

# An Active Learning Workshop to Teach Active Learning Strategies

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## Abstract

College instructors who learn how to teach actively at the beginning of their careers do not have to modify deeply set habits that rely on lectures. Instead, they develop their teaching while they learn evidence-based practices. We developed a workshop for the Science Teaching Experience Program: Working in Science Education (STEP-WISE), a professional development opportunity for postdoctoral scholars who want to learn how to teach effectively and gain undergraduate teaching experience. The program's mission is to "engage a diverse pool of postdoctoral scholars at the University of Washington and affiliate institutions in a closely mentored apprenticeship to learn how to teach scientifically with inclusive, demonstrably effective, student-centered pedagogies." In this workshop, STEP-WISE participants learn how to implement active learning techniques they can use in their own classes by experiencing inclusive strategies that include individual quick writes, think-pair-share, gallery walk, and a jigsaw. Through these activities, workshop participants experience the different learning techniques as they explore different aspects of teaching. Afterwards, they reflect on how they can use these same strategies in teaching their own classes. This workshop was developed for postdoctoral scholars who are new to active learning, but it can also work for graduate students, faculty, and others interested in the topic.

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## Learning Goals

Workshop participants will...

- Experience active learning strategies and reflect on how they can be used as an effective means to help students learn.
- Experience discussion strategies that engage and include all students.
- Discuss strategies for setting students' expectations and for assessing student learning.
- Consider how their own teaching can be informed by discipline-based education research.

## Learning Objectives

After this workshop, participants will be able to...

- Identify different active learning strategies (e.g., individual write, gallery walk, jigsaw, and think-pair-share) and their effective implementation in the classroom.
- Implement inclusive and equitable strategies for facilitating discussions.
- Evaluate the strengths and challenges of using different kinds of active learning strategies.
- Assess student learning with in-class activities.

## INTRODUCTION

Active learning in science classes improves student learning (1), especially for students from historically underserved demographics (2, 3). However, even though research has shed light on all the benefits that come with active learning, a recent study found that only about 20% of undergraduate science classes leveraged best practices (4). Given the challenges and barriers that established faculty face in adopting active learning practices (5–7), we have decided to focus our professional development on postdoctoral scholars (postdocs) — future faculty who have had little, if any, teaching experience (8–10).

The Science Teaching Experience Program: Working in Science Education ([STEP-WISE](#)) is a professional development program that introduces state-of-the-art pedagogy and offers teaching experiences for postdocs who have 100% research appointments and little-to-no prior teaching experience (11). [Our mission](#) is "to engage a diverse pool of postdoctoral scholars at the University of Washington (UW) and affiliate institutions in a closely mentored apprenticeship to learn how to teach scientifically with inclusive, demonstrably effective, student-centered pedagogies" (11). Because our postdocs' priority is their research, we aim to make our training as

efficient as possible to respect their limited time and packed schedules. STEP-WISE postdocs work in teams of three to co-design and co-teach a quarter-long (~10 classes) special topics seminar course. All of the seminar courses are tied to biology curricula, and thus the postdocs' disciplines are from biologically-relevant fields.

The training is centered around three events: all of the teaching teams attend two training workshops at the beginning of the academic year with their entire cohort, plus a separate meeting with their team and a faculty mentor a few weeks before their teaching begins. During the postdocs' teaching, the mentors observe each two-hour class meeting, take notes on what seems to be working and what could be improved, and debrief with the teaching team for approximately an hour after each class. During these debriefing meetings, the faculty mentor and the team discuss their teaching, address the postdocs' concerns, and brainstorm ideas for improvement and strategies for future classes.

The features of STEP-WISE allow the postdocs to set and meet reasonable training and teaching goals without disrupting their research progress. During the initial training, STEP-WISE postdocs are required to attend two 2-hour training workshops that efficiently introduce backwards course design (Workshop 1) and active learning strategies (Workshop 2) to prepare them in developing and teaching their own student-centered classes. In the first training workshop, the scholars are introduced to their teaching teams and start developing their course using backwards design and Bloom's Taxonomy. By the end of the first meeting, the scholars have started drafts of their course title, learning goals, and course description.

This lesson plan describes the second STEP-WISE training workshop (Workshop 2). This workshop uses several different active learning strategies to engage the STEP-WISE postdocs in learning about evidence-based teaching. The postdocs are asked to complete individual quick writes about active learning (12, 13), brainstorm strategies that facilitate effective and inclusive discussions through a gallery walk (14), and explore the biology education literature through a jigsaw activity (15, 16). Both whole group and small group discussions are used throughout the lesson. The workshop concludes with a think-pair-share (13, 17) on strategies for setting expectations and for assessing discussions. Through the different activities, STEP-WISE postdocs experience the different active learning strategies themselves and reflect on how they can use these same strategies in teaching their own classes.

