2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC

Host Sponsor UNC Charlotte

Paper ID #50983

WIP: Preliminary Evaluation of the First Iteration of an Interactive Online Pedagogy Course for Microscopy Trainers

Ms. Rhonda Reigers Powell, Clemson University

Rhonda Reigers Powell is the Research Lab Manager at the Clemson Light Imaging Facility, a core light microscopy facility. She is a doctoral candidate in the Department of Engineering and Science Education, and she is interested in improving light microscopy education. She works as an international collaborator to research, design, and implement online, interactive, professional development workshops and courses for fellow microscopists and technology trainers in order to help them improve the quality of their training.

Alexandra Claire Harding
Maria Isabella Sanchez Bedoya, Clemson University
Sylvie Le Guyader, Karolinska Institute
Dr. D. Matthew Boyer, Clemson University

Dr. Boyer is a Research Associate Professor in the Department of Engineering and Science Education and an Educational Proposal Writer in the College of Engineering, Computing and Applied Sciences.

WIP: Preliminary Evaluation of the First Iteration of an Interactive Online Pedagogy Course for Microscopy Trainers

Abstract

In this work-in-progress paper, we present the initial findings from the first iteration of an interactive online pedagogy course for microscopy trainers. This study results from a collaboration between two microscopists in North America and Europe who developed this unique professional development experience for core facility staff. It is a continuation of a prior collaboration to develop two-hour online pedagogy workshops for large audiences of microscopists, and it is part of the doctoral dissertation of one of the course designers, a professional microscopist studying technology education.

The microscopy community has published standards and guidelines for equipment calibration and image analysis, but no minimum guidelines exist for microscopy training. However, proper training is required to ensure end users collect light microscopy data ethically, responsibly, and reproducibly. Light microscopy training often takes place in centralized research laboratories, commonly known as core facilities. These cores are often staffed by highly skilled trainers with well-developed content knowledge in their discipline. Technology trainers typically hold advanced degrees in disciplines such as life sciences, engineering, or physics, but they may have little to no pedagogical knowledge. We propose that training the trainers to use evidence-based pedagogical practices can serve as a type of quality control standard in light microscopy education.

Following an application process, twenty people from North America and Europe were accepted to participate in the first iteration of this course. Each person has at least one year of experience as a microscopy trainer. They self-report a variety of levels of pedagogical knowledge, and they have expressed different goals for implementing pedagogical principles in their microscopy training and workshops. We will teach four, two-hour interactive synchronous course sessions on Zoom between October and December 2025. Course participants will complete approximately two hours of assignments in between sessions, receive feedback from peers and instructors, and produce a portfolio of ideas for improving their own training.

We have designed the course using Cognitive Apprenticeship principles. Using backward design, course participants will be guided to improve their own microscopy training. They'll develop assessable learning objectives, select inclusive and active teaching tools to implement in their training routines, and use constructive alignment to select learning experiences that help their own trainees achieve the desired learning goals. The eighteen course participants who elected to enroll in the companion study will complete open-ended surveys, self-reflections, and portfolio assignments throughout Fall 2025. In this work-in-progress paper we will report the ways that participants valued the Cognitive Apprenticeship-based aspects of the course design. These results will inform future iterations of the course and allow us to make recommendations for technology trainer professional development within the microscopy community and beyond.

Introduction

Technology trainers serve an important role in the research enterprise. For example, at Clemson University, four institution-level cores offer access to advanced technological equipment for all disciplines, including engineering researchers. These "big 4" core research centers include light microscopy (which also houses histology and cell sorting), electron microscopy, animal research, and aquatic animal research, with each facility staffed by technical experts. At this institution, department-level core facilities provide additional research support; for example, the bioengineering department offers centralized facilities for biomaterials testing, bioreactors, regenerative medicine, and translational imaging.

These core research facilities serve as research hubs for anyone who uses advanced technological equipment to collect data. Research cores offer access to equipment, scientific expertise, and training for end users [1]. Operating models are unique for each facility; Kos-Braun et al. reported that it is common to find variety in core facility models for staffing, funding, and training, even within a single institution [2]. Since different core facilities and private laboratories operate within the constraints of their own human, financial, and technological resources, the development and implementation of education standards are determined by individual staff. These core facility staff may have expertise in a given technology, but this does not mean they have expertise in *teaching,* and yet, they are often tasked with teaching end users to use equipment safely and ethically. In addition to lacking pedagogical knowledge, technology trainers may also lack teacher self-efficacy (TSE), and they may not identify themselves as teachers.

A 2024 survey of imaging scientists revealed that over 30% selected “teaching skills” as a general skill they would like to improve [3]. Even when they recognize the importance of developing their skills as teachers, technology trainers, such as light microscopists, may have limited access to opportunities for improving these professional skills. As reported by Boyd *et al*., in the United States, “non-tenure track instructors often do not have access to professional development funds to assist with travel or fees for [faculty development] opportunities outside their institutions” [4]. Even when people have access to institutional support for teaching effectiveness, the centers “do not have STEM-specific professionals…to support faculty in a discipline-focused manner” [4]. (It is worth noting that this support may vary depending on the country the technology trainer is located in.) Of the twenty technology trainers enrolled in the pedagogy course described in this report, only three reported formal pedagogical education on their applications, with several others describing their participation in workshops or reading literature about pedagogy. Although the interest in improving their teaching skills exists among technology trainers, the opportunities to develop these skills do not.

Core facility staff need community support to define their teaching goals and prepare training plans centered around evidence-based pedagogical practices. Throughout 2024 and 2025, Powell and Le Guyader developed and implemented six iterations of a two- to four-hour pedagogy workshop for technology trainers in online and hybrid formats. Since our technology expertise is light microscopy, our workshop audience was primarily other microscopists, but we also presented to other technology trainers, including those in histology, cytometry, and genomics. Yet, we discovered from participant feedback that the workshop format did not give people time to think deeply about their own training. Furthermore, there was little time for the workshop participants to discuss ideas with peers, almost no time for the instructors to provide feedback and assess pedagogical skill development, and no structured long-term support.

To address the lack of professional development options for core facility staff who want to improve their teaching skills, we present a theory-informed pedagogy course designed for light microscopy trainers. We share evidence suggesting that social learning mechanisms, such as community of practice (CoP) and cooperation, were valued by course participants. The results of this study will inform professional development opportunities for other research technology training contexts.

Theoretical Framework and Research Question

Our course was designed and evaluated using the principles of Cognitive Apprenticeship. Modeled after traditional apprenticeship, Cognitive Apprenticeship is a theoretical framework that explains how novices can learn professional thought processes from an expert or mentor [5]. It includes four major components, all of which were incorporated into our course design: Content, Methods, Sequencing, and Sociology (Figure 1). Although all four components were incorporated in course design, the in-course surveys collected in Fall 2025 focused heavily on the sociological aspects of Cognitive Apprenticeship. Therefore, we have limited the scope of the analysis in this paper to two of the four sociological sub-constructs: CoP and cooperation.

