Supplemental Material

CBE—Life Sciences Education

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Supplemental Material Table of Contents **Pages**

Supplement 1. Interview Questions

Note to the reader: Interviews were read and analyzed in their entirety for affordances, constraints, and incentives. However, the interview questions were originally designed to capture broad descriptions of QB instruction so as to better understand CC QB instruction as a whole, including descriptions of the types of QB instruction each instructor practiced and the classes in which they introduced QB topics. Thus, many of the interview questions may seem unrelated to the research questions and data presented in this paper. Despite this, we found that instructors referred to affordances and constraints frequently throughout their interviews.

Interview questions:

1. How would you describe quantitative biology to someone who was unfamiliar with this term?
2. Please tell me about the topics you teach that involve QB.
    a. Do you typically teach these topics during a lecture section? A lab section?
    b. If you teach introductory biology, which quantitative biology skills do you teach?
3. Please explain why you teach these topics in particular, what prompted you to teach these topics?
    a. Was your curricula for these classes inherited from a prior instructor or designed by you?
4. Please describe any barriers you perceive to teaching quantitative biology in your course.
    a. Barriers imposed by the institution?
    b. Barriers imposed by class structure?
    c. Barriers imposed by existing curricula or learning objectives?
    d. Barriers imposed by student background?
    e. Barriers imposed by personal capacity?
    f. Is there anything else that discourages you or makes it harder to incorporate these skills into your classes?
5. Please describe any incentives or supports that exist to support faculty in teaching quantitative biology at your institution.
    a. Are these incentives sufficient to support quantitative biology instruction?
    b. Please describe other incentives or supports that would motivate you to incorporate more quantitative biology skills in your courses.
6. Please describe your use of quantitative biology skills in activities other than teaching.
    a. How often do you use these skills?
    b. Describe the context and purpose for their use.

We think of self-efficacy as one's confidence in their ability to succeed at or accomplish a given task. We will first ask you about your personal quantitative biology skills and then how confident you are teaching these skills to your students.

7. Please describe the quantitative biology skills in which you are confident.
    a. Describe experiences that helped you develop confidence in performing quantitative biology skills.
    b. What training or experiences do you feel would help you or your colleagues to increase your confidence in performing quantitative biology skills?
8. Please describe the quantitative biology skills in which you are least confident.

9. Please describe the quantitative biology skills which you are confident in teaching.
    a. Describe experiences or actions you took to help you develop confidence in your quantitative biology teaching.
    b. What kinds of training do you feel would help you or your colleagues to increase your confidence in teaching quantitative biology?
10. Please describe the quantitative biology skills in which you are least confident in teaching.
11. Have you participated in any quantitative biology teaching trainings? If so, please describe your experience
    a. Did this training improve your confidence in your ability to teach quantitative biology skills?
    b. Describe how this training influenced your teaching of QB skills in your biology courses, if at all.
12. If QB training were available to you, describe what incentives would motivate you to participate.
13. Is there anything you would like to add or any thoughts you have on teaching quantitative biology skills?

Supplementary Table 1. Constraint codes, definitions, and examples. Codes arranged by the code frequency among participants. Codes marked with an * were not included in the constraints results as they either did not contribute strongly to a central theme or were the converse of a theme included in the affordances section.