### *Intended Audience*

This professional development workshop was developed for postdoctoral scholars in the life sciences who have not been formally trained in education. However, graduate students and faculty interested in learning about and incorporating active learning strategies in their classes can also benefit from it. Because of the broader target audience of this lesson, we refer to our STEP-WISE postdocs as "participants" in this lesson plan. This workshop emphasizes how active learning strategies can be incorporated into a class, so participation in this workshop would be most beneficial to people preparing to design and teach a class in the near future.

### *Required Learning Time*

This single workshop is intended to last two hours, including a 10-minute break in the middle.

### *Prerequisite Student Knowledge*

Workshop participants should be familiar with reading and analyzing primary literature. Having some knowledge of undergraduate learning contexts in the United States (US) would also be helpful, but is not required. Some of the STEP-WISE scholars are from other countries, and we answer their questions about US classrooms as they arise. Most STEP-WISE scholars have no teaching experience (11), and those who have teaching experience are largely unfamiliar with facilitating active learning. Moreover, few participants are familiar with these strategies from a student perspective. We therefore assume that participants have no background with the materials presented in this workshop.

### *Prerequisite Teacher Knowledge*

The facilitator(s) must be familiar with implementing the techniques used in the workshop, namely quick writes (12, 13), gallery walks (14), jigsaws (15, 16), and think-pair-shares (13, 17). The facilitator(s) should also be experienced with and model best practices for facilitating discussions, such as using unbiased call (18) to solicit answers during whole-group discussions and circulating during small group work to listen in and assist. Familiarity with discipline-based education research is preferable; however, if that is not possible or practical, the facilitator(s) must have at least read and be familiar with the three primary literature articles (8, 19, 20) used in the workshop. Advance knowledge of who will be attending the workshop is also necessary so that the three different articles for the jigsaw activity can be assigned prior to the workshop (see Lesson Plan: Pre-workshop Preparation).

## **SCIENTIFIC TEACHING THEMES**

### *Active Learning*

Workshop participants engage in several active learning exercises as they discuss and reflect on the strategies presented and how these can be used in their own classes. Activities include individual quick writes, small group discussions, gallery walk, jigsaw, think-pair-share, and whole group discussions. These activities are all described in the lesson plan and on the worksheet that is distributed to each participant (Supporting File S1. Active Learning Workshop – Worksheet). Potential responses to the worksheet are also presented (Supporting File S2. Active Learning Workshop – Potential Responses). A list of the active learning tools and strategies that are used in this workshop, as well as tips and considerations for their implementation, is also distributed to each participant (Supporting File S3. Active Learning Workshop – Resource List).

### *Assessment*

The discussions and activities throughout the workshop provide formative assessment for the facilitators. We listen to the different conversations during the small group activities (e.g., gallery walk and jigsaw) when we circulate around the room. Questions, answers, and comments brought up during the small and whole group discussions give us direction on where to guide the conversations, redirecting when necessary. At different times throughout the workshop, we ask participants

to reflect on these activities and how they can use these same strategies — including the opportunity to reflect — in their own classes.

We also use an online discussion board to follow up on the final activity in the workshop (Supporting File S4. Active Learning Workshop – Homework). Participants apply what they have learned in the workshop to brainstorm on how they will lead the first class and how they will introduce the syllabus during that first class.

Within STEP-WISE, the efficacy of this training workshop is also assessed by observing the strategies used by the postdocs during their classroom teaching later on in the program (11).

### *Inclusive Teaching*

This workshop is designed to teach participants inclusive active learning strategies by involving all participants actively and inclusively. Each participant has a handout (Supporting File S1. Active Learning Workshop – Worksheet) with all question prompts for them to answer and space to take notes. Everyone completes the quick write questions individually. In a gallery walk, participants work in small groups at different stations to discuss questions and write their responses. After a few minutes, the groups rotate to a new station with a different question and change scribes to allow equitable contributions from the group members. This process is repeated until all groups have rotated through all questions.

Every participant is also responsible for reading their assigned article prior to the workshop in preparation for the jigsaw activity. In a jigsaw, participants first form expert groups with members who have read the same article to discuss the takeaways and respond to questions based on their assigned article. Afterward, they form new reshuffled groups with members that have read different articles; each member then teaches their article to their peers in their new groups. The jigsaw format is both equitable and inclusive as everyone is responsible and held accountable for their learning and teaching (20).

We also use unbiased call in this workshop to solicit ideas from the participants, tracking who has spoken to make sure that the most voices are heard (18, 21, 22). To increase participants' comfort with unbiased call and to decrease anxiety, we always give the participants a chance to discuss their answers with their peers prior to calling on them (18). Questions in several workshop activities also address strategies on ensuring equitable participation and/or creating an inclusive classroom that engages everyone (Supporting File S1. Active Learning Workshop – Worksheet), so more ideas may emerge during the discussion.

