe the incoming teaching styles and interests of participants or to craft differentiated tasks for different subgroups.

We investigated some possible influences on the teaching styles of interviewees. We did not find a strong correlation between any teaching style and the support of colleagues or administrators: most interviewees felt supported by at least some colleagues and administrators, while simultaneously feeling tension with colleagues who use different teaching styles. We were struck by the fact that interviewees tended to elaborate upon negative social experiences around teaching more than the structural barriers to teaching or attending PD, even when structural barriers were present. Understanding the relationship between teaching style and support is important, because local collegial support has been reported to affect implementation of EBIPs (Bathgate *et al.*, 2019), even if this is weak in comparison to strong PD support (Archie *et al.*, 2021). Several interviewees reported finding supportive individuals external to their departments or colleges—often through PD experiences. Similarly, almost all interviewees identified "PD with community or follow-up support" as an important PD structure, and this desire resonates with the known efficacy of faculty learning communities in 2YC settings (Cox, 2013). For instructors who lack collegial support or who are at small campuses, such broader community support may be a lifeline.

We did notice a pattern in the origin of individuals' preferred strategies: those with didactic and interactive styles reported frequently developing their own strategies or learning them from colleagues, while those with student-centered styles mostly reported sourcing strategies from PD experiences and books. This finding points to a perennial challenge for education reform: how to involve instructors who otherwise do not participate in PD. Innovative marketing, programming, incentives, and research are needed to investigate what approaches will bring such participants in the 2YC setting into PD.

Institutional factors, including a teaching-focused mission and smaller class sizes, may support 2YC faculty in using student-centered teaching strategies. The most common reported class size among these 2YC faculty was 15–29 students, and only one individual taught a class of more than 100 students—smaller than class sizes for many 4YC faculty (Belfield, 2015). Two-year colleges are also focused on a teaching mission, while many 4YC faculty have research duties. The mission of 2YCs and the focus of 2YC instructors on providing quality teaching may also support better participation in teaching PD and the adoption of EBIPs.

Small class sizes may also support 2YC instructors in advancing goals around equity in their classrooms. We found that individuals' use of inclusion strategies was independent of teaching style. Moreover, the principle of inclusive teaching that was least reported by interviewees was Embracing Diversity, or "creating opportunities to develop awareness of diversity and global issues" (Draffan *et al.*, 2017, p. 2). This is a principle through which the experiences of students from marginalized groups could be directly addressed. Strategies that address the other principles, such as Being Equitable, tend to benefit all students. This pattern may be related to instructors having relatively less experience or comfort with empowering marginalized students in the classroom (Calabrese Barton and Tan, 2019).

PD providers would benefit from considering a variety of frameworks now available around inclusive teaching when designing their offerings. While Draffan and colleagues (2017) grounded their work in the universal design for learning and the social model of disability, other frameworks aim to decolonize the curriculum (Eglash *et al.*, 2020; Parson and Weise, 2020). Reviewing such frameworks can help PD developers interrogate their goals for PD and find design guidance that aligns with their goals.

We note some differences in 2YC instructor–reported EBIPs, compared with the literature describing 4YC instructor strategies. In their review, Driessen and colleagues (2020) found that 4YC instructors most frequently reported group work, discussion, and metacognitive strategies (out of a set of nine categories). In this study, interviewees most frequently reported strategies in the categories of Practicing Core Competencies (as defined by AAAS, 2009) and Assessment. The emphasis in 2YCs on developing skills that transfer to jobs or 4YC programs (e.g., Levin, 2000) may lead 2YC faculty to focus on core competencies, and smaller class sizes on average may allow faculty to manage more frequent or more varied assessments within a course. PD providers may wish to embed core competencies in designing and marketing their offerings to potential 2YC participants.

Another important characteristic of 2YC instructors is that they are often teaching outside their subdisciplines of expertise, with a number of different classes to prepare. This may explain why some of our interviewees expressed interest in subdiscipline-specific PD and prescriptive plug-and-play curricula. These desires are in tension with the K–12 research finding that prescriptive PD is generally not effective (Kennedy, 2016). However, it should be possible to combine rich subdiscipline-specific content with strategic and insightful approaches to PD (Kennedy, 2016).