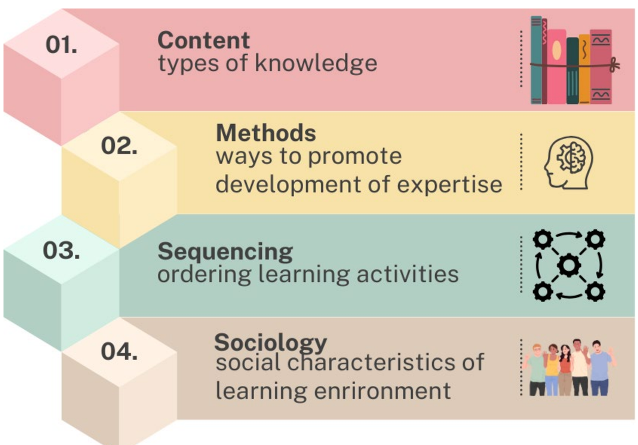

Figure 1. Cognitive Apprenticeship describes an approach for sharing expert knowledge with novices using four major principles: Content, Methods, Sequencing, and Sociology. Each of these major strategies was considered in our course design and can be implemented using a subset of best practices. See Table 1 for an example list of the best practices for Sociology implementation.

Our research question was: how did participants value CoP and cooperation features of the course design? We examined how aspects of the online, synchronous course format and the asynchronous course assignments fostered a developing CoP, which is a sociological framework that highlights learning through shared experiences, conversation, and collective problem solving [6]. Participants cooperated with one another to develop learning objectives (LOs), planned teaching and learning activities (TLAs), and assessed their peers' comprehensive training plans, slowly establishing shared standards, language, and proficiency around microscopy instruction. Through these linked assignments and peer interactions, the group began to foster the shared understanding, sense of ownership, and reflective discussions that are characteristic of a CoP [6], offering insight into how professional educators learn from both the course content and through their involvement in a collaborative learning environment.

COGNITIVE APPRENTICESHIP PRINCIPLES **Sociology**: social characteristics of learning environment	
BEST PRACTICES FOR IMPLEMENTATION	**ASPECTS OF COURSE DESIGN**
Situated learning *learning happens in realistic contexts*	• Students prepared a training plan portfolio that reflected the equipment and resources available in their own core facilities • Instructors modeled active & inclusive teaching techniques
Community of practice *different ways to accomplish meaningful tasks are communicated with a group at different levels of expertise*	• Instructors and students arrived with different levels of content knowledge about microscopy and pedagogy • Instructors and students shared strategies to implement active and inclusive pedagogical techniques in microscopy training • Instructors and students shared resources with one another
Intrinsic motivation *personal goals set by students to accomplish meaningful tasks*	• Shared struggles with existing training procedures • Created a plan to improve their OWN microscopy training • Students implemented new training techniques during the course
Cooperation *students work with one another to accomplish their goals*	• Worked together in groups to complete in-class activities • Worked in pairs to peer review each other's work outside class • Asynchronous discussion board activity to explore pedagogical tools

Table 1. Sociological aspects of Cognitive Apprenticeship that were integrated into the course design. Codes related to CoP and cooperation were used to analyze the data in this study.

Background and Significance

The international microscopy community has identified light microscopy as a technology that is frequently used to generate unreliable and irreproducible data [7]. Inadequate training and/or lack of expert guidance in the use of advanced light microscopes can result in irresponsible or unethical practices, such as misinterpreted data or misleading image editing [8] or the use of "sloppy science" practices [9]. To improve reproducibility in light microscopy, multiple international working groups have published guidelines for instrument calibration and manuscript preparation [10] [11] [12]. These best practices for microscopy methods [13], equipment calibration, and reproducible experiments [14] [15] [16] are important, but so are guidelines to standardize microscopy training. As emphasized by Imreh et al., "…it is important to remember that perfectly calibrating microscopes and fully reporting metadata will not prevent poorly trained researchers from unknowingly acquiring and publishing flawed and unreliable data" [17]. Despite the efforts to standardize the technical aspects of microscopy data collection, no universal standards for light microscopy training have been published [17]. Even if training *content* cannot be standardized, we propose that the use of evidence-based pedagogical principles can be used as a form of quality control for light microscopy training design.

Teaching and learning light microscopy are complicated. Complex cognitive processes are required to operate a microscope. Fitch designed a rubric to "assess the ability to use a compound, binocular, light microscope" [18]. The rubric, meant to evaluate introductory biology college students, is 18 items, illustrating the number of steps required to complete the most basic microscopy techniques. Muna *et al*. [19] used direct observations and analysis of lab reports to study first-year university students as they completed a microscopy lab practical. Students were tasked with preparing a sample of their own stained cheek cells, viewing the samples using the microscope, drawing and labeling the cells, and including a scale bar. The researchers recorded

14 unique acts and 11 informational cues, each of which required decision making. They observed that to complete the lab practical, approximately 12 “mode switches” were required. Modes included “manual/technical, visual, and symbolic/mathematical.” When they evaluated 28 students, “only 8 were able to perform all acts to a satisfactory level” [19].

The studies above explore the complexity of the use of a microscope in a teaching laboratory setting. To use a light microscope for collecting scientific data, researchers must also use advanced procedures to prepare samples and use a digital detector or documentation system to record their observations. Microscopy experts use expert decision-making skills to assess project feasibility and integrate best practices for sample preparation, image collection, and data analysis, but inexperienced researchers may not be aware of this complexity [14] [20]. As illustrated in Figure 2, the design of an ethical, responsible, and reproducible microscopy study requires multidisciplinary knowledge, including subjects such as biology, optical physics, computer science, and digital imaging ethics [8][20]. As Imreh *et al.* state, “pressing…acquire..always delivers an image” [17]. In other words, anyone can collect an image, but they may not collect scientific data that is meaningful. Knowing all this, how does a microscopy trainer decide where to draw a distinction between what must be taught or what should be provided as scientific advice?

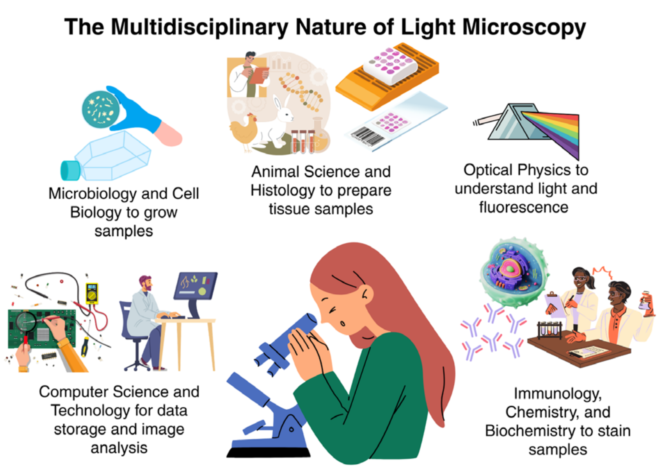

Figure 2. To ethically and responsibly conduct a light microscopy experiment, one needs a working knowledge of many different disciplines. A successful microscopist must integrate sample preparation techniques, sample staining, optical physics, and computer science. Diagram inspired by Weber and Huisken [20].

Most core facility staff recognize that learning advanced light microscopy requires hands-on practice over time. Kubow and Harsh [21] recently measured the acquisition of fundamental microscopy skills by undergraduate students after participating in 2 or 3, one-hour training sessions, spaced over two or more weeks. They hypothesized and confirmed that this training schedule helps students develop confidence in their microscopy skills [21]. However, many light microscopy trainers are likely unaware of evidence-based principles that facilitate learning. The problem faced by many core facility staff is undoubtedly similar to many novice professors: “they have been taught a lot about the subject they are about to teach, but little about how to teach it” [22]. Kugel hypothesized that new professors progress from a focus on the self (“how” to teach) to the subject (“what” to teach) before they reach a stage recognizing the importance of “them” (the learners) [22]. The pedagogy course we developed in this study aims to help core facility staff recognize the needs of the “them” (the learners).