## **LESSON PLAN**

### *Pre-workshop Preparation*

#### Jigsaw reading assignments

Because our workshop participants are STEP-WISE postdocs who work in teams of three to teach their courses, we divide them into groups so each member of the teaching team reads a different paper from the primary literature (Supporting File S1. Active Learning Workshop – Worksheet, 8, 19, 20). We

assign the papers at least one workday before the workshop by sending the participants an email message with the paper attached and asking them to identify the primary message of each paper. We also ask them to bring an electronic or paper copy of their assigned reading to the workshop to reference during the activity. At this stage, workshop participants can only access their assigned paper because we want to avoid the unnecessary expectation that they are responsible for reading all three papers. However, all three papers are made available after the workshop.

### Materials

We bring a worksheet (Supporting File S1. Active Learning Workshop – Worksheet) for each participant as well as extra copies of the jigsaw readings. We also bring nametags for the participants to wear. We only project a single slide, which has the learning objectives for the workshop so that we can refer to these while the workshop is in progress.

### Gallery walk stations

We set up the gallery walk stations in the classroom prior to the start of the workshop. Each gallery walk station has a single question; because we have five questions in the gallery walk, this activity works best for at most five groups. If we have more than 15 participants (five groups of three), we duplicate the stations for a maximum number of 30 workshop participants. If there are 30 participants, 15 would rotate through one set of stations, and the other 15 would rotate through a second set of stations.

We write questions on whiteboards at different stations around the classroom, if they are available, or large poster-sized sheets of self-adhering paper (e.g., Post-it™). Each station has one question with enough writing space for participants' responses and enough physical space for a group of three to work together comfortably without interfering with a neighboring group. Groups should also be able to easily move from one station to another. If the classroom is not sufficiently large, stations can be set up in a neighboring hallway. We also provide different-colored markers, so that each group uses its own colored marker.

### *Workshop Facilitation*

This workshop is a two-hour lesson on active learning consisting of four structured activities guided by a worksheet: individual write, gallery walk, jigsaw, and think-pair-share. Whole group discussion follows each learning activity. During these discussions, we bring to attention the techniques that the participants have just experienced and ask them to reflect on the potential uses for these strategies in their own classes. Facilitators can shorten or lengthen these discussions or different aspects of the lesson plan based on how their participants process the material. We recommend that facilitators track who has spoken to give all workshop participants a chance to speak or report out. Potential responses for all of the workshop questions are in Supporting File S2. Active Learning Workshop – Potential Responses.

All components of the lesson are in the handout (Supporting File S1. Active Learning Workshop – Worksheet), which we provide to the participants as they arrive. Participants use the worksheet for quick writes, taking notes, and reflections. The worksheet itself is an example of an active learning tool that the participants can develop for their class and collect to



assess students' progress toward the learning goals.

### Introduction

After asking participants to introduce themselves, we situate the workshop into the broader context of their professional development. In our case, this active learning workshop is the second meeting of the STEP-WISE program that provides teaching experience for postdoctoral scholars to prepare for faculty positions. We emphasize the shift towards the use of evidence-based pedagogies for improving undergraduate education, such as *Vision and Change* (23) for biology. We also stress that knowledge of active pedagogical approaches to learning will make the postdoctoral scholars more competitive for many faculty positions, especially those with a teaching emphasis.

We introduce the learning objectives of this workshop and highlight the four structured activities (individual write, gallery walk, jigsaw, and think-pair-share) that they will experience while learning about active learning strategies. We ask the participants to attend to how the different activities are implemented and reflect on their potential uses in their own classes.

#### *1. Individual Write – What is active learning? Why use active learning strategies?*

We ask the participants to answer the first question on the worksheet (Supporting File S1. Active Learning Workshop – Worksheet) by taking a few minutes (~3 min) to complete the following phrases:

1. Active learning is ...
2. Active learning strategies help students ...
3. One concern I have about facilitating active learning is ...

We circulate slowly among the participants as they are writing to gauge their progress. When most people have finished, we announce that they have 20 seconds to wrap up their writing.

After time is up, we tell the participants a statement such as “We will leave these aside for now and will return to them later at the end of the workshop so you can revise your work.” We then invite a randomly selected participant to share whether they considered the quick write to be active learning even though they did not discuss their responses with anyone. Usually the participant shares their thoughts, although they have the option to pass (17, 18). This conversation helps highlight that writing ideas on paper is a form of active learning (13). Note that other examples of active learning that do not have a discussion component include individual problem sets, reflective writing, peer review, and one-minute papers.

#### *2. Gallery Walk – How can you facilitate effective discussions and include all students?*

We introduce the *gallery walk* (14) technique as an inclusive activity that is good at getting students to move around the classroom. Five questions (Supporting File S1. Active Learning Workshop – Worksheet) are posted at different stations around the classroom or hallway for the participants to think

about, discuss, and respond to in small groups. This suite of questions is intended to address some of the anxieties that the participants may have about teaching an active class. We briefly explain how the gallery walk technique works and show them the five different questions at the gallery walk stations. We have the participants rotate among stations in their pre-assigned teaching teams (groups of 3) so that they can tailor their answers to their particular courses.