One possible approach was suggested by some interviewees with high interest in PD related to non-biology learning goals such as study skills, quantitative skills, and metacognitive skills. Some of these same interviewees expressed desire for PD that was directly applicable to their specific biology courses. In exploring these apparent contradictions, interviewees often imagined PD experiences drawing examples or lessons from a specific area of biology, combined with a pedagogical strategy around a non-biology goal. For example, a session about teaching students how to take effective textbook notes with daily accountability via formative quizzes could be set within the context of a unit about evolution. Participants might consider examples of student work on evolution, then use individual work time to revise materials for their own evolution units or adapt the approach to their materials on another topic. Such PD would offer instructors both targeted, topical materials that they can use soon and a more general strategy that they can apply broadly to improve student learning and that may thus foster their own reflective practice (e.g., Yoshinobu *et al.*, 2021).

These are some ways that PD developers can answer a call to action by the authors of a recent framework for teachers' pedagogical knowledge to carry out active learning. Auerbach and Andrews (2018) point to a lack of research around designing learning opportunities for instructors that use active-learning techniques and offer "legitimate generative work" in the PD context, thus modeling the approaches that instructors are encouraged to use with students. They suggest that professional developers should support seven areas of pedagogical knowledge (Auerbach and Andrews, 2018), including two areas that particularly interested our interviewees: prompting metacognition and increasing equity. In emphasizing these knowledge domains, their framework offers useful guidance for designing the kinds of strategic PD approaches that Kennedy's (2016) review identifies as particularly impactful.

CONCLUSIONS

In this paper, we have explored the perspectives of ten 2YC biology instructors in order to inform the inclusive design of 2YC biology instructor PD. Implications drawn include the imperative to design and market PD to meet 2YC instructors where they are, regardless of the teaching style they currently use. Didactic instructors may be more interested in biology content and student-centered instructors may be more interested in new pedagogical approaches, but all may be interested in strategies around student skill-building in a disciplinary context. We identify a need for innovative programming to engage more 2YC instructors who have not regularly engaged with PD, and we suggest an approach based on interviewee preferences and suggestions: combining specific biology content, teaching strategy, and an opportunity for participants to work on their own courses.

ACKNOWLEDGMENTS

This work was supported in part by the HHMI BioInteractive program of the Howard Hughes Medical Institute. We thank Javier Robalino, Melissa Csikari, and Marjee Chmiel and two anonymous reviewers for their contributions to this project. We greatly appreciate the time, candor and insights shared by the 2YC faculty interviewed for this study.

REFERENCES

Akroyd, D., Bracken, S., & Chambers, C. (2011). A comparison of factors that predict the satisfaction of community college faculty by gender. *Journal of the Professoriate*, *4*(1), 74–95.

Allen, J. P., Pianta, R. C., Gregory, A., Mikami, A. Y., & Lun, J. (2011). An interaction-based approach to enhancing secondary school instruction and student achievement. *Science*, *333*(6045), 1034–1037.

American Association for the Advancement of Science. (2009). *Vision and change: A call to action.* Washington, DC.

Apkarian, N., Henderson, C., Stains, M., Raker, J., Johnson, E., & Dancy, M. (2021). What really impacts the use of active learning in undergraduate STEM education? Results from a national survey of chemistry, mathematics, and physics instructors. *PLoS ONE*, *16*(2), e0247544.

Archie, T., Laursen, S. L., Hayward, C. N., Daly, D., & Yoshinobu, S. (2021). Investigating the linkage between professional development and mathematics instructors' adoption of IBL teaching practices. In Karunakaran, S. S., & Higgins, A. (Eds.), *2021 Research in undergraduate mathematics education reports* (pp. 1–10).