Code	Definition	Example
Student math background	Student math backgrounds are often limited or out-of-date, making it more challenging to teach QB.	*[The students] have the ability to look at stuff, and we can work with them to figure out how to interpret. That's a skillset they have to work on, but in terms of their math backgrounds, a lot of our students come in with eighth grade or lower math levels. Trying to get them to understand and do the math behind any sort of statistical analysis, or even trying to get a nicer, maybe more complex or more in-depth kind of graphical representation can be difficult. - Cindy*
Lack of time in class	The lack of time available during class for QB topics constrains QB instruction.	*I guess another barrier would just be time. We have 15 week semesters and I just feel like I am just pressed for time a lot, to cover the information. Especially having going through and teach them how to do some basic algebra. - Sunny*
Student math self-efficacy	Students' confidence in their ability to do math or their fear of math make it more challenging to teach QB.	*[the students] have a lot of math anxiety. I think that's true, pretty much across the board with my students. I have a few students who come in and are reasonably comfortable with math, but even the students who are in higher math classes, will typically say that they're not very comfortable doing it. - Debbie*
Lack of time to develop materials	The time it takes to develop new materials is substantial, constraining QB instruction.	*...because of our teaching load, I did kind of just stick with that order because that's what I inherited when I got here, and I hadn't had time to fix it. I had that room this summer and this fall. - Mikaela*
Low familiarity with math	Instructors' lack of familiarity or experience with certain math concepts, tools, or skills makes it more challenging to teach QB.	*I would really like to teach R, and know R, but I don't know it at all. So I definitely can't teach it because I don't know it myself. - Ana*
Low math PCK	Instructors' lack of math pedagogical content knowledge (how best to teach math topics) makes it more challenging to teach QB.	*Respondent: As far as modeling goes, I feel comfortable talking about the theory behind the modeling but actually teaching the equations and the derivatives and the step by step, how we get there through the modeling,*

		not comfortable with. Interviewer: Are you comfortable personally with those derivations? Instead of just teaching it do you think ... are you comfortable looking at a derivation of a model and you're like, "Oh yeah, I get that." Respondent: Yes, the teaching part, no. - Mikaela
Lack of curricular resources in QB	The lack of previously developed curricular resources available for CC QB instruction makes it more challenging to teach QB.	*You see the latest equipment, or the cool lab, or whatever, but you don't see how to incorporate t tests and chi squared into your curriculum. - Cindy*
Inherited curricula	Teaching materials that have been handed down from previous teachers or are the standard in what is used may constrain incorporation of QB into curricula if they do not already include QB skills.	*[the curricula] was inherited. We have freedom with how we present it but as far as the curriculum map of the objectives and that sort of stuff, that was all laid out... The major's biology is [very] scripted. Way too cookbook for my liking but we did that because we have so many adjuncts, they figure it out that a lot of them weren't even doing labs, they were skipping a bunch of stuff they were ... and so they .... and because we are so spread out at different campuses and stuff, and we teach a lot of concurrent stuff in high schools, they made it very ... we have a lab manual, we have a study guide that's all the same. We still have variation in how we do things in class, but it's all very scripted for the most part. - Cam*
Lack of social support*	The lack of social support from departmental higher-ups or peers makes it more challenging to teach QB.	*The intro is more of a barrier because there's so many faculty teaching and they're resistant to change. They know that it needs to be changed. They just are not convinced that this is the way to [successfully change] - Mary Beth*
Cognitive overload with math content	Adding QB to curricula results in cognitive overload (students being unable to cognitively process more information) which makes it more challenging to teach QB.	*For the actual science majors, the ones that are in there, I think the class is just a lot, so they will do it, but I think at the time, there's just so much information coming out, and it's all new, all the cell stuff is new, that they have a bit of a harder time with the quantitative skills on top of everything else, and just putting*

		it into place. - Ronnie
Math-averse biology culture*	The culture of biology and the expectations of biology are such that math is not viewed or presented as an important part of biology, making it more challenging to teach QB.	*There is an underlying cause. We've taught them that. Our biology education in the community has taught them to not expect [math], and to select against [math]. For the gen-ed classes they're taking it 'cause it's not chemistry and it's not physics. Part of that too is that we've done this to ourselves. - Vicky*
Student lack of math interest	Students are not interested in and/or will not engage with QB content, making it more challenging to teach QB.	*And then personally, I just think most students, like I said earlier, when you get to anything math, their eyes gloss over and roll back in their head and they zone out, and you can sit there for an hour, giving a great talk or whatever it is, and they'll still have no clue what you did an hour later, because they just zoned out because they heard the word 'math' or saw a summation sign. - Hugh*
Learning outcomes	Institution-wide learning outcomes for biology courses often do not contain quantitative skills, making it more difficult to justify inclusion of QB skills in a class curriculum.	*We don't have any learning objectives or anything like that in the biology or any of the science curriculum that are quantitative in nature. It's more knowledge, content based. They'll know this, they'll know this, they'll learn that. That's probably one barrier, because we just don't, as a group, say that it's important. - Hugh*
Inertia	Inertia constrains becoming engaged in QB instruction (i.e., there is no "activation energy" to initiate a change).	*Sometimes it can be difficult, honestly, from an inertia standpoint. I already have my lecture slides prepared. Why would I want to modify them and make my life hard adding these two things? - Curt*
Part-time instructor limitations*	Part-time instructors experience unique challenges associated with resources or time available to dedicate to teaching, making it more challenging to teach QB.	*I have to say that I think many instructors don't focus on [incorporating math]. I do not blame the adjunct faculty. They get paid less than full-time faculty and so I would say they're de-incentivized to do anything really extra. - Mary Beth*