The participants discuss the question at their station and a designated scribe writes down their group's responses and/or comments under the question. After a few minutes, we direct groups to rotate to the next station and a new scribe takes notes for the group. Groups should read the question at their new station and add to, modify, and/or elaborate on the previous written responses. We repeat this process until all groups have rotated through all five stations.

While the participants are working, we circulate among the stations to listen to conversations, answer questions, gauge progress, encourage ideas, and keep time. From our experience, a quiet timer may be helpful for the facilitator in tracking time, especially as we find ourselves engaged in many conversations. We find that at the beginning of the activity, groups spend approximately 3-5 minutes at each station, but that they spend only 2-3 minutes at a station when most responses have already been given. We find it helpful to announce when there are only 30 seconds left at a station, so that groups can finish forming ideas and writing down responses. We also remind the participants to take turns as the scribe by passing the marker to another group member with every rotation.

After each group has returned to their original station, the team reads through and synthesizes the writing about their original question. Then, they have 5 minutes to create a graphic that synthesizes that content. Figure 1 shows some examples of the gallery walk responses and graphical summaries. A representative from each group is then asked to summarize their graphic in 1-2 minutes to the whole group; we remind the participants that there is space on their handouts to write down the summaries and take notes on each question (Supporting File S1. Active Learning Workshop – Worksheet). After each presentation, we briefly summarize/list the key ideas on the board for everyone and elaborate if necessary. We conclude this activity by asking participants to reflect on the gallery walk technique that they have just experienced, the nuances of how it was implemented, and how they can use it in their own class.

#### *3. Jigsaw – How can biology education literature inform the strategies you use in your course?*

We introduce the three primary literature articles (Supporting File S1. Active Learning Workshop – Worksheet, 8, 19, 20) to acquaint participants to discipline-based education research and to illustrate the value of using data to inform and improve our own teaching. Each participant was assigned one of these articles to read in advance. In the workshop, everyone will explore and reflect on these articles during a jigsaw. After introducing how the jigsaw structure works, we have the participants form expert groups of 3-5 with those who have read the same paper. We ask the groups to discuss and think about (A) the basic approach or strategy outlined in the paper;

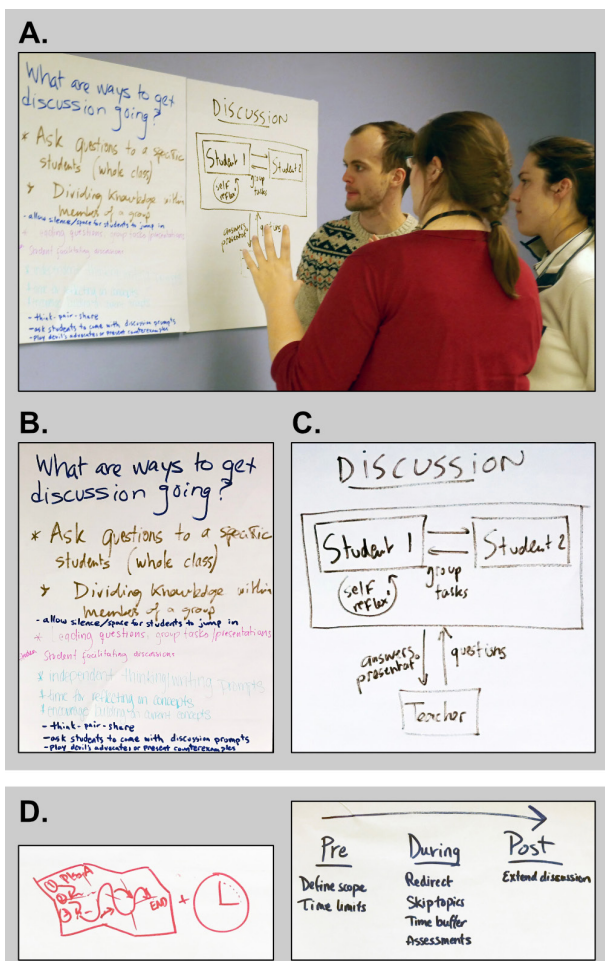


Figure 1. Examples of the gallery walk activity show different ways postdoctoral STEP-WISE scholars synthesized answers in a graphic or diagram. (A) A team of three STEP-WISE postdoctoral scholars discussing and summarizing answers to a gallery walk question (B) with a diagram (C). (B) Poster of the gallery walk question “What are the ways to get discussion going?” with answers written by different groups in different marker colors. Synthesis and summary of answers as a diagram by this group is shown in (C). (D) Two different representations of synthesizing answers to the question “How can you keep the discussion on track and make sure students understand the key ideas?” One group chose to represent their answers as a drawing (left), while another group’s diagram was more text-based (right).