Auerbach, A. J. J., & Andrews, T. C. (2018). Pedagogical knowledge for active-learning instruction in large undergraduate biology courses: A large-scale qualitative investigation of instructor thinking. *International Journal of STEM Education*, *5*(19), 1–25.

Barbezat, D. P., & Bush, M. (2014). *Contemplative practices in higher education: Powerful methods to transform teaching and learning.* Wiley.

Bathgate, M. E., Aragón, O. R., Cavanagh, A. J., Waterhouse, J. K., Frederick, J., & Graham, M. J. (2019). Perceived supports and evidence-based teaching in college STEM. *International Journal of STEM Education*, *6*(1), 1–14.

Beach, A. L., Henderson, C., & Finkelstein, N. (2012). Facilitating change in undergraduate STEM education. *Change: The Magazine of Higher Learning*, *44*(6), 52–59.

Belfield, C. (2015). *Efficiency gains in community colleges: two areas for further investigation* (Community College Research Center Working Paper No. 80).

Blank, R. K., & De Las Alas, N. (2009). *The effects of teacher professional development on gains in student achievement: How meta analysis provides scientific evidence useful to education leaders*. Washington, DC: Council of Chief State School Officers.

Bonwell, C. C., & Eisen, J. A. (1991). Active Learning: Creating Excitement in the Classroom. *ASHE-ERIC Higher Education Report.* Washington DC: School of Education and Human Development, George Washington University.

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate.* Princeton, NJ: Princeton University Press.

Bradforth, S. E., Miller, E. R., Dichtel, W. R., Leibovich, A. K., Feig, A. L., Martin, J. D., ... & Smith, T. L. (2015). University learning: Improve undergraduate science education. *Nature News*, *523*(7560), 282.

Brawner, C. E., Felder, R. M., Allen, R., & Brent, R. (2002). A survey of faculty teaching practices and involvement in faculty development activities. *Journal of Engineering Education*, *91*(4), 393–396.

Brownell, S. E., & Tanner, K. D. (2012). Barriers to faculty pedagogical change: Lack of training, time, incentives, and… tensions with professional identity? *CBE—Life Sciences Education*, *11*(4), 339–346.

Burke, C., Richard, L., Lai, A., Hsiao, V., Cheung, E., Tamashiro, D., & Ashcroft, J. (2020). Making STEM equitable: An active learning approach to closing the achievement gap. *International Journal of Active Learning*, *5*(2), 71–85.

Bonney, K. (2015). Case study teaching method improves student performance and perceptions of learning gains. *Journal of Microbiology and Biology Education*, *16*(1), 21–28.

Calabrese Barton, A., & Tan, E. (2019). Designing for rightful presence in STEM: The role of making present practices. *Journal of the Learning Sciences*, *28*(4–5), 616–658.

Cataldi, E. F., Bradburn, E. M., & Fahimi, M. (2005). *2004 National Study of Postsecondary Faculty (NSOPF:04): Background characteristics, work activities, and compensation of instructional faculty and staff: Fall 2003* (NCES 2006-176). Washington, DC: National Center for Education Statistics, U.S. Department of Education. Retrieved September 14, 2021, from http://nces.ed.gov/pubsearch

Chasteen, S. V., & Chattergoon, R. (2020). Insights from the Physics and Astronomy New Faculty Workshop: How do new physics faculty teach? *Physical Review Physics Education Research*, *16*(2), 020164.

Chasteen, S. V., Wilcox, B., Caballero, M. D., Perkins, K. K., Pollock, S. J., & Wieman, C. E. (2015). Educational transformation in upper-division physics: The Science Education Initiative model, outcomes, and lessons learned. *Physical Review Special Topics—Physics Education Research*, *11*(2), 020110.

Connolly, M. R., Lee, Y. G., & Savoy, J. N. (2018). The effects of doctoral teaching development on early-career STEM scholars' college teaching self-efficacy. *CBE—Life Sciences Education*, *17*(1), ar14.

Corbo, J. C., Reinholz, D. L., Dancy, M. H., Deetz, S., & Finkelstein, N. (2016). Framework for transforming departmental culture to support educational innovation. *Physical Review Physics Education Research*, *12*(1), 010113.

