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Utilizing Equitable and Inclusive Design Principles to Promote STEM Identity of Community College Transfer Students

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Abstract

Research suggests that developing an identity as a person in STEM is necessary for learners from marginalized groups to persist in STEM education and careers. These learners may perceive that their race, gender, or other characteristics make it difficult for their peers and supervisors to recognize them as scientists or engineers, thus disrupting their ability to maintain successful degree progress and to pursue their STEM career aspirations. Here we discuss the specific ways we designed inquiry workshops to not only clarify difficult core STEM content, but to also promote learners' competence, performance, and targeted recognition as scientists. Our workshops were designed for students interested in chemistry, climate science, physics, and toxicology at the University of California, Santa Cruz (UCSC), Workshops for Engineering & Science Transfers (WEST) 2019 program. In designing our workshops, we focused on promoting the scientific identities of our learners by incorporating authentic ways for students to receive recognition from both peers and instructional facilitators, as well as allowing students to tap into their own personal interests and values. Insights from our designed assessments for learners' understanding of our content demonstrate the success of our initiatives and provide further areas of improvement. Our goals are to create inclusive workshops to support students from all backgrounds, with emphasis on underrepresented backgrounds (community college, first generation, students of color, women, and LGBTQ+ students, etc.) as well as support them in other contexts, such as when mentoring STEM students in academic laboratory settings.

Keywords: backward design, equity & inclusion, growth mindset, recognition, STEM identity

1. Introduction

1.1 Overview of 2019 Professional Development Program & Workshops for Engineering & Science Transfers

The Professional Development Program (PDP) was a program run by the Institute for Scientist & Engineer Educators (ISEE) at University of California, Santa Cruz (UCSC), from 2001 to 2020. In the PDP, graduate students and postdoctoral fellows gained training on effective teaching methods utilizing Backwards Design principles (Wiggins & McTighe, 1998), with an emphasis on equity and inclusion in activity design (Seagroves et al., 2022). PDP participants worked in teams to develop **inquiry activities** — hands-on STEM activities designed to teach learners core concepts about specific themes — which were then taught in one of several venues. One venue, and the subject of discussion in this paper, was the Workshops for Engineering & Science Transfers (WEST). WEST was a 2.5-day program for learners transferring from community colleges to UCSC and took place prior to the start of classes each fall since 2007. The overarching goal of WEST was to promote the success of incoming STEM transfer students at UCSC. WEST challenged participants to think critically about science and engineering topics, foster a community of transfer students, provide experience with research techniques, and introduce students to research opportunities and resources.

In 2019, the authors participated in the PDP, where we developed and facilitated inquiry activities for a total of 96 students in four different WEST "strands," or fields: Chemistry, Climate Science, Physics, and Toxicology. Each strand had different content goals the students were expected to learn.

1. Chemistry: Learners will apply (Bronsted-Lowry) acid-base principles to understand molecular interactions that are occurring.
2. Climate Science: Learners will use the concept of climate variability to analyze and evaluate global and regional climate differences in the present and in future climate.
3. Physics: Learners will use experimental and mathematical evidence to describe the relationships between the variables that affect the oscillation of a harmonic oscillator.
4. Toxicology: Learners will understand dose-response, and how this relationship may vary based on the chemical, organism, and other factors, and may not always be linear.

Despite differences in content goals, these strands were all designed specifically for the WEST program with **equity and inclusion (E&I) principles** at the forefront, to help each learner develop an identity as a person in STEM. This paper will describe examples of E&I principles incorporated into the four WEST activities, examine the effectiveness of these design choices at helping students develop identities as scientists, and discuss ways in which these principles can be incorporated into other teaching and mentoring settings. We have separated the paper into detailed descriptions of each strand and the E&I principles that were incorporated into the inquiry activity for that strand.

1.2 Developing a STEM Identity is important for learners' persistence in STEM

E&I principles are critical when designing lessons, as learners from underrepresented backgrounds and those lacking support in STEM courses throughout their scholastic careers are less likely to have developed a strong **STEM Identity**. STEM Identity is the thought of oneself as a practitioner or a learner of a STEM field who knows, uses, and can contribute to their respective field (Singer, 2020). The absence of STEM Identity can be/is reinforced by lack of **recognition by meaningful others** such as family, friends, educators, or others in learners' communities supporting their identities; **lack of role models**, such as people they can identify with in STEM positions; and **lack of meaningful events** that bolster their confidence in STEM classes or extracurricular activities. This low self-esteem can lead to low retention in their respective fields. To bypass negativity and help foster learners' identities within classes, educators should strive to make learning topics and spaces equitable and inclusive.