(B) the potential uses of this strategy in their own course; and (C) the benefits and challenges of the approach or strategy (Supporting File S1. Active Learning Workshop – Worksheet). The expert groups discuss their papers through these lenses for about 10 minutes, taking notes on their worksheets. We then ask the participants to return to their original teaching team — their “reshuffled” jigsaw groups — with each member an “expert” of one of the three primary research papers that have been discussed. Everyone then takes turns teaching their groupmates their article, taking about 5 minutes each. The other group members ask questions, take notes, and reflect on how they can use the research in this article to inform their own teaching.

While participants are working in both their expert and jigsaw groups, we circulate around to check in with the different groups during their discussions, listen to conversation, interject comments, or answer questions as appropriate. We keep track of time, remind groups how much time is left, and help make sure all three papers are discussed by the reshuffled

groups.

After the jigsaw, we invite individuals who have not spoken earlier to start a whole group discussion. We ask them to share and highlight what they learned from each paper and/or how they can use these strategies in class. At the end of the discussion, we summarize the takeaway points from the three papers and the usage of the jigsaw format in teaching. We also emphasize the importance of using active learning activities — such as the jigsaw — as a means of assessing student learning during class.

4. Think-pair-share – What strategies can you use for setting expectations and for assessing discussions?

For the final activity, we stress the importance of the first day of class in establishing the expectations that students will be talking and participating in active learning activities throughout the course. We ask the participants to reflect on what they have learned in the workshop to answer the final two questions (Supporting File S1. Active Learning Workshop – Worksheet):

1. How can you establish expectations and guidelines for participation on the first day of class?
2. How can you assess the effectiveness of discussions on student learning?

Participants are asked to take a minute to respond to the prompts on their worksheet and then discuss their responses with their neighbor(s). After a few minutes of discussion, we invite randomly selected participants to share the responses from their discussions. We recommend that the facilitator(s) use — and highlight in their discussion — strategies that make this *sharing* part of think-pair-share equitable (17): this includes phrasing the option to speak as an invitation during unbiased call (18) so that those who do not want to speak can pass and, while circulating among the groups, asking participants if they would be willing to openly share their ideas with the whole group (17). The fact that the questions are open-ended with multiple potential responses is also illustrative of more equitable *sharing* (17). If the use of worksheets has not been brought up previously, we make sure that the participants realize that the worksheet they have been using throughout the workshop is itself a helpful active learning tool and that it can be collected at the end to assess participation and student learning. Finally, we note that the think-pair-share technique is one of the most common and straightforward ways to incorporate discussion and active learning in their classrooms. This technique can be used in conjunction with unbiased call, which we emphasize as an inclusive technique that allows for all voices to be heard in class (18, 22).

We conclude the workshop by sharing extra teaching tips and additional resources at the end of their handout (Supporting File S1. Active Learning Workshop – Worksheet) and in their supplementary resource list provided (Supporting File S3. Active Learning Workshop – Resource List). When time permits, we ask the participants to revisit their responses in the first activity (individual write), noting whether their concerns have been addressed by the workshop. We stay after the workshop for another half hour to field additional questions and concerns. We also take photos of our written board notes

and all of the gallery walk posters and make them available online for participants to access after the workshop.

### Homework

After the workshop, we pose two online discussion questions for the teaching teams to answer. These questions are about the first day of class and introducing the syllabus (Supporting File S4. Active Learning Workshop – Homework), and they serve as an exercise for the participants to apply what they learned in the workshop to their teaching. We ask participants to post their responses within a week of the workshop and then reply to two posts within another two days.

## TEACHING DISCUSSION

### *Context of Workshop in STEP-WISE*

This active learning workshop is the second of three required meetings that prepare STEP-WISE scholars to work in teams of three to develop and teach their own special topics seminar class. STEP-WISE scholars are postdoctoral researchers with 100% research appointments who are trained in science and research, but not in education. The majority of the STEP-WISE scholars are from the life sciences. The STEP-WISE leadership team groups postdocs with similar research backgrounds into teams of three to develop and teach their own special topics seminar classes.

Here, we have described the second training workshop in which we introduce the postdocs to the active learning techniques that they are encouraged to use when they teach. Thus, we designed the activities in this workshop with these three-member teaching teams in mind. Each teaching team works together throughout the entire gallery walk activity. For the jigsaw, each team member is assigned a different reading so that all three articles are covered after reshuffling. This arrangement gives the teaching teams an opportunity to bring different ideas about active learning and educational research into their shared class, making for rich small group discussions.

In addition to introducing STEP-WISE scholars to the field of discipline-based education research, the three papers chosen for the jigsaw activity are specifically relevant for teaching the STEP-WISE special seminar courses. The first paper by Round and Campbell (19) introduces a strategy called figure facts, which is a method for analyzing figures to help students read and understand primary literature. STEP-WISE scholars often decide to use this approach to assign homework to help students prepare for class. The second paper by Theobald et al. (20) addresses the issue of forming equitable groups based on group dynamics and is a great example of using data-driven research to inform teaching practices. The main takeaway of this paper is that jigsaws are one of the best practices for student-centered and inclusive teaching (20). The last paper by Ebert-May et al. (8) evaluates how well instructors adopt student-centered learning. In the past, we have also used articles from *CourseSource*, because the STEP-WISE scholars sometimes prepare materials that could be submitted to the journal as a lesson plan (e.g., 24, 25). In the future, we anticipate that the articles we use will change as new literature emerges that is relevant to the teaching styles we promote.