In a 2024 survey by Global Bioimaging, less than 10% of those who work in imaging core facilities reported a background in engineering & technology; there was no information in the survey about the disciplines of the end users who are served by the technology [3]. Although some light microscopy trainers may only interact with life sciences researchers, others routinely assist engineering researchers as well. At the Clemson Light Imaging Facility, for example, researchers from disciplines such as bioengineering, chemical and biomolecular engineering, materials science, and mechanical engineering commonly request access to advanced microscopy equipment. Engineering labs may use light microscopy to investigate the impacts of new drug delivery systems on animal tissues, they may explore the conditions under which biofilms grow on implant devices, or they may observe changes in wound healing caused by environmental toxins (Figure 3). Engineers may also use electron microscopy, animal research, histology, cytometry, and genomics, all of which may be housed in core research facilities. In summary, it is clear that engineering researchers are often taught by core facility staff.

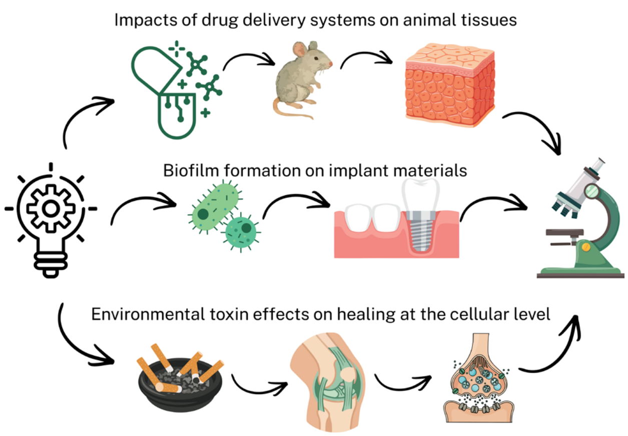

Figure 3. Bioengineers and chemical engineers often employ light microscopy and other research technologies to investigate their translational research projects. They may design studies that require animal facilities, histology, cytometry, genomics, and electron and/or light microscopy.

Study Context

Following an application process, twenty professional microscopists were enrolled in an online pedagogy course that two of the authors designed and implemented in Fall 2025. Eighteen of the twenty students agreed to participate in the study. Of these study participants, seventeen manage/direct academic core light microscopy facilities, while one has an industry affiliation. They work at institutions throughout North America and Europe, but none work at the home institutions of the course instructors. They have self-reported that they conducted microscopy training for at least one year. When asked to explain what prior experiences they had with learning pedagogical principles, some reported "none," while others reported some formal training. Many participants had attended workshops or explored literature related to pedagogy.

Four LOs were published for the course:

- Write a list of LOs for your own microscopy training,
- Incorporate new pedagogical tools in your microscopy training,
- Critically evaluate the quality of your training considering the Constructive Alignment principles, and
- Write a plan to improve your microscopy training.

The course consisted of four, two-hour sessions on Zoom (see Figure 4 for details). We used Canvas as our learning management system (LMS). Students completed assignments between synchronous sessions, which supported the course learning objectives. In addition, they prepared items for their final portfolio.

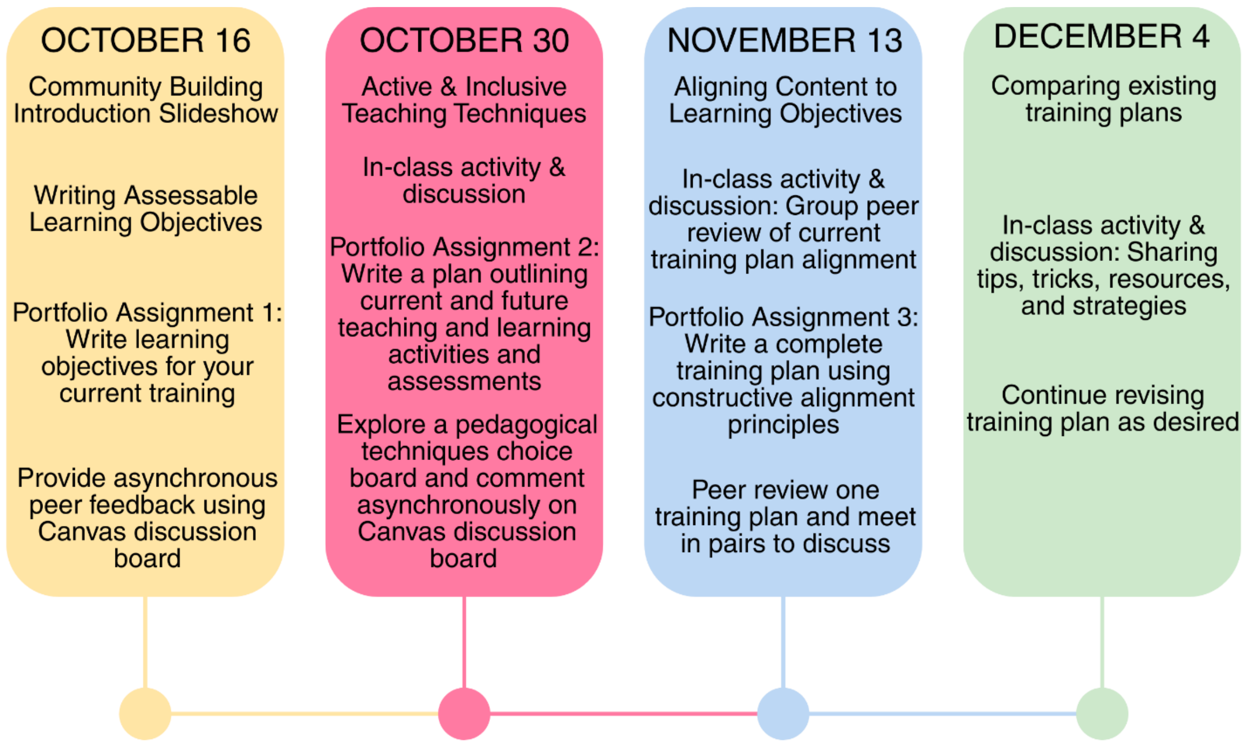

Figure 4. Timeline and topic outline for the four-session online course. The course meetings were separated by two or three weeks, with a portfolio assignment due in between.

The final portfolio served as a complete microscopy training plan, and it was created using the principles of constructive alignment. The portfolio assignment was completed in stages. Microscopy trainers with experience already have a plan in place for teaching end users; however, it's likely that they have not considered this plan from the perspective of the learner. Therefore, we began by introducing students to the idea of LOs. Students were asked to define at least three LOs for their current training plan. In addition to feedback from one of the course instructors, students received comments from three of their peers using a Canvas discussion board.

In the next assignment, we asked students to use Padlet, a visual collaboration tool, to organize a detailed plan for three of their LOs. They were asked to brainstorm active and inclusive TLAs that they currently use, along with a list of future goals. In addition, we asked them to consider how they currently assess their LOs (if at all) and again, prepare a list of future ideas for assessments. At least one of the course instructors provided feedback about the full plan for their first LO. This was the second activity that focused primarily on asking the course participants to "de-construct" their current training.