Corrales, A., Goldberg, F., Price, E., & Turpen, C. (2020). Faculty persistence with research-based instructional strategies: A case study of participation in a faculty online learning community. *International Journal of STEM Education*, *7*, 1–15.

Corwin, L. A., Kiser, S., LoRe, S. M., Miller, J. M., & Aikens, M. L. (2019). Community college instructors' perceptions of constraints and affordances related to teaching quantitative biology skills and concepts. *CBE—Life Sciences Education*, *18*(4), ar64.

Cox, M. D. (2013). *Developing faculty learning communities at two-year colleges: Collaborative models to improve teaching and learning*. Stylus Publishing.

Daly, D., Archie, T., Laursen, S., & Hayward, C. (2021, June). *Access, awareness, audience: The function of traveling introductory workshops in discipline-based professional development. Summative evaluation report from PRODUCT traveling workshops*. Boulder: Ethnography & Evaluation Research, University of Colorado Boulder. Retrieved September 10, 2021, from www.colorado.edu/eer/content/daly-traveling-workshop-summative-report-2021

Dean, C. B., & Hubbell, E. R. (2012). *Classroom instruction that works: Research-based strategies for increasing student achievement* (2nd ed.). Denver, CO: ASCD and Mid-continent Research for Education and Learning.

DeMonbrun, M., Kerst, J., Pfershy, H., & Finelli, C. J. (2018). The long-term impact of a faculty development program on student evaluations of teaching. *International Journal of Engineering Education*, *34*(4), 1325–1334.

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199.

Diegel, B. L. (2013). Perceptions of community college adjunct faculty and division chairpersons: Support, mentoring, and professional development to sustain academic quality. *Community College Journal of Research and Practice*, *37*(8), 596–607.

Dokter, E. (2008). *"It's the journey": Exploring the consequences of a professional development workshop for college astronomy faculty (Doctoral dissertation)*, University of Arizona. Tucson, AZ: ProQuest Dissertations and Theses Global.

Draffan, E. A., James, A., & Martin, N. (2017). Inclusive teaching and learning: What's next? *Journal of Inclusive Practice in Further and Higher Education*, *9*(1), 1–11.

Driessen, E. P., Knight, J. K., Smith, M. K., & Ballen, C. J. (2020). Demystifying the meaning of active learning in postsecondary biology education. *CBE—Life Sciences Education*, *19*, ar52, 1–9.

Eagan, M. K., Jr., & Jaeger, A. J. (2009). Effects of exposure to part-time faculty on community college transfer. *Research in Higher Education*, 168–188.

Ebert-May, D., Derting, T. L., Henkel, T. P., Middlemis Maher, J., Momsen, J. L., Arnold, B., & Passmore, H. A. (2015). Breaking the cycle: Future faculty begin teaching with learner-centered strategies after professional development. *CBE—Life Sciences Education*, *14*(2), ar22.

Edenfield, C., & McBrayer, J. S. (2020). Institutional conditions that matter to community college students' success. *Community College Journal of Research and Practice*, *45*(10), 1–23.

Eglash, R., Lachney, M., Babbitt, W., Bennett, A., Reinhardt, M., & Davis, J. (2020). Decolonizing education with Anishinaabe arcs: Generative STEM as a path to indigenous futurity. *Educational Technology Research and Development*, *68*(3), 1569–1593.

Elrod, S., & Kezar, A. (2017). Increasing student success in STEM: Summary of a guide to systemic institutional change. *Change: The Magazine of Higher Learning*, *49*(4), 26–34.

Felder, R. M., & Brent, R. (2010). The National Effective Teaching Institute: Assessment of impact and implications for faculty development. *Journal of Engineering Education*, *99*(2), 121–134.

Finelli, C. J., Daly, S. R., & Richardson, K. M. (2014). Bridging the research-to-practice gap: Designing an institutional change plan using local evidence. *Journal of Engineering Education*, *103*(2), 331–361.