Math support for students*	The lack of support originating from outside of the classroom for students to learn and practice math skills makes it more challenging to teach QB.	*I would guess no. If I can think of [no supports for students] other than ... I mean we have math tutors, but they don't know Hardy-Weinberg is the example. They don't know what that is. They'll know the math if they look at it, but they don't know it either.* - *Linda*
Difficulty in developing QB materials*	It is difficult to develop QB lectures making it more challenging to teach QB.	*As far as developing resources, yeah, it's harder. It would be way easier to develop a lecture about something, than to find actual, real quantitative data on a lot of topics.* - *Debbie*
Classroom physical structure*	Specific classroom physical structures make it more challenging to teach QB.	*The class is typically taught in a standard lecture room, which makes it difficult sometimes in terms of technology with quantitative skills, so it tends to be limited to worksheet based, with calculators on their table.* - *Ronnie*

Supplementary Table 2. Affordances codes, definitions, and examples. Codes arranged by code frequency among participants. Codes marked with an * were not included in the affordances results as they did not contribute strongly to a central theme.

Code	Description	Example
Professional development	Professional development in QB instruction can support incorporation of QB skills into instruction.	*I think one of the things I actually got out of [professional development in QB] that I'm using right now is I'm doing figure of the day with my classes, which is working amazingly well. I do it in my lab courses, and my labs meet once a week. - Ana*
Autonomy	Being able to decide on one's own topics and determine the direction of one's own teaching allows incorporation of QB skills into instruction.	*However, this semester I am the only person teaching the class, so I have redesigned the labs to be more quantitative focused. Much more so than they were in the past. - Ana*
Previously developed curricula	Having access to previously developed and implemented QB instructional materials supports incorporation of QB skills into instruction.	*[The national network] has lots of various activities that work in incorporating quantitative biology into courses. That has, at least for me, really improved the students' education. Instead of me coming up with something, using these well-developed materials that have been used over and over again and have been modified as problems have arisen and developed by other faculty. - Ana*
Social supports	When colleagues, chairs, or deans are supportive of and enthusiastic about QB teaching, this supports incorporation of QB skills into instruction.	*Understanding that colleagues are [incorporating new curricula too], doing the same thing, colleagues are helping to kind of break this path through and we talk about it at meetings, we talk about it at undergraduate research meetings, department meetings, at conferences, seeing new ideas and basically stopping and thinking and going, "Okay, well, you know, maybe I don't have to keep doing it that way," I can toss it out and do something new. - Brianna*
Prerequisites	Having a math prerequisite or corequisite for taking a course may support incorporation of QB skills into instruction.	*Again, when we have a prerequisite on this class, which is something they keep fighting a little bit to try to get rid of because it does prolong a lot of students' time at the college, but thus far we're still winning. We are still winning that they have to take the math before they take our course. Then they still have to take this general class before they take anatomy*