During the third synchronous course session, students were introduced to constructive alignment principles. They worked in groups of four during the synchronous course session to evaluate the full training plan for their second LO. They discussed whether the plan was aligned and whether the TLAs and assessments were comprehensive, active, and inclusive. This peer discussion was important to practice together in class, as they were assigned to continue this exercise in pairs outside of class for their third LO. Once they incorporated our feedback and peer feedback into their tentative final training plan, we provided another round of instructor feedback.

For the last synchronous course session, the instructors shared ideas and resources for improving training. Students requested that we also allocate some time for them to share their own ideas with one another. We used surveys and Mentimeter polls to share differences and similarities in the training plans. We asked students to consider parts of their training plans that could be removed and assessed outside of hands-on training, since training time is often a limiting factor. We also asked them to share their favorite microscopy teaching techniques. No additional assignments were required after the last session; instead, students were asked to complete two final surveys and were encouraged to upload their final training plan to a public Canvas discussion board for sharing with their peers.

Positionality

Two of the authors, who work as professional microscopists, designed and taught the course. One of the course instructors was not involved in the study design and is a non-native English speaker. The other instructor is a Ph.D. candidate in a science education research program and was responsible for study design, data collection, and data analysis. We acknowledge the potential for bias due to these multiple roles in the project. To mitigate this possibility, we included a Research Associate Professor of science education and two undergraduate education researchers on our analysis team (one of whom is also a non-native English speaker). None of these three authors were directly involved in the design and implementation of the course. Collectively, our academic backgrounds include life sciences, education research, educational technology, and anthropology; this diversity of perspectives adds to the quality and validity of our data.

Methods

This study was reviewed and approved by Clemson University institutional review board (IRB2025-0717). Everyone enrolled in the course was invited to participate in the study; eighteen out of twenty students opted in. Although everyone who agreed to participate in the study attended all four course sessions, there was some variation in participation in data collection and other course assignments (details provided below). Students were invited to select their own pseudonym or ask us to choose one for them. Study participants received two pedagogy books as incentives for enrollment after attending all four course sessions.

Using thematic analysis [23], we implemented a deductive coding approach to explore how the course participants valued the sociological aspects of the course design (see Table 1). The codebook is provided in Appendix 1. Three authors comprised the coding team (one course instructor and two undergraduate researchers). Each of us coded twelve interviews so that two coders were assigned to each participant's data set. The codes were discussed asynchronously using the group coding document. We also met in-person to discuss coding disagreements, with all three members of the coding team present to help us reach consensus.

For this paper, we analyzed responses from the open-ended surveys. Study participants completed surveys after Session 1 (18/18), Session 2 (18/18), Session 3 (18/18), and Session 4 (16/18). We also examined self-reflections from Portfolio Assignment 1 (17/18), Portfolio Assignment 2 (16/18), and Portfolio Assignment 3 (14/18). Finally, we looked at responses to two open-ended survey questions that were answered as part of a larger teacher self-efficacy survey (pre- [18/18] and post-course [16/18]) and responses to two open-ended prompts that students completed as part of the participant introduction slideshow. Because we analyzed written responses, all excerpts provided below include any original errors in spelling or grammar. All survey questions and self-reflection prompts are listed in a table in Appendix 2.

Limitations

This analysis represents the first iteration of a course using a design-based research approach [24]. Although the course instructors have experience teaching pedagogical principles to microscopy professionals, previous implementations have been in a two- to four-hour online or hybrid workshop format. Furthermore, as a work-in-progress, we have only examined surveys and artifacts generated during the course in Fall 2025. Similarly, we have not yet analyzed all the aspects of Cognitive Apprenticeship that were incorporated into course design.

Results

Community-building activities were valued by some and seen as extraneous by others. To build community, we spent time during Session 1 asking students to introduce themselves. They shared their observations about their struggles and successes with microscopy training. In the subsequent sessions, we used icebreaker activities in the 5-10 minutes prior to class for those who already joined Zoom. We also used Mentimeter polls and other in-class activities to explore how different people learn in different ways.

Some students recognized the importance of building rapport with one another through these exercises and craved more time for peer discussions.

> "[I think you could improve the course with] More peer interaction and experience exchanges, maybe this is planned in future sessions? But I understand that time is limited." --Jellyfish

> "I enjoyed all the menti polls, kept us students active and engaged while allowing some level of anonymity." --Andromeda

Other students did not feel that making personal connections was a good use of time.

> "I think you could improve you [sic] use of time. We spent a long time going over the rubber ducky chart and beverage choices that were not relevant to the course. None [sic] course

> relevant material should be kept for people who show up early and want to socialize or who want to stay late." --Neurotrace

Course participants cooperated with one another to explore new ideas during synchronous group work activities. Students had mixed feelings about how helpful the cooperative learning activities were. They seemed to enjoy the peer interactions and group discussions, but they were sometimes confused about the purpose of group work activities. Some students felt confused about the instructions and the assigned group roles, especially after the first course session.

> "The task [during group work about learning objectives] was not defined very well, which made the assignment challenging. We wasted a lot of time trying to understand the assignment, and did not focus on the right tasks in the end. I think the concept that the assignment is trying to teach is important, but I think a quick demonstration from the instructors (roleplay?) would have been very helpful to keep everyone on track." --Subject1

> "So far, I think the instructions could be clearer. Sometimes it's not easy to quickly understand what we are supposed to do in the exercises or assignments. Having more detailed explanations or concrete examples would make the activities easier to follow and more effective." --Tico

We, as instructors, reviewed student feedback and made adjustments during the course. As a result, subsequent group work activities were more productive.

> "I really liked the group discussion because it just went very smoothly (roles were predefined = no discussion about who has to do what even if someone is missing and the task was clearly defined and we all understood it). The group discussion from session one was more chaotic and made me fear this one a little, so it felt extra good that it went so nicely." --Phoenix

Regardless of the changes we made, students often felt rushed during group work. They felt that we did not allocate enough time for meaningful discussions.

> "I found the last breakout room discussions a bit difficult. Our group really ended up just talking about the person's LO and activities and giving advice, but didn't really follow the questions because we found they were difficult to address individually and a more wholistic [sic] conversation was more valuable. Maybe fewer questions for this part would have helped us target the discussion better without feeling cumbersome?" --GrimParakeet

> "I got to know some of my course mates, but it was too little time to go through everything!" --Oravla

> "It was challenging because the time we had on this group session was a bit short." --Princess

Students encouraged us to provide instructions and resources prior to the class meetings for future course iterations. They reported that it would allow them to feel more prepared for class activities. The non-native English speakers also reported that providing resource materials ahead of class would give them more time to process the information so that they could feel more comfortable having a discussion in English.

> "[To improve the course] providing information/expectations for group work. If we did the survey and discussed during class prior to group work, it may have helped with the group assignment." --Kevin

> "I think we could have access to some documents before the lesson. Sometimes it goes too fast, and I had trouble keeping up because we have to concentrate on several tasks: understanding English, discovering the topic, and then working in groups. I didn't quite understand the instructions, and when we did the group work, it took me a while to grasp them. If I had had the instructions beforehand, it would have helped me prepare my arguments better and participate more effectively." --Zina

Cooperation through peer review was enjoyed by most participants. During synchronous class sessions and in between classes, peers worked in groups or pairs to provide feedback about one another's training plans. The instructors assigned the groups or pairs, and these were switched throughout the course sessions so that multiple students could work with as many of their colleagues as possible. Many participants reported benefits from these peer interactions.