Incorporating student-centered teaching strategies and running an active classroom is emphasized throughout the

entire STEP-WISE apprenticeship; this workshop is only the beginning. Even though this workshop is presented here as a standalone lesson, results that we observed are from the entire program. Thus, the training needs to be contextualized by the ongoing support offered in STEP-WISE. The scholars receive additional guidance in implementing active learning throughout their teaching experience. They meet with their faculty mentors prior to teaching to help plan their courses. When they are teaching, the faculty mentor observes each class meeting and then debriefs with the teaching team after class to give feedback and advice for future classes (11).

### *Workshop Effectiveness*

Observations about the effectiveness of the workshop were collected by author ERK, an external evaluator who conducted ethnographic observations of the training and of the scholars' teaching. The University of Washington Institutional Review Board determined that the data used in this research were exempt from review under category 1, normal education practices (STUDY00005114). A complete evaluation of the entire STEP-WISE experience can be found elsewhere (11), and we complement that paper here by focusing specifically on feedback about this workshop.

During focus group interviews with the 21 scholars who taught in 2019, ERK asked "What was the most useful aspect of the STEP-WISE meetings held in the fall?" In these interviews, STEP-WISE scholars reported that this workshop was particularly helpful, while also acknowledging that it is a lot of information for only two hours. Given that some of the scholars had never been in a classroom that used active learning and that they were expected to use active learning in their seminar courses, they found that learning about the jigsaw and gallery walk was particularly helpful:

*"I think the exposure to ideas, or like specific, concrete techniques that facilitate student-led learning was useful. I know I heard, maybe I'd experienced and not registered, jigsaw, or gallery walk, things like, concrete things you can put in a class; that when you do them right, they'll be student-led."*

Knowing what these activities felt like from the student perspective helped the scholars prepare their classes:

*"I found in the literature [that we reviewed in the jigsaw] and some of the discussions and even some of the practice that actually seeing it be done were pretty useful throughout [for getting a sense of] timing, like estimate when I was planning the class, like this is going to take more or less this amount of time. I don't think if I hadn't seen them before would I be able to more or less estimate how long or how complex some of the activities were going to get."*

This workshop helps lay the foundation for STEP-WISE scholars' successes in the classroom. The majority of the STEP-WISE scholars were new to teaching, and this workshop was the first time many of them had experienced these types of active learning strategies. We found that the scholars generally used active learning strategies, tools, and techniques often and consistently in the courses they developed and taught, with minimal lecture or direct instruction (11). In line with the training provided in this workshop, the main learning



activities that scholars used were jigsaws, think-pair-shares, gallery walks, and figure facts. Student worksheets guided the class activities and structured the students' engagement with the content and each other in class discussions. STEP-WISE scholars also incorporated verbal reminders to manage time, circulated during small-group activities to engage with students, used unbiased call to prompt students to share what they had discussed in small groups, and facilitated complex student discussions (11).

## Challenges

### Timing of activities and discussions

The biggest challenge to facilitating this workshop has been timing. Because discussions can proceed in many different directions, we have made decisions on when to follow the discussion flow — which was often interesting, informative, and beneficial — and when to stop the discussion in favor of keeping the workshop on track. The two longer activities, the gallery walk and jigsaw, elicited the most discussion afterwards, but either one of them could easily take twice as much time as was allotted. Therefore, keeping an eye on the timing is crucial to covering all workshop components. We often did not have much time at the end of each activity to thoroughly reflect on how the activity itself went and discuss the nuances of how it was implemented (e.g., flexible timing, circulation, etc.). However, during the rest of the apprenticeship, we usually revisited these activity or strategy nuances before the postdocs taught their own class or afterwards during the debriefs.

Because of timing issues, the first individual write activity was cut down significantly from the earlier iterations. Originally, we would invite 2-3 individuals to report their answers, with a more extensive discussion following. However, we felt that an extended discussion at this point early in the workshop was extraneous as many of the concerns that scholars raised were addressed later in the workshop. Therefore, we decided to keep the individual write activity brief to serve as an introduction to the different forms active learning, so that we would have enough time for the later activities.

Running late on planned activities also meant that we often did not have enough time to fully complete the last think-pair-share activity on setting expectations and assessing discussions (Supporting File S1. Active Learning Workshop – Worksheet). When this was the case, we would introduce the think-pair-share technique but ask the scholars to reflect on these questions on their own after the workshop. The faculty mentor would then discuss their responses at the next STEP-WISE meeting with their teaching team. This compromise still allowed us to meet our learning goals because the topics had typically already been addressed during the gallery walk. The participants' responses for how to establish expectations and guidelines for participation should also be reflected in their discussion post for the follow-up homework question (Supporting File S4. Active Learning Workshop – Homework) on the lesson plan for the first day of class.