		and physiology. We still have that. I think that support has been okay - Mikaela
Math colleagues	Coordination or collaboration with a math department or colleagues supports incorporation of QB skills into instruction.	*And so I reached out to a math colleague and they had some really better ways of explaining [the math concept], and helping the student understand, "Oh, okay, I get it. Now it's gonna inverse." - Julie*
Active learning	Teaching using active learning styles supports incorporation of QB skills into instruction.	*We discuss things. This past semester I put the genetics lectures on Canvas and then we did a lot of the Punnett squares, monohybrid crosses, and dihybrid crosses in class. I think that worked out. Possibly that might be a route to go in the future to incorporate more quantitative elements into the classes, just put the lectures online and just cross your fingers and hope they watch them before they come to class. - Sunny*
Instructional grants or funds	Obtaining or receiving instructional grants supports incorporation of QB skills into instruction via added time to develop curricula or incentives to try new things.	*...if I get the grant money that I applied for from the college, I'm gonna try some [QB curricula] with my [Biology class] this semester. - Hugh*
Access to technology	Having access to computer programs, such as Excel, can provide a resource that supports QB instruction.	*I use Excel just because it's an easy program to teach students, and most students have access to Excel. - Hugh*
National initiatives*	National initiatives and programs (e.g., Vision and Change, PULSE, or HHMI BioInteractive) support incorporation of QB skills into instruction.	*I think for us, the importance of incorporating and growing quantitative skills in our program, is based on our focus on Vision and Change, and quantification is one of the important competencies that is a part of that. And so, I think that any change that we have in our department, is gonna be motivated by that philosophical desire to improve our biology teaching based on that framework. - Tom*
Developmental math support	Support for students to gain developmental math skills before or outside of class supports incorporation of QB skills into instruction.	*[The institution] has counselors and tutors available in a math resource center that we can contact and help put in touch with those students if they need some extra help, or remediation in certain skills...I've been able to send a student somewhere to help, and they've gotten that help if they sought it. - Julie*

Learning outcomes	When QB is part of the explicit learning outcomes for a class, it supports incorporation of QB skills into instruction.	*We do do some common questions for course-level outcomes. And some of those involve some quantitative reasoning. If you can give faculty these answers, say, "This is an example of an exam. We look at it every year, and we drop questions." If you introduce that at the beginning of the quarter, then that helps scaffold what [new faculty members'] expectations are. - Vicky*
Articulation agreements	Articulation with four-year school curricula can provide an incentive to teach QB if the four-year curricula include QB skills.	*Like if the four-year schools in our state that our Board of Regents negotiates with started to demand those kinds of skills and competencies; I think that that would be probably the only incentive for faculty to go there. Because I think it is a challenging thing to do with students and if they don't have to, they don't. - Julie*
Learning assistance centers	Learning or Instructional Support Centers on campus can offer out of class support to students learning QB or support instructors' learning of QB and QB PCK.	*Incentives and support...We do have a large ... It's called a STEM learning center, so science, technology, engineering and math, that has tutors. They were usually part-time work, full-time faculty members how are paid through a tutoring budget to assist students. - Curt*
Small class size*	Small class size allows more interaction with students and knowledge of what is happening in the class, supporting incorporation of QB skills into instruction.	*I'm in a very small class size numbers; I get to know every single one of my students. I can usually, I mean as long as they're self-reported, I can pick up on any challenges that they're having and I can work with them one-on-one - Julie*
Required for accreditation	When QB is required for accreditation, it supports incorporation of QB skills into instruction.	*...you know, for part of our accreditation you have to show that you include quantitative reasoning, so we know better than to remove it, at least from the course... - Sandy*
Classroom physical structure*	Specific classroom physical structures may make it easier to teach QB.	*Sometimes we can get into a computer lab and do a little bit of heavier stuff in the lab. We can use laptops, which is great, but in lecture, we tend to be a little limited because our classes are bigger. - Ronnie*

Supplementary Table 3. Incentives codes, definitions, and examples. Codes arranged by broader codes and then code frequency among participants.