Gonzalez, K., Lynch, K., & Hill, H. C. (2022). *A meta-analysis of the experimental evidence linking STEM classroom interventions to teacher knowledge, classroom instruction, and student achievement* (EdWorkingPaper: 22-515). San Francisco CA: Annenberg Institute at Brown University. https://doi.org/10.26300/d9kc-4264

Handelsman, J., Miller, S., & Pfund, C. (2007). *Scientific teaching*. New York NY: Macmillan.

Hardré, P. L. (2012). Community college faculty motivation for basic research, teaching research, and professional development. *Community College Journal of Research and Practice*, *36*(8), 539–561.

Haukoos, G. D., & Penick, J. E. (1983). The influence of classroom climate on science process and content achievement of community college students. *Journal of Research in Science Teaching*, *20*(7), 629–637.

Hawkins, L. A. (2011). *Clicker technology and course retention: A quantitative study of Maryland community colleges* (Doctoral dissertation). Minneapolis MN: Capella University. Retrieved November 11, 2021, from www.proquest.com/docview/901925552?pq-origsite=gscholar&fromopenview=true

Henderson, C. (2008). Promoting instructional change in new faculty: An evaluation of the Physics and Astronomy New Faculty Workshop. *American Journal of Physics*, *76*(2), 179–187.

Henderson, C., & Dancy, M. H. (2007). Barriers to the use of research-based instructional strategies: The influence of both individual and situational characteristics. *Physical Review Special Topics—Physics Education Research*, *3*(2), 020102.

Herreid, C. F., & Schiller, N. A. (2013). Case studies and the flipped classroom. *Journal of College Science Teaching*, *42*(5), 62–66.

Hora, M. T., Chhabra, P., & Smolarek, B. B. (2020). Exploring the factors that influence how (and why) community college instructors teach communication and teamwork skills in computer technology courses. *Community College Journal of Research and Practice*, *46*(6), 1–20.

Hora, M. T., Ferrare, J., & Oleson, A. (2012). *Findings from classroom observations of 58 math and science faculty*. Madison: Wisconsin Center for Education Research, University of Wisconsin–Madison. Retrieved September 10, 2021, from http://tdop.wceruw.org/Document/Research-report-Observations-of-STEM-Faculty-Spring2012.pdf

Huang, M. (2018). *2016–17 impact report: Six years of results from the Carnegie Math Pathways*. Stanford, CA: Carnegie Foundation for the Advancement of Teaching.

Hyson, A. R., Bonham, B., Hood, S., Deutschman, M. C., Seithers, L. C., Hull, K., & Jensen, M. (2021). Professional development, shifting perspectives, and instructional change among community college anatomy and physiology instructors. *CBE—Life Sciences Education*, *20*(3), ar49.

Jensen, M., Hull, K., Hood, S., Lawford, H., Ross, K., Gerrits, R., & Ott, B. (2020). Community college anatomy and physiology education research: Conducting research where it ought to be done. *HAPS Educator*, *24*(1), 11–17.

Kennedy, M. M. (1999). Form and substance in mathematics and science professional development. *NISE Brief*, *3*(2), n2.

Kennedy, M. M. (2016). How does professional development improve teaching? *Review of Educational Research*, *86*(4), 945–980.

Laursen, S., Andrews, T., Stains, M., Finelli, C. J., Borrego, M., McConnell, D., … & Malcom, S. (2019). *Levers for change: An assessment of progress on changing STEM instruction*. Washington, DC: American Association for the Advancement of Science.

Levin, J. S. (2000). The revised institution: The community college mission at the end of the twentieth century. *Community College Review*, *28*(2), 1–25.

Lloyd, P. M., & Eckhardt, R. A. (2010). Strategies for improving retention of community college students in the sciences. *Science Educator*, *19*(1), 33–41.