> "I enjoyed the discussion with the peer. The person I was paired up with works in a very different core, so we were able to compare each of our settings and then make suggestions to each other. It was also useful to get feedback from another person with a different learning style on my learning objectives and goals." --PlaneCheese

> "I think these [in-course discussions] were invaluable, I gathered information for improving my own LO as well as gained better understanding of LO development from helping others develop theirs." --Andromeda

> "I think the peer feedback was helpful for me to get a view from an expert in microscopy but who is not involved in the organisation of our facility. They identified critical points I could not see." --Hogger

However, some participants reported their peers provided little to no constructive feedback.

> "I got peer feedback from 3 peers on my first version and then a one on one session with a peer on my final version. I tried to include the feedback in my plan but most of it wasnt [sic] too helpful as only one person out of these 4 really had feedback asking me to change something. however, i didnt really understand at that point how to change what was pointed out so that was also only semi helpful." --Phoenix

> "My peer did not provide any feedback." --Subject1

An asynchronous discussion board was useful, but technically challenging, for sharing impressions of new teaching tools with colleagues. After Session 2, students were introduced to new inclusive teaching tools and ideas using a Choice Board. They could read, watch, or listen to resource materials, so that they could experience the benefits of offering multimodal educational materials to their trainees. They selected two options to explore, and then they discussed how these new techniques could be applied to microscopy training. Students enjoyed the autonomy of selecting their own materials.

> "[The choice board] is helpful because we have the options to choose from, and different people learn differently or absorb knowledge better in one way than other ways." --Jellyfish

> "[The choice board] was nice because it let me pick the learning modality that was best for me (videos). I also really liked being able to choose topics I was interested in." --Neurotrace

> "[The choice board and selecting my own learning materials] was very helpful because for me it varies each day which kind of learning material (read, listen, watch) I can focus on better. So, I was able to select material which I could focus on the best." --Phoenix

> "Having a choice board was very helpful because it gave me new ideas and confirmed some of the things I had already been thinking about. It also inspired me to explore more sources on my own, like a snowball effect, where the initial options led me to discover even more materials and perspectives. I liked having the freedom to choose what matched my interests and way of learning." --Tico

Though they enjoyed choosing their own materials, their enthusiasm was tempered by frustration with the format of the discussion board. Although we created different threads for different topics, many students posted in the wrong place, or they did not provide enough context for people to know what topic others were responding to.

> "I find a lot of the things on Canvas a little challenging to navigate. I always feel like I am missing somethings, and it turns out I usually am... Also, the discussion board seemed to be very slow to load. As far as using it as a discussion area, it is like any other internet forum, so scrolling through and finding things to respond to." --PlaneCheese

> "The board itself does not look great to me as the comments take a lot of space and it´s a bit hard to keep track of groups of comments relating to the same post, but that is more of a personal preference and something about Canvas we cannot change I guess." --Hercules

> "To be honest, it took me longer than I expected because my Canvas was extremely slow. I'm not sure whether it was due to my computer or the large number of messages displayed, but it was quite challenging to find the right tool to comment on and to read through my colleagues' comments...technically, it was quite tricky." --Oravla

Becoming part of a community validated their feelings about the difficulties of teaching microscopy. Light microscopy training is complicated, as it requires the instructor to decide how much technical knowledge is necessary to share with the trainee in order for them to conduct a reproducible scientific experiment. Trainees (and their supervisors!) often express an interest only in "taking a picture," but experts recognize that picture as data that should be collected with the same quality control concerns as any other experiment. Recognizing the difficulty of this balance is a feeling shared by their colleagues worldwide was validating for the students.

> "I am greatly enjoying this course because it feels like a space where all of my daily training struggles can be *seen* and I finally have a way forward to improve my training skills. It is also great to interact with colleagues with the same struggles and get to talk together about how to improve." --Andromeda

> "I like the introductions [to other core facility staff] - it is gratifying to know we are all dealing with the same kind of challenges when training new users. Without community, it is often easy to feel that the challenges are isolated to the trainer/core." --Kevin

> "I really enjoyed hearing from my peers and learning that they have struggles similar to mine. That was so validating and makes me excited to work together on how we can all improve." --Jessie

The members of the developing CoP were excited to share ideas, resources, and training strategies. The students recognized the value in sharing their struggles and successes with one another. They were vulnerable in sharing what aspects of training were difficult for them, and they were honest about what new teaching techniques felt intimidating. Although they recognized the course instructors as a valuable source of pedagogical knowledge, they also began to depend on each other for advice and feedback during the course.

> "I think the best part by far was hearing all of the wonderful ideas from both the instructors and other participants. It was very inspiring and has given me a ton of great ideas!" --GrimParakeet

> "I like the Menti poll because it allows me to quickly see other people's ideas." --Bill

> "As mentioned, my favorite part has been the inspiration the comes from feeling like I'm discovering new resources and part of a dedicated community." --Cassiopeia

Students recognized and appreciated the warm and welcoming community environment developed by the instructors. Course participants enjoyed the way that the instructors related to the class. They recognized our goal of developing a culture where everyone's ideas and experiences were valued, and where each person could succeed in improving their training.

> "FIRST, [both instructors] were both great with feedback and approachable. It made it feel like "we're all in this together" and we know you want us to succeed. I liked that the classes were recorded and I could go back and rewatch them for any sort of needed explanation. All of the people that signed up and participated really added to the experience. We were able to ask questions to each other during the discussion sessions, and it helped when we realized some of us were equally lost or misunderstood that assignment." --PlaneCheese

> “I liked the teachers. they were extremely kind, understanding and approachable. this helped me feel more comfortable than i have ever felt before duringca [sic] course. I also liked all the shared resources and material.” --Phoenix

> “The "raise your hand if you've never had formal microscopy education" was a wonderful way to be inclusive and make us all feel more comfortable/less imposter syndrome!” --Raccoon

Discussion and Design Implications

We explored how course participants described the sociological aspects of Cognitive Apprenticeship and found that design features related to cooperation and CoP were valued by most students. Because our expertise is light microscopy, we developed and tested our course using our technology as the model, but we believe the techniques of forming CoP and using situated learning (outside the scope of this analysis) are universal for all technology trainers. Three major design themes emerged that will easily translate to other professional development contexts for technology trainers: explicitly include activities that foster long-term community building, provide clear instructions and goals, and create a respectful learning environment that encourages personal growth and reflection.

Design for Community-building. Participants enjoyed community-building through various modalities such as ice-breakers, Mentimeter polls, discussion boards, and group work assignments since these activities allow them to share their ideas, successes, and challenges with colleagues. Whenever possible, we recommend that community-building activities should relate to the LOs of the course. The instructors may need to make the connections explicit for some of the participants to recognize their value.

Students enjoyed cooperating with their colleagues through peer review and group work. They also developed a thriving CoP, sharing resources, ideas, and experiences with one another through synchronous, in-class discussions and asynchronous discussion boards in the learning management system. This is not surprising, as nearly 40% of respondents to the Global Bioimaging survey indicated that they wanted to improve their so-called “soft-skills,” such as communication and teamwork; in addition, many respondents wanted to improve their management skills, which included networking and diplomacy [3].

Design with Clear Instructions and Goals. People enjoyed synchronous group work activities when we gave clear instructions and goals. To be more inclusive of international audiences and students who are unfamiliar with LMS platforms, we recommend that plans for activities and discussions be provided ahead of course meetings. This allows students to use translation software, screen readers, or other inclusive learning technologies prior to class; in general, it allows students an opportunity to navigate new software, be aware of what to expect, and generally feel prepared if that is one of their learning preferences. Whenever possible, we recommend that instructors provide directions in multiple formats, such as written instructions plus an optional video, to accommodate multi-modal learning preferences and/or participants who speak different languages.