Code	Definition	Example
Attainment value	Motivation to participate in PD that originates from viewing the PD activity as an activity of value to the communities the individual identifies with. This is often manifested by representations of value, such as awards.	
Award or recognition	An award given or recognition from a meaningful community incentivizes participation.	*Certainly, teaching awards can be nice... I don't know, recognition, small award from the department level or something or incorporating novel techniques and quantitative aspects into your microbiology course. Some nice sounding blurb. - Curt*
Intrinsic value	Motivation to participate in PD that originates from being interested in the topic or a closely connected topic.	
Interest in QB	Interest in QB as a topic incentivizes participation.	*[Attending] be very intrinsic. I'd be like, "This is something I want to do." I would move forward. Again, I'm lucky that I'm at an institution where there's typically support for any sort of interest that you show in learning a new skill or bringing a skillset into the classroom. - Cindy*
Interest in student success	Interest in students' success and recognition of QB as a component contributing to success.	*The biggest incentive, just be improving my teaching and to help improve student's knowledge. - Sunny*
Utility value	Motivation to participate in PD that originates from viewing the PD as providing the necessary skills, experiences, or credentials to achieve a desired goal beyond simply attending the PD.	
New teaching materials	New teaching materials that can be used in one's classes to incorporate QB skills.	*And, you know, the incentive of, at the end of the workshop, not only would I have new skills, but I would have things I could take directly into the classroom. I think that would be a big incentive. - Julie*

Gains in new math skills	New math skills that can be employed when teaching QB topics.	*[The professional development team] came out for a day and did professional development to a group of faculty at our community college and one other community college, they had faculty send to this workshop, and I brought them in specifically to help me with this skillset and try to encourage my colleagues to do more with this. - Julie*
Math PCK	New skills and knowledge regarding *how* to teach QB skills that can be employed when teaching QB topics.	*Then I would love a work-through session where you could bring in some labs or some stuff and start to actually dig into the how would I adapt this, how would I incorporate those pieces into this material. - Cindy*
Payment	Monetary payment as compensation for time spent.	*Interviewer: ... if quant bio training were available to you, describe what incentives would motivate you to participate. Respondent: Probably money...Because it's hard to get ... we do so much without getting paid. To do something extra and not get paid is very challenging because we're always asked to do something extra - Sandy*
Credential or CV	A credential or potential for a note to be included on a CV or in a future letter of recommendation, enabling access to future professional opportunities.	*For me, personally, it would basically be about putting the recognition, the awards on future job applications, my CV saying, "My colleagues have recognized me for this kind of expertise, this kind of ..." - Curt*
Networking	Introductions to and interactions with a new network of people that can offer various supports that assist with teaching QB skills.	*So having that incentive that there are going to be people in the region that [those who attend PD] can also interact with later when [the curriculum change] gets hard, and they have problems that they need to solve. - Vicky*
Lower costs	Alleviation of barriers to participation that are associated with added difficulties including financial, time, and access difficulties.	
Alleviating financial costs	Paying for expenses associated with attending PD.	*So travel costs paid would be a benefit. We don't have a lot of travel money at our institution and so, sort of help with those costs would be really important. - Julie*
Covering class	Finding someone to teach an individual's classes during the time of the PD so that they can attend.	*Time, like if it was during the week, to have substitutes to teach my class for example, so I could participate. - Kathy*

Considering timing	Timing the PD so as to not conflict with important other obligations, such as finals, the first and last week of classes, etc.	*And also just a lot of people don't know how ... It's like this is a Friday Saturday, or a Thursday Friday, my answer's, "No I can't do it 'cause I teach." If you have something that says, "If you're teaching on these days here's how to do it." That would be a big help, because our teaching load is really high. - Vicky*
Considering location	Locating PD nearby or offering PD at locations that are easy to physically access.	*The biggest one is, for those kinds of trainings ... If they're local, if they're at my school, I wouldn't really need incentives because it's something I really do want to improve. - Ana*

Supplement 2. Incentives Results and Discussion

Results: Incentives for Participating in Professional Development (PD)

When coding for incentives, we found that Expectancy-Value Theory (Wigfield & Eccles, 2000) was useful as a broader framework in which to couch our inductive codes. Thus, codes fell into four categories that align with the theory. Attending professional development could be motivated by its *utility value*, or the usefulness of the PD in assisting to achieve an external goal, *intrinsic value*, or the enjoyment of or interest in the subjects of the PD, *attainment value* or the importance of attending the PD to one's sense of self or identity, or perceived *cost* or the stress, loss of opportunity, or other negative experiences associated with attending. Attainment value was very rarely discussed (individuals = 2) and so we do not discuss it in detail here. Interest was discussed (individuals = 10) but almost always with the caveat that it had to be paired with utility; thus, we do not dedicate a separate section to interest. Utility value was frequently discussed (individuals = 17) as was cost (individuals = 15). Therefore, our discussion focuses on these two themes.