### Attendance and jigsaw

Incomplete attendance was also a challenge because success of the jigsaw activity relied on all members of each teaching team being present. We try to schedule the STEP-WISE workshops at a time that works with everyone's schedule, but with a group of this size, inevitably there are some absences.

When a team member was missing, the facilitator briefly taught the other two members the missing article or “piece” of the jigsaw.

### *Limitations and Adaptations*

This workshop is an introduction to evidence-based pedagogies and is meant to serve as a primer for participants to consider and practice incorporating some of these active learning strategies into their classes. This workshop is by no means comprehensive, as there are only four main activities that the participants experience, with several other strategies used and topics introduced. However, this workshop can be easily modified to include and/or highlight additional strategies and topics. One such example is the use of case studies. In the jigsaw activity, three different case studies can be presented in lieu of the three primary literature articles.

In addition to case studies, the jigsaw activity can also be easily modified to include other media to highlight additional techniques, tools, or other aspects of teaching that may be of interest to the participants. Engaging article topics can include managing tough classroom situations, microaggressions, stereotype threat, student metacognition, promoting a growth mindset, student and faculty diversity, and the use of technology in the classroom among others. However, many of these topics alone can fill an entire workshop, so the time limitation of the workshop is a factor that needs to be considered. For the 30-minutes allotted for this jigsaw activity (Table 1), we recommend only using 2-3 sources to allow for sufficient time for discussion of each source.

For this lesson to be a standalone professional development workshop, one challenge would be distributing the pre-workshop reading for the jigsaw. Groups for the gallery walk activity and the reshuffled jigsaw groups can be pre-designated as well, similar to our STEP-WISE teaching teams, or they could be assigned in the workshop.

This workshop can also be conducted synchronously online (e.g., using Zoom or Microsoft Teams) to accommodate remote instruction. Participants can download and work on their own electronic copy of the worksheet (Supporting File S1. Active Learning Workshop – Worksheet) for the individual write, followed by small group discussions in breakout rooms for the gallery walk and jigsaw. Collaborative online documents such as Google Docs can be used for the gallery walk, where each page can be a different station for groups to rotate through and respond (see Supporting File S3. Active Learning Workshop – Resource List). Online implementation of this workshop can benefit from co-facilitators, who can help assign participants into different groups for the two parts of the jigsaw. Introducing active learning in a synchronous online teaching environment will also exemplify to the workshop participants what this might look like in an online course and give them the requisite familiarity with this design.

## SUPPORTING MATERIALS

- S1. Active Learning Workshop – Worksheet
- S2. Active Learning Workshop – Potential Responses
- S3. Active Learning Workshop – Resource List
- S4. Active Learning Workshop – Homework

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Table 1. Active Learning Workshop Lesson Plan Timeline.