Lo, S. M., Gardner, G. E., Reid, J., Napoleon-Fanis, V., Carroll, P., Smith, E., & Sato, B. K. (2019). Prevailing questions and methodologies in biology education research: A longitudinal analysis of research in *CBE—Life Sciences Education* and at the Society for the Advancement of Biology Education Research. *CBE—Life Sciences Education*, *18*(1), ar9.

Lysne, S., Miller, B., & Eitel, K. (2013). Exploring student engagement in an introductory biology course. *Journal of College Science Teaching*, *43*(2), 14–19.

Madson, L., David, T., & Tara, G. (2017). Faculty members' attitudes predict adoption of interactive engagement methods. *Journal of Faculty Development*, *31*(3), 39–50.

Michael, J. (2007). Faculty perceptions about barriers to active learning. *College Teaching*, *55*(2), 42–47.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage.

Missett, T. C., & Foster, L. H. (2015). Searching for evidence-based practice: A survey of empirical studies on curricular interventions measuring and reporting fidelity of implementation published during 2004-2013. *Journal of Advanced Academics*, *26*(2), 96–111.

Mohamed, A. R. (2008). Effects of active learning variants on student performance and learning perceptions. *International Journal for the Scholarship of Teaching and Learning*, *2*(2), n2.

Nerio, R., Webber, A., MacLachlan, E., Lopatto, D., & Caplan, A. J. (2019). One-year research experience for associate's degree students impacts graduation, STEM retention, and transfer patterns. *CBE—Life Sciences Education*, *18*(2), ar25.

Olmstead, A., & Turpen, C. (2016). Assessing the interactivity and prescriptiveness of faculty professional development workshops: The real-time professional development observation tool. *Physical Review Physics Education Research*, *12*(2), 020136.

Otero, V., Pollock, S., & Finkelstein, N. (2010). A physics department's role in preparing physics teachers: The Colorado Learning Assistant Model. *American Journal of Physics*, *78*(11), 1218–1224.

Paige, C. (2013). *Examining the effects of inquiry-based teaching strategies on community college students (Doctoral dissertation)*. University of Texas at Austin. Retrieved August 22, 2021, from http://hdl.handle.net/2152/23249

Pape-Lindstrom, P., Eddy, S., & Freeman, S. (2018). Reading quizzes improve exam scores for community college students. *CBE—Life Sciences Education*, *17*(2), ar21, 1–8.

Parson, L., & Weise, J. (2020). Postcolonial approach to curriculum design. In Parson, L., & Ozaki, C. (Eds.), *Teaching and learning for social justice and equity in higher education* (pp. 93–116). Cham, Switzerland: Palgrave Macmillan.

Pelch, M. A., & McConnell, D. A. (2016). Challenging instructors to change: A mixed methods investigation on the effects of material development on the pedagogical beliefs of geoscience instructors. *International Journal of STEM Education*, *3*(1), 1–18.

Pfund, C., Mathieu, R., Austin, A., Connolly, M., Manske, B., & Moore, K. (2012). Advancing STEM undergraduate learning: Preparing the nation's future faculty. *Change: The Magazine of Higher Learning*, *44*(6), 64–72.

Prather, E. E., & Brissenden, G. (2008). Development and application of a situated apprenticeship approach to professional development of astronomy instructors. *Astronomy Education Review*, *7*(2), 1–17.

Prevost, L. B., Vergara, C. E., Urban-Lurain, M., & Campa, H. (2018). Evaluation of a high-engagement teaching program for STEM graduate students: Outcomes of the Future Academic Scholars in Teaching (FAST) fellowship program. *Innovative Higher Education*, *43*(1), 41–55.

Prunuske, A., Wilson, J., Walls, M., Marrin, H., & Clarke, B. (2016). Efforts at broadening participation in the sciences: An examination of the mentoring experiences of students from underrepresented groups. *CBE—Life Sciences Education*, *15*(3), ar26, 1–8.

Reece, B. (2021). *Social justice and community college education: Promoting equity as administrators* (1st ed.). New York, NY: Routledge.

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). London: Sage.