Utility value is a strong and consistent incentive to attend PD, while interest alone may not be sufficient.

Utility value consisted of six discrete codes: *Credential or CV, new teaching materials*, *payment*, *gains in new math skills*, *math PCK*, or *networking*. By far, gains in new math skills (individuals = 9), new teaching materials (individuals = 11), and math PCK (individuals = 8) were the most frequently mentioned, and these were often mentioned in concert with participants' interest (*interest in QB*, individuals = 8; or *interest in student success*, individuals = 6, Supplementary Figure 1). However, many participants stated or implied that interest, by itself, was rarely sufficient to incentivize participation in PD. As one participant explained,

> *...a lot of trainings become available that look really cool and I would be interested to go and take them, but knowing that what I'm going to learn I would probably not be able to incorporate into my class because it will be beyond the skill level and abilities of those students that I teach...It doesn't prevent me from going, but it doesn't incentivize me to go. Then it would only be for my own self-interest or if I needed the skill for my own research. I look at those trainings and I say, "Okay, that looks really awesome and I would love to go, but if I've got a million other things going on it's not a top priority because I know I'm not gonna be able to use that with my students." - Dave*

Similar to Dave's quote above, instructors primarily discussed gains in new teaching materials and/or gains in new math skills as valuable components of professional development that would incentivize attendance. Some instructors mentioned teaching materials that they could readily incorporate into their courses.

> *For faculty to say, "Hey, do you want to learn something new?" might not be as appealing as, "Do you want to learn something new that you can directly use ... " Like ready to go, use the next semester in your courses. - Julie*

The other codes that constituted this theme were mentioned less frequently (Supplementary Figure 1). A limited number of instructors described how professional development on teaching quantitative skills would be useful on their CV or as a credential, especially for adjunct instructors.

> *... [a] structure that sends a letter to whoever they want it to at the end [of the professional development], saying "So and so did X, and we really appreciate their involvement in this national program," that goes to either their dean, or multiple deans, or their chairs, or multiple chairs. So it's something that is easily translatable onto their vita. - Vicky*

This sentiment was echoed by Curt, an adjunct who was on the job market for more permanent positions.

> *For me, personally, it would basically be about putting the recognition, the awards on future job applications, my CV saying, "My colleagues have recognized me for this kind of expertise, this kind of..." - Curt*

Thus, the opportunity to incorporate PD experience on a CV or as a credential may be more important for adjunct than for full-time instructors.

Lowering costs to attend PD was an extremely strong and prevalent theme

Lowering costs consisted of four discrete codes: *alleviating financial costs* (individuals = 12), *considering location* (individuals = 5), *covering class* (individuals = 6), and *considering timing* (individuals = 5, Supplementary Figure 1). Many instructors expressed that if the financial costs were directly covered or even partially alleviated they would be able to attend, but were clear that they could not attend if costs were high. Expressions like the following were common.

> *Yeah. I think just, I mean if it was something I had to travel to, just having travel expenses covered would do it. - Kathy*

Instructors also discussed strategies that would both help them to save money and make attending professional development more convenient. Considering location, covering class, and considering timing were all codes that described this. A location near their institution was frequently mentioned as a factor that would facilitate attendance. Hugh elaborated on why location was important, especially for QB PD.

> *I personally like those kinds of activities in person. Webinars are okay for certain things, but I think for something in math and applying math, that kind of situation, having someone there that you could actually interact with, they stand right in front of you and say, "This is how this works," or something like that. If it was within a driving distance of where I live or where I work, that would be all I really needed [to incentivize attendance]. - Hugh*

Having classes covered was seen as essential by some instructors. They explained that, without having their classes covered, they could not get approval to attend professional development events.