Activity	Description	Estimated Time	Notes
<b>Pre-workshop Preparation</b>			
Jigsaw reading assignments (Facilitator)	<ol style="list-style-type: none"> <li>1. Get list of workshop attendees.</li> <li>2. Divide attendees into 3 groups.</li> <li>3. Assign each group a different article to read prior to attending workshop.</li> <li>4. Email attendees their article.</li> </ol>	< 1 hour	<ul style="list-style-type: none"> <li>• Jigsaw reading references provided in Supporting File S1. Active Learning Workshop – Worksheet.</li> <li>• Assign readings at least one day in advance of workshop.</li> </ul>
Jigsaw reading assignments (Participant)	<ol style="list-style-type: none"> <li>1. Read assigned article.</li> <li>2. Bring a copy of the article to the workshop.</li> </ol>	< 1 hour	
Gallery walk stations	<ol style="list-style-type: none"> <li>1. Write gallery walk questions on posters and/or whiteboards.</li> <li>2. Make two sets for &gt; 5 groups. (15-20+ attendees)</li> <li>3. Place stations around room or hallway.</li> <li>4. Optional: Pre-assign gallery walk groups (3-5 per group).</li> </ol>	< 30 min	<ul style="list-style-type: none"> <li>• Gallery walk questions provided in Supporting File S1. Active Learning Workshop – Worksheet.</li> <li>• Bring colored markers (5+ different colors).</li> <li>• Bring extra posters (if classroom does not have enough whiteboards).</li> </ul>
Other	<ol style="list-style-type: none"> <li>1. Print out and bring enough worksheets for each participant.</li> <li>2. Prepare learning objectives for referencing during workshop (on slide or write on board).</li> </ol>	< 30 min	Optional: <ul style="list-style-type: none"> <li>• Bring extra copies of the jigsaw readings.</li> <li>• Bring nametags.</li> </ul>
<b>Workshop Facilitation</b>			
Introduction	<ol style="list-style-type: none"> <li>1. Introduce topic in professional development context.</li> <li>2. Introduce learning goals and objectives.</li> </ol>	5 min	Distribute worksheets and have nametags available when participants arrive.
1. Individual write	<ol style="list-style-type: none"> <li>1. Individuals complete three phrases [~3 min].</li> <li>2. Facilitator informs participants that they will be leaving this activity for now and returning to their answers later.</li> <li>3. Brief whole class discussion on whether NOT discussing their answers is considered active learning. [~2 min]</li> </ol>	~5 min	<ul style="list-style-type: none"> <li>• Ask: “Is this activity still considered active learning?” (Yes!)</li> <li>• Keep this initial discussion on active learning brief.</li> <li>• Let participants know that many concerns will be likely be addressed in this workshop.</li> </ul>
2. Gallery walk	<ol style="list-style-type: none"> <li>1. Introduce gallery walk activity.</li> <li>2. Assign small groups (3-5 per group).</li> <li>3. Each group starts at a different station and writes their answers.</li> <li>4. Groups rotate to a new station and add to/modify/elaborate the previous answer. Repeat until all questions are answered. [~20 min]</li> <li>5. Synthesize all answers from original question into a single graphic/diagram. [~5 minutes]</li> <li>6. Presentation of graphic and whole class discussion. [~20-25 min]</li> <li>7. Summarize takeaway points. Reflect on gallery walk strategy.</li> </ol>	~45-50 min	<ul style="list-style-type: none"> <li>• Facilitator circulates around to listen in and gauge conversations.</li> <li>• Allow 3-5 minutes at each station. Shorten the time for later rotations (2-3 min).</li> <li>• Give 10-30 sec warnings before directing groups to rotate.</li> <li>• Remind groups to pass their markers to another person with each rotation.</li> <li>• Remind participants to take notes on worksheet during the presentations and discussion.</li> <li>• Optional: Take a 5-10 min break after this activity.</li> </ul>

Activity	Description	Estimated Time	Notes
3. Jigsaw	<ol style="list-style-type: none"> <li>1. Introduce jigsaw activity.</li> <li>2. Form “expert” groups to discuss the same pre-assigned paper and answer questions. [~10 min]</li> <li>3. Reshuffle to form new groups with “experts” from different papers.</li> <li>4. Group members take turns teaching each other their article/strategy. [~15 min]</li> <li>5. Random (unbiased) call to start whole group discussion. [~10-15 min]</li> <li>6. Summarize takeaway points from papers. Reflect on jigsaw strategy.</li> </ol>	~35-40 min	<ul style="list-style-type: none"> <li>• Facilitator circulates around to listen in and gauge conversations.</li> <li>• New reshuffled groups should have at least one expert of each article (ideally groups of 3).</li> <li>• Remind groups to switch “experts” after ~5 min per paper. Make sure all groups get through discussing all 3 papers.</li> <li>• Keep track of who has talked in the group discussions and use unbiased call on those who have not yet spoken.</li> </ul>
4. Think-pair-share	<ol style="list-style-type: none"> <li>1. Introduce think-pair-share strategy.</li> <li>2. Think: Individually answer two questions. [~2 min]</li> <li>3. Pair: Discuss answers with their neighbor(s). [~3 min]</li> <li>4. Share: Random (unbiased) call on 2-3 individuals to share their answers and start whole group discussion. [~10 min]</li> <li>5. Summarize takeaway points. Reflect on think-pair-share and random call strategies.</li> </ol>	~15 min	<ul style="list-style-type: none"> <li>• Facilitator circulates to listen in during small group/pair discussion.</li> <li>• Remember to ask for their “group” answer when random calling.</li> <li>• Note that the worksheet can be collected to assess participation and student learning.</li> </ul>
Conclusion	<ol style="list-style-type: none"> <li>1. Assign online discussion board “homework.”</li> <li>2. Go over the extra teaching tips and additional resources.</li> <li>3. If time permits, ask participants to revise their answers to their first individual write question.</li> </ol>	~5 min	<ul style="list-style-type: none"> <li>• Homework questions provided in S4. Active Learning Workshop – Homework.</li> <li>• Tips and resources in Supporting Files S1. Active Learning Workshop – Worksheet and S3. Active Learning Workshop – Resource List.</li> <li>• Be prepared to continue answering questions after the workshop.</li> </ul>
<b>Post-workshop Homework</b>			
Online discussion board	<ol style="list-style-type: none"> <li>1. Participants post answers to the two homework questions.</li> <li>2. Respond to two separate posts within two days after due date.</li> <li>3. Facilitator can respond as they see fit.</li> </ol>	< 1 hour	<ul style="list-style-type: none"> <li>• Questions provided in Supporting File S4. Active Learning Workshop – Homework.</li> <li>• Provide participants with link to online discussion board.</li> </ul>