In our course, there are areas for improvement. For example, Canvas is a useful LMS for the instructors, but we overestimated the skill level of our learners who do not interact with this software on a regular basis. In the future, we can provide video tutorials for navigating Canvas and/or provide real-time demonstrations during synchronous class sessions to help build comfort and confidence in students who may be new to this platform. Some activities, like the discussion board, were valued by the students, but they were disappointed in the format. We can provide clearer written instructions, add video tutorials, and break the single discussion board into multiple, separate ones about focused topics rather than having one central thread. Importantly, the students enjoyed interacting with one another, even if the format was frustrating. There were over one hundred posts on the discussion board!

Group work can be very effective, but requires ample time, clear instructions, purpose, and guidance, and this is an area where we can continue to improve. Chiriac and Granstrom attempted to establish best practices for group work based on a student perspective and reported, "It is important that the time allotted to the group is adapted to the task. The students seem to have extensive experience of too short time allocated to group work..." [25]. Indeed, our participants were frustrated with rushed group activities. Chang and Kang (2016) explored challenges and benefits of online group work [26]. Students enjoyed different perspectives, appreciated each other's strengths, and motivated one another. However, they expressed challenges with group structure, group leadership, and different skill levels among group members [26]. It seems our course participants had a similar experience; despite our efforts to suggest group roles and provide what we perceived as clear instructions, we did not provide an optimum group work experience early in the course.

We made assumptions about the students' peer review skills that we should not have. In some cases, course participants may have struggled with peer review simply due to a lack of time for participating in these types of asynchronous activities. In other cases, students' lack of pedagogical knowledge truly created a barrier to providing feedback to one another. There may have been some language barriers as the course is conducted in English, but many of our participants are non-native English speakers. Additionally, there could also be cultural differences in how comfortable some people felt about criticizing one another or providing honest feedback. Finally, this might have been due to lack of guidance from the instructors. Although many STEM professionals have had their own publications peer-reviewed, this does not automatically mean that they know how to give constructive feedback, and we likely did not provide enough information or modeling to help students understand the expectations for this exercise. This can be improved in the future by providing concrete examples of peer reviews prior to these exercises.

Design for Respect, Personal Growth, and Reflection. Instructors should set a warm and approachable tone that allows students to make mistakes and share different opinions. Our students felt respected, and because of this, they were empowered to provide honest feedback and share ideas for improving the course. They were also excited to ask us for additional resources, and they were eager to share their own ideas and experiences with one another. In *Cognitive Apprenticeship in Action* [27], the authors share that developing the sociological aspects of Cognitive Apprenticeship requires "creating a learning environment where students feel safe to share their ideas in an atmosphere where the work is genuinely valued by all those involved." Participants described this sort of environment, and they recognized and valued the respectful and encouraging tone set by the instructors. Whenever possible, we recommend that instructors create opportunities that invite self-reflection, resource sharing, and goal setting.

Alsayer interviewed eight graduate students who participated in an international, online educational technology course [28]. These students were happy with some of the asynchronous peer interactions in the course, as they felt it provided them with time to think and reflect about their new knowledge. However, they reported that synchronous components were too short to let them reflect; instead, these activities were best to help them clarify new concepts and make meaning with one another. In the future, we can consider dividing these categories of activities into synchronous and asynchronous assignments.

The course participants depended less on the instructors and more on one another over time. They recognized their peers as experts, and they asked for more ways to interact and to share resources with one another beyond the planned activities. Because this was such a popular request, we modified the format of the fourth course session to include extensive peer discussion. We also opened a form for students to submit their favorite microscopy teaching resources and developed a separate module in Canvas to share these. In the end, five participants submitted a resource. At the end of the course, nine students voluntarily uploaded their complete training plan portfolio to share with their peers, one participant asked to create an email list-serv to stay in touch (eight students shared their contact information here), and at least thirteen students agreed they would like to attend an alumni reunion about six months after the course. It will be interesting to see how this CoP continues to develop and how it supports their self-efficacy as teachers.

Cognitive Apprenticeship is an excellent model for training in STEM disciplines, including technology trainers. Previous studies have explored student experiences with Cognitive Apprenticeship-informed training models, but researchers typically analyze the implementation of "methods" (See Figure 1). For example, Cognitive Apprenticeship models have been used to develop the research skills of science and engineering doctoral students [29]. In this case, the faculty member or other mentors (such as post-doctoral fellows and fellow graduate students) may serve as the expert, while the student serves as the novice/apprentice. The model works well, but it does require "deliberate action" from both members of the dyad (the apprentice/mentor pair) [29]. Similarly, researchers investigated the use of Cognitive Apprenticeship models in the training of clinical students. Study participants reported that some clinical teachers lacked basic teaching skills, which interfered with effective use of some methods components during training [30]. We attempted to avoid the pitfalls outlined in these studies in our course design: we deliberately modeled active and inclusive teaching practices, resulting in the welcoming learning environment described by our course participants.

Conclusions

Although there are areas for improvement, the sociological aspects of the course design were valued by the participants. Modeling the importance of the social aspects of learning was particularly important for teaching pedagogy to a group of STEM professionals as they may have discounted this idea had they not experienced it. By the end of the course, the course participants often shared that they were proud of themselves for creating welcoming training environments, and they valued the notion of collaborative learning environments. Some of them shared a goal for implementing similar environments with their own trainees by using peer feedback in training or by offering informal coffee hours in their facilities.

By the end of the course, the participants developed a training plan that worked well for them. We chose not to analyze their portfolio for this preliminary analysis, as we will continue to track their training improvement progress throughout Spring 2026. However, the course participants who submitted a final portfolio (19/20) made dramatic changes to their training plans throughout the course. They used constructive alignment principles to create a plan with assessable LOs, and nearly everyone planned TLAs that were active and inclusive. Taken together, we believe our online course design provided a valuable and practical professional development opportunity for technology trainers to improve their pedagogical skills.

Future Directions

Not all students were convinced that these pedagogical principles were the best way to improve their microscopy training plan. We recognize that we cannot design a course that is totally universal, but we also acknowledge the constructive criticism offered by some of the students. For example, Jessie did not feel that these techniques would work well for adults, and they did not think that their trainees would react well to assessments, given a lack of a formal teacher/student dynamic with the trainees. Another participant (Subject1) reported that the "content is excellent so far, albeit not very advanced." Similarly, a participant who reported formal teaching experience, Neurotrace, did not feel that we shared novel material about pedagogical principles. Finally, Kevin reported that some of the examples shared in class were not applicable to all light microscopes. Although we shared the LOs in the course advertisement, we will make it clear in subsequent iterations that this is an *entry-level* pedagogy course for advanced fluorescence light microscopy trainers.

In the future, we will implement a flipped classroom approach so that students have time to engage with the topics before our class meetings and discussions. Although this will likely help everyone, it will be particularly useful for students who expressed concerns about lack of time for activities. Moreover, our non-native English speakers suggested that having access to learning materials prior to class would help them feel more prepared for activities and discussions. We were conscious of cultural differences when we designed the course, but it is obvious we still created some unnecessary barriers for some learners.