Schinske, J. N., Balke, V. L., Bangera, M. G., Bonney, K. M., Brownell, S. E., Carter, R. S., … & Corwin, L. C. (2017). Broadening participation in biology education research: Engaging community college students and faculty. *CBE—Life Sciences Education*, *16*(2), mr1.

Seidel, M.-D., Whitehead, L., Mossman, M. A., & Sá, C. (2017, August 6). The Distributed Network of Cooperating Teams (DNCT) : A Multi-Level Initiative for Organizational Change [R]. http://dx.doi.org/10.14288/1.0354236

Shadle, S. E., Marker, A., & Earl, B. (2017). Faculty drivers and barriers: Laying the groundwork for undergraduate STEM education reform in academic departments. *International Journal of STEM Education*, *4*(1), 1–13.

Smith, B. L., Stuff, L. M., & Cole, R. (2012). Engaging students from underrepresented populations: The Enduring Legacies Native Cases Initiative. *Journal of College Science Teaching*, *41*(4), 64–72.

Stains, M., Harshman, J., Barker, M. K., Chasteen, S. V., Cole, R., DeChenne-Peters, S. E., ... & Young, A. M. (2018). Anatomy of STEM teaching in North American universities. *Science*, *359*(6383), 1468.

Stains, M., Pilarz, M., & Chakraverty, D. (2015). Short and long-term impacts of the Cottrell Scholars Collaborative New Faculty Workshop. *Journal of Chemical Education*, *92*(9), 1466–1476.

Stains, M., & Vickrey, T. (2017). Fidelity of implementation: An overlooked yet critical construct to establish effectiveness of evidence-based instructional practices. *CBE—Life Sciences Education*, *16*(1), rm1.

Stang, J. B., Strubbe, L., Holland, T., & Sherman, S. B. (2017). *Paired teaching: High-impact, low-cost professional development in evidence-based teaching for new faculty*. Vancouver: UBC Faculty Research and Publications, University of British Columbia Library. https://doi.org/10.14288/1.0363340

Sturtevant, H., & Wheeler, L. (2019). The STEM Faculty Instructional Barriers and Identity Survey (FIBIS): Development and exploratory results. *International Journal of STEM Education*, *6*(1), 1–22.

Tamari, F., Bonney, K., & Polizzotto, K. (2015). Prop demonstrations in biology lectures facilitate student learning and performance. *Journal of Microbiology & Biology Education*, *16*, 6–12.

Wieman, C. (2017). *Improving how universities teach science*. Cambridge, MA: Harvard University Press.

Wieman, C., Deslauriers, L., & Gilley, B. (2013). Use of research-based instructional strategies: How to avoid faculty quitting. *Physical Review Special Topics—Physics Education Research*, *9*(2), 023102.

Willie, R., & Stecklein, J. E. (1982). A three-decade comparison of college faculty characteristics, satisfactions, activities, and attitudes. *Research in Higher Education*, *16*(1), 81–93.

Windham, M. H., Rehfuss, M. C., Williams, C. R., Pugh, J. V., & Tincher-Ladner, L. (2014). Retention of first-year community college students. *Community College Journal of Research and Practice*, *38*(5), 466–477.

Yoshinobu, S., & Jones, M. G. (2012). The coverage issue. *PRIMUS*, *22*(4), 303–316.

Yoshinobu, S., Jones, M. G., Hayward, C. N., Schumacher, C., & Laursen, S. L. (2021). A broad doorway to the big tent: A four-strand model for discipline-based academic development on inquiry-based learning. Retrieved August 22, 2021, from www.colorado.edu/eer/content/yoshinobu-workshop-model-preprint-2021

Zajonc, A. (2014). Contemplative pedagogy in higher education. In Gunnlaugson, O., Sarath, E. W., Scott, C., & Bai, H. (Eds.), *Contemplative learning and inquiry across disciplines* (pp. 15). Albany, NY: State University of New York.

Zerwin, S. M. (2020). *Point-less: An English teacher's guide to more meaningful grading*. Portsmouth, NH: Heinemann.