...they're pretty good about approving me to go to [professional development] as long as we can get somebody to cover courses. I wouldn't want to ... I was very uncomfortable leaving students alone for finals week this last time, and so I would probably prefer to avoid that. - Gwen

Yet, even when they did get approval, leaving their students at critical times of year was not desirable. This is reflected in Gwen's quote above and in additional quotes illustrating that the time-of-year was an important consideration in weighing whether they would attend.

Interviewer: Was that your first [quantitative group] meeting? Mikaela: Yes. Yep, and so because they moved it, because it's always in June, when I'm teaching but this year it got moved to July, so I could go. - Mikaela

Costs most often related directly to the structures and affordances (or lack thereof) at the instructors' institutions, implying that the institutional culture and resources had a large part to play in encouraging (or allowing) attendance of PD.

Discussion: Both utility value and "convenience" may incentivize participation in QB PD

Apart from examining affordances and constraints to teaching QB, an intention of this work was to examine what would motivate CC instructors to participate in QB PD. The reported incentives mirrored participants' comments regarding what would help them to teach QB. Specifically, instructors highlighted that PD must offer them opportunities to learn math skills *and* ways in which they could include those skills in their classrooms (both PCK and developed curricular materials). Only learning math skills without a specific way to integrate them into their class was not likely to be sufficient to motivate CC instructors to attend. Past studies have found that CC instructors have a strong desire to learn higher cognitive skills in PD settings so that they are prepared to answer students' questions in class (Edwards, Sandoval, & McNamara, 2015). Likewise, detailed examples of lessons or archives of examples that included implementation tips were of high value to PD participants (Edwards, Sandoval, & McNamara, 2015; Schuchardt, Tekkumru-Kisa, Schunn, Stein, & Reynolds, 2017; Bates & Morgan, 2018). These findings align closely with our results.

Beyond discussions of the content and curricula of PD, past studies have highlighted how CC instructors value *convenience* and ease of access to PD (Van Ast & Mullen, 1999; Fenton & Watkins, 2007; Diegel, 2013). Our results extended and elaborated upon prior findings via the theme "Lowering costs to attend PD." Describing the idea of "convenience" in greater detail, participants highlighted that a nearby location, timing that did not conflict with work obligations, and covering classes made professional development more accessible. For some instructors, these aspects were the linchpins that would enable or disable PD attendance. Although this study did not examine differences between incentives for four- and two-year faculty, these incentives may be more important for CC faculty. Because CC faculty have heavy teaching loads (typically five three-hour classes per semester; Twombly & Townsend, 2008), they may have less scheduling flexibility than four-year faculty with lighter teaching loads. This may add to the burden of finding someone to fill classes or handle class administration. The faculty in our study also commonly express that their institution had limited funds to attend PD. Again, while we

cannot say that this is specific to CCs or characteristic of all CCs, it is important to recognize that resources are often limited for these institutions, especially when they are located in rural or underserved parts of the United States (Pennington, Williams, & Karvonen, 2006). Thus, it is important to consider the context and accessibility of PD at CCs and other institutions that experience similar challenges related to attending and accessing such opportunities.

Finally, though not frequently discussed, some participants highlighted that a credential would be an incentive for part-time instructors. Specifically, Curt, a part-time instructor, mentioned that this would help him to obtain a job. Many job ads for CC biology instructors emphasize dedication to innovative teaching techniques, technology competencies, and expertise in active learning (see *higheredjobs.com*). An added credential or CV line could be one way to demonstrate such competency and dedication. Thus, providing certificates that could help CC instructors gain access to future positions may indeed serve as a powerful incentive for part-time instructors seeking additional employment or full-time positions.

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Supplementary Figure 1. Frequency of incentives codes among individuals (n = 20). Codes with the same colored bars are grouped together under the same value from expectancy-value theory. Black: Attainment value; Pink: Intrinsic value; Green: Utility value; Orange: Lower costs