This work is part of a larger design-based research and course development project, which is iterative by nature [24]. The first iteration of the course concluded in Fall 2025, but the study will continue throughout Spring 2026. Study participants will attend two interviews and two focus groups, continuing an exploration of the ways that students enrolled in the course implemented what they learned into their own microscopy training We will use the results of this study to inform future course design, with the second implementation planned for Fall 2026.

We believe that offering high quality training, informed by pedagogical principles, to end users is a form of quality control in light microscopy (and likely all research technologies). We want to make these types of professional development opportunities available to all core facility staff. Developing these educational CoPs for technology trainers will allow us to develop and share novel, effective ways to teach end users the appropriate and ethical methods for implementing light microscopy into their research projects, and it will ultimately lead to greater reproducibility in science.

Acknowledgments

We are immensely grateful for our participants, who took the time to provide us with thoughtful feedback. Thank you to Gabriela Imreh (Karolinska Institutet, Stockholm, Sweden) and Dr. Eliza Gallagher, Cora Allard-Keese, and Sofia Brewer (Clemson University, Clemson, South Carolina, USA) for serving as critical friends during our course and study design and implementation. Thank you to Jayda Gilliard and Justin Scott (Clemson Light Imaging Facility) for assisting us with data management logistics and user statistics. We thank our colleagues throughout North America and Europe for sharing our course advertisement. We thank Clemson University Creative Inquiry, Clemson University UPIC program, Clemson University Division of Research, and Clemson Light Imaging Facility for providing funding and staffing support for our study.

References

[1] D. Meder *et al*, "Institutional core facilities: prerequisite for breakthroughs in the life sciences," *EMBO Reports,* vol. 17, *(8),* pp. 1088–1093, 2016. Available: https://api.istex.fr/ark:/67375/WNG-72J3SBFJ-G/fulltext.pdf. DOI: 10.15252/embr.201642857.

[2] I. C. Kos-Braun, B. Gerlach and C. Pitzer, "A survey of research quality in core facilities," *eLife,* vol. 9, 2020. Available: https://www.ncbi.nlm.nih.gov/pubmed/33241998. DOI: 10.7554/eLife.62212.

[3] J. W. Pylvänäinen, I. Oy and D. Gütl, "GLOBAL BIOIMAGING INTERNATIONAL SURVEY REVEALS TRAINING NEEDS FOR CORE FACILITY IMAGING SCIENTISTS GLOBAL BIOIMAGING PUBLICATIONS PART 3.2: TRAINING SURVEY," 2024. DOI: 10.5281/zenodo.13384863.

[4] E. Boyd *et al*, "Lessons Learned from the Development and Implementation of Teaching Postsecondary STEM Through E-Learning," 2024. Available: https://www.thecuvette.org/pub/ly9qk36m/release/1. DOI: 10.21428/a70c814c.90f591e1.

[5] A. Collins, J. S. Brown and A. Holum, "Cognitive Apprenticeship: Making Thinking Visible," *American Educator,* 1991.

[6] E. Wenger-Trayner and B. Wenger-Trayner. (-06). *Introduction to communities of practice: a brief overview of the concept and its uses.* Available: https://www.wenger-trayner.com/introduction-to-communities-of-practice/.

[7] S. M. Mische *et al*, "A Review of the Scientific Rigor, Reproducibility, and Transparency Studies Conducted by the ABRF Research Groups," *J Biomol Tech,* vol. 31, *(1),* pp. 11, 2020. DOI: 10.7171/jbt.20-3101-003.

[8] D. W. Cromey, "Avoiding twisted pixels: ethical guidelines for the appropriate use and manipulation of scientific digital images," *Sci. Eng. Ethics,* vol. 16, pp. 639–667, 2010.

[9] E. M. Bik, A. Casadevall and F. C. Fang, "The Prevalence of Inappropriate Image Duplication in Biomedical Research Publications," *mBio,* vol. 7, *(3),* pp. e00809–16, 2016. DOI: 10.1128/mBio.00809-16.

[10] H. Jambor *et al*, "Creating clear and informative image-based figures for scientific publications," *PLoS Biol,* vol. 19, *(3),* 2021. DOI: 10.1371/journal.pbio.3001161.

[11] F. Crameri and G. E. Shephard, "Heron PJ The misuse of colour in science communication," *Nat. Commun,* vol. 11, 2020.

[12] C. Schmied *et al*, "Community-developed checklists for publishing images and image analyses," *Nature Methods,* 2023. Available: https://search.proquest.com/docview/2865786259. DOI: 10.1038/s41592-023-01987-9.

[13] G. Marques, Pt and M. A. Sanders, "Imaging methods are vastly underreported in biomedical research," vol. 2020.

[14] E. C. Wait, M. A. Reiche and T. -. Chew, "Hypothesis-driven quantitative fluorescence microscopy -the importance of reverse-thinking in experimental design," *J. Cell Sci,* vol. 133, 2020. . DOI: 10.1242/jcs.250027.

[15] G. Nelson, "QUAREP-LiMi: A community-driven initiative to establish guidelines for quality assessment and reproducibility for instruments and images in light microscopy," *J Microsc,* vol. 284, pp. 56–73, 2021.

[16] J. &. Aaron and T. Chew, "A guide to accurate reporting in digital image processing -can anyone reproduce your quantitative analysis?" *J. Cell Sci,* vol. 134, 2021.

[17] G. Imreh, J. Hu and S. Le Guyader, "Improving light microscopy training routines with evidence-based education," *Journal of Microscopy,* vol. 294, *(3),* pp. 295, 2023. DOI: 10.1111/jmi.13216.

[18] G. K. Fitch, "Rubric for Assessing a Student's Ability to Use the Light Microscope," *The American Biology Teacher,* vol. 69, *(4),* pp. 211–214, 2007.

[19] N. Muna *et al*, "Unpacking the multimodal discourse demands of microscopy in a bioscience laboratory," *International Journal of Science Education,* vol. 42, *(16),* pp. 2742–2764, 2020. Available: https://www.tandfonline.com/doi/abs/10.1080/09500693.2020.1836429. DOI: 10.1080/09500693.2020.1836429.

[20] M. Weber and J. Huisken, "Multidisciplinarity Is Critical to Unlock the Full Potential of Modern Light Microscopy," *Frontiers in Cell and Developmental Biology,* vol. 9, pp. 739015, 2021. Available: https://search.proquest.com/docview/2595115439. DOI: 10.3389/fcell.2021.739015.

[21] K. E. Kubow and J. A. Harsh, "Training module and assessment strategy for light microscopy skills training in a research environment," *J. Microbiol. Biol. Educ.,* pp. e0017925, 2025. DOI: 10.1128/jmbe.00179-25.

[22] P. Kugel, "How professors develop as teachers," *Studies in Higher Education,* vol. 18, *(3),* pp. 315, 1993. DOI: 10.1080/03075079312331382241.

[23] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology,* vol. 3, *(2),* pp. 77, 2008. DOI: 10.1191/1478088706qp063oa.

[24] Design-Based Research Collective, "Design-Based Research: An Emerging Paradigm for Educational Inquiry," *Educational Researcher,* vol. 32, *(1),* pp. 5–8, 2003. DOI: 10.3102/0013189x032001005.

[25] E. H. Chiriac and K. Granström, "Teachers' leadership and students' experience of group work," *Teachers and Teaching,* vol. 18, *(3),* pp. 345, 2012. DOI: 10.1080/13540602.2012.629842.