Likewise, transfer and community college students tend to have a harder time adjusting to new STEM communities due to multiple factors, including many being first-generation and/or from underrepresented backgrounds and having less time to adjust to new settings and communities before upper-division classes with more strenuous requirements begin. These factors may cause learners to experience **stereotype threat**. Commonly felt amongst students from underrepresented backgrounds in STEM, like women, people of color, and the LGBTQ+ community, students may experience added anxiety due to the impression that "their performance may confirm negative stereotypes about a group they are a part of" (Price & Veerman, 2021). Coupled with the quick pace of four-year university courses and little time to acclimate and integrate themselves into already established social and study groups within their majors, negative stereotypes are more likely to be reinforced, leading to **disrupted (STEM) identities**, threatening the learners' retention in the major.

As STEM Identity is crucial for a student's development as a scientist, it is critical that STEM courses be designed to fit an **active learning** style. Such design means students are actively involved in course material through problem solving and discussion, engaging in **STEM practices** regardless of their prior familiarity with a topic, and thus taking ownership of their learning. STEM practices are the efforts conducted by scientists and engineers daily — the tasks they perform such as generating hypotheses, designing investigations, and interpreting their results.

1.3 Relevant E&I concepts defined

Here, we summarize some E&I concepts used in the design of our inquiry activities, which are referred to in the section of each individual activity.

The main focus was helping learners develop or enhance their STEM Identities. Our role as the **facilitators**, or the activity leaders, was not to spoon-feed answers or explanations to learners during the planning and investigation portions of the activities, but rather to facilitate learning by helping guide their thought processes. Facilitators supervise to make sure there is engagement, help overcome learning roadblocks, ensure safety, and intervene if learners stray too far from the content goal. However, the learners are told from the beginning that they are responsible for the experimental design and execution of the activity instead of following a step-by-step "cookbook" lab. These activities are **backwards designed** in that the desired **content goal** — or the final learning outcome — informs the design of the activity as opposed to making the content of a lesson fit a specific activity. This allows creativity in learning and flexibility for learners to investigate topics from various angles, allowing easier exploration of easily misunderstood topics at learners' own level of comfort. This helps strengthen not only their skill set and the collective knowledge of the entire class, but also their confidence in their own abilities to tackle problems.

Furthermore, our lessons incorporate opportunities for students to take ownership of their learning through activities that mirror authentic scientific approaches, increasing the students' confidence in their proficiency with STEM practices. Specifically, these activities engage learners in experimental design, which is atypical of lab courses. In performing these actions, as opposed to blindly following a set of written directions, learners are able to see themselves as scientists because they are able to define the questions they want to answer and see themselves overcome challenges like those that professional scientists face daily. Putting the critical design and rationale aspects of a lesson in the hands of learners helps better cement their understanding of the concepts, while bolstering their self-esteem as scientists.

Also, we provided **multiple ways for learners to productively participate** at their own comfort levels and benefit. Additionally, we aimed to give real-world scientific examples that would speak to the learners' individual interests and align with their values, as this has been shown to promote STEM Identity and persistence in STEM (Habig & Gupta, 2021).

We also incorporated a variety of **facilitation** techniques during our activities. Facilitation refers to the actions that activity leaders take to guide learners and provide feedback in real-time, depending on the specific needs in each interaction. In designing our workshops, we anticipated opportunities throughout our lesson plans that may require extra facilitation to guide our learners' interactions and progression to achieving the content goal. One specific facilitation move we utilized was discussing ground rules prior to beginning the activity. We acknowledged that people learn in different ways, and some may be more dominant than others with regards to participating in a group setting, but that we should be aware of this and try to consider everyone as an equal team player. We also described stereotype threat and tried to combat this by acknowledging that some students may have more prior knowledge than others, but that learners' effort level was more important than their prior experience with the content. Another way to counteract stereotype threat is through an activity structure known as a "**jigsaw**." For this technique, learners are first divided into small groups to design and carry out their experiments. At several points, learners come together in different mix-matched groups such that one individual from each original group joins each new group. This allows for sharing of ideas, successes, pitfalls, etc., between groups while also providing an opportunity for each learner to function as the "expert" from their original group, ensuring that the learner has multiple opportunities to feel like an integral part of the activity.