[26] B. Chang and H. Kang, "Challenges facing group work online," *Distance Education,* vol. 37, *(1),* pp. 73, 2016. DOI: 10.1080/01587919.2016.1154781.

[27] J. Tomsett, O. Caviglioli and E. Huntington School (York, *Collins Et Al's Cognitive Apprenticeship in Action.* 2021.

[28] A. A. Alsayer, "Learners' Experiences in an Online Learning Environment: An Analysis of the Impact of International Collaboration," *Sage Open,* vol. 13, *(4),* 2023. DOI: 10.1177/21582440231208524.

[29] M. A. Maher *et al*, "Cognitive Apprenticeship and the Supervision of Science and Engineering Research Assistants," *Journal of Research Practice,* vol. 9, *(2),* 2013.

[30] R. E. Stalmeijer *et al*, "Cognitive apprenticeship in clinical practice: can it stimulate learning in the opinion of students?" *Adv in Health Sci Educ,* vol. 14, *(4),* pp. 535, 2008. DOI: 10.1007/s10459-008-9136-0.

Appendix 1: Codebook used for analysis.

Cooperation: students work together to accomplish their goals. These could be about their own training, but these will more likely be about working with a group or peer to complete a task related to the course.	
Code	**Definition**
Group work	Use for any referral to experiences working or discussing in pairs or groups, including synchronous in-class activities or anything that they did outside of class.

<table>
<tr><td>Peer review</td><td>Use when the participant describes feedback about an assignment for class from another student and/or a course instructor. Could overlap with working in groups code if they discuss what it was like to work with a peer on this. If it’s more about the feedback itself, code as peer review.</td></tr>
<tr><td colspan="2">Community of practice: communication about different ways to accomplish meaningful tasks. These are more likely to be about microscopy broadly, though they could provide examples in the context of their own training.
Domain: microscopy trainers interested in implementing pedagogical practices
Community: joint problem-solving, activities, discussions, information-sharing, building relationships
Practice: build resources/ideas to share & maintain collective knowledge to take back and implement in our microscopy training</td></tr>
<tr><td>Code</td><td>Definition</td></tr>
<tr><td>Sharing strategies</td><td>Use this if the participant shares a specific strategy for teaching/training/assessing a microscopy task or concept. This is different than a general teaching technique and would be more comprehensive and directly related to microscopy: “a way to teach saturation that I use is....”</td></tr>
<tr><td>Sharing resources</td><td>Use this if they share their OWN teaching/training materials with the group. This could be a checklist, a handout/worksheet, a video, a quiz, something on their facility website, etc. This should be something they made themselves and want to share with the group because they find it useful for teaching microscopy.</td></tr>
<tr><td>Community resources</td><td>Use this if they share a resource they found that could be useful for teaching/training microscopy. This could be primary literature, books, videos, professional development opportunities that they did NOT create, but they think would be beneficial for the group. These must be related to the domain (microscopy, pedagogy, microscopy-specific pedagogy).</td></tr>
<tr><td>Peer interactions</td><td>They used the discussion board as an asynchronous tool in Canvas to interact with peers. We used Menti polls to help them share anonymous personal experiences- those interactions might fall into this code. Use this code if they specifically mention opportunities to interact with peers as a way to improve/consider changing something about their training. This is different than group work code. Group work code should be used when they worked together to accomplish a specific task.</td></tr>
<tr><td>Community environment</td><td>Use if they discuss the ways the community functions. This could relate to the culture of the group (languages, time zones, holidays). This could relate to the online nature of the community, time requirements of the assignments, how external obligations impacted their participation in the community, relationship building activities in class, etc.</td></tr>
</table>

Appendix 2: Open-ended survey questions and reflection prompts.

Pre-Course Introduction Slideshow
I notice my trainees struggle with...
I learn best...
Pre-Course Teacher Self-Efficacy Survey
Other than lack of time, please explain one area of your training where you are struggling.
Explain one area of your training where you are doing an excellent job.
Portfolio Assignment 1 Self-Reflections
What was difficult about writing your Learning Objective list? What was surprising?
How did it feel to be a student? Did anything feel uncomfortable? Do you also sometimes put your trainees in situations that could make them feel uncomfortable?
Describe how what you learned this week might impact your future trainings. What do you expect to change?

If you have trained people since Session 1, have you changed anything about your training? Please tell us what you changed and what happened as a result of these changes. Consider your perspective and that of the end users.
Post-Session 1 Survey
Describe what you already knew about Bloom's Taxonomy before Session 1, if anything. How would you explain Bloom's Taxonomy now?
We asked you to work in a group during class to discuss a list of Learning Objectives. In what ways was working on this in-course assignment as a group helpful or challenging for you?
What have you liked best so far? You can consider anything you like from pre-course activities until the time you are taking this survey.
So far, what do you think we could improve? You can consider anything you like from pre-course activities until the time you are taking this survey.
Portfolio Assignment 2 Self-Reflections
In this module you reflected about if and how you assess each of the Learning Objectives you wrote. How did this feel? Was anything surprising or uncomfortable?
Share your ONE favorite inclusive Teaching and Learning Activity that you have not used so far and that you want to implement in your microscopy training. When are you planning on trying?
If you have trained people since Session 2, have you changed anything about your training? Please tell us what you changed and what happened as a result of these changes. Consider your perspective and that of the end users.
Post-Session 2 Survey
You were offered a choice board for your out of class assignment. In what ways was it helpful or challenging for you to be able to select your own learning materials?
You discussed with your peers the teaching tools you learned about from the choice board. How did it feel to use the Canvas discussion board for this activity?
What have you liked best during this part of the course? You can consider anything from the end of our Session 1 meeting (Oct 16) until the time you are taking this survey.
What do you think we could improve about this part of the course? You can consider anything from the end of our Session 1 meeting (Oct 16) until the time you are taking this survey.
Portfolio Assignment 3 Self-Reflections
Has your opinion about what you teach and what you give as advice evolved during the course? If yes in which way and will this change have any consequences on your training?
How did it feel to try and align the elements of your training? Was anything uncomfortable or surprising?
If you have trained people since Session 3, have you changed anything about your training? Please tell us what you changed and what happened as a result of these changes. Consider your perspective and that of the end users.
Post-Session 3 Survey
You used Padlet to organize your Learning Objectives, assessments, and TLAs. Describe what was helpful and/or frustrating about using this tool. Will you continue using this planning tool after the course is over?
Considering all the pedagogy resources we provided so far, (those on the Choice Board, those on the practice Padlet, those in the Resources Module, anything that has been mentioned in class) which one(s) have you found the most helpful for improving your training and why?
What have you liked best during this part of the course? You can consider any aspects of the course that have happened since the last survey you completed.
What do you think we could improve about this part of the course? You can consider any aspects of the course that have happened since the last survey you completed.
Post-course teacher self-efficacy

Other than lack of time, please explain one area of your training where you are struggling. Your perspective on this may or may not have changed based on what you learned in the course.
Explain one area of your training where you are doing an excellent job. This may or may not include something you've added since the course began.
Post-Session 4 Survey
We modeled active and inclusive teaching techniques throughout the course. Describe something you noticed us do. In what ways did your observations inspire you to incorporate one of these strategies in your own training, if at all?
In what ways was peer feedback used during the development of your training plan?
In what ways were in-course discussions helpful or challenging for the development of your training plan?
Thinking about the entire course, what worked well for you?
Thinking about the entire course, what would you do differently?