Another technique was facilitators utilizing targeted and authentic feedback. **Targeted feedback** refers to entering each learner-interaction with a specific goal and providing feedback that is intended to spur critical thinking without giving answers. **Authentic feedback** means providing feedback that is specific to the learner, rather than generalized feedback (such as, "I'm impressed with your creative solution to the problem your group was facing" versus the generalized "you're doing a great job!"). Sprinkled into this mix is **recognition**. While remaining authentic, we wanted to ensure every student's voice was heard and their efforts were acknowledged. The purpose of feedback was for learners to understand what they did well and how they can continue improving - building up the students with specific and attainable goals to keep them motivated.

Finally, central to the success of these backwards-designed lessons is having the learners understand that learning is not fixed, but rather that learning relies on a **growth mindset** (Dweck 2007; 2015). A growth mindset is the recognition that knowledge and skills will develop over time, so a learner will not come in with a fixed understanding of STEM concepts, but they are allowed the time and space to grow, justifying their frustrations or struggles within an activity. This is an overlying, fundamental concept that makes the inquiry activity so successful — the student is allowed to acknowledge what they do not yet understand, then design and conduct their experiments to explore the topic. They are allowed the space to explore and grow as opposed to needing to meet certain criteria right off the bat or at the same time as everyone else (which can be frustrating because people learn in various ways and at different paces)! Our role as facilitators was to ensure that while learners were exploring their ideas, they kept on a focused path to the desired content goal so that they eventually reached new understanding and avoided solidifying typical misconceptions.

2. Workshop E&I elements and implementation

The following section is broken up into an overview of each WEST 2019 workshop, the designed E&I practices, and a reflection on their implementation to help students build their STEM Identities.

2.1 ChemistryWEST

The chemistry-strand activity was comically named, "OH^-, what the H^+!?!" in allusion to the fundamental components of acid-base chemistry, the hydroxide ion (OH^-) and the hydronium ion (H^+). Two, then four facilitators, taught cohorts of fifteen to seventeen 2nd and 3rd year community college students, over the course of a two days each, as a bridge to help their transition into the Chemistry department at UCSC preceding their first fall quarter.

The activity was designed for learners to explore compounds that either experienced a color change or did not because of an interaction (or lack of interaction) with an acid and/or base. The learners would either work with sets of immiscible solvents or alginate as the medium to show the color change. Analyzing the electronic structures of the compound and incorporating their knowledge of chemical interactions would help them determine if there was an acid or base reaction occurring.

The ideal scenario was that a student would identify one solvent as a variable and then use that solvent with every compound solution to observe if there was a chemical change or not. Then, after grouping the compounds based on the change (or lack thereof) and reevaluating their hypothesis, they would perform follow up experimentation with other solvents to confirm if they were indeed seeing an acid/base exchange. To start fostering STEM Identity, step-by-step directions were not provided, and learners were told to raise their own hypotheses as to why phenomena were occurring after an initial demonstration by the facilitators, which they then designed experiments to answer (Figure 1). Learners had total control over a series of benign compounds to test with various reagents including acids, bases, and inert solvents.

The goal was to get the learners comfortable with the concepts of acid-base chemistry, as it is fundamental in higher level chemistry courses and crucial in real world applications, including drug development, protein-protein interactions, catalysis, etc. Students in grade school and then in collegiate general chemistry are introduced to acid-base chemistry, but even though it is repeatedly covered in subsequent classes, students will still typically fall into misconceptions regarding identifying acid-base reactions, understanding acid-base reaction terminology, connecting acid-base reactions to electrophiles/nucleophiles, and reasoning through reaction mechanisms (Copper et al., 2016; Stoyanovich et al., 2015). In addition, students fail to make connections between the concepts learned in general chemistry to their larger applications in organic chemistry, biochemistry, and beyond. Thus, our content goal was: "Learners will apply (Bronsted-Lowry) acid-base principles to understand the molecular interactions that are occurring." Successful mastery of this goal would include being able to: differentiate between acids and bases; relate protonation/deprotonation states to the chemical species/pH of the environment; and explain the concepts of Electron Density/Electronegativity.

2.1.1 E&I design elements and rationale

Heavy thought was put into incorporating STEM practices; engaging in these reasoning processes used to understand the natural world and solve problems allows learners to engage in some of the actual intellectual and physical activities professional researchers engage in daily. While many STEM practices were touched on, including generating research questions, defining problems, and designing investigations, the practice we really wanted to emphasize was the "Ability to Explain Results and/or Solutions Based on Evidence." This was achieved by designing tasks that would cause the learners to determine a hypothesis based on experimental evidence, create experimental design based on evidence, and draw appropriate conclusions from experiment evidence. This was our chosen STEM practice because students frequently struggle with translating experimental results into conclusions that help deepen their understanding of a subject. For example, many times a student will perform a lab and complete the accompanying lab report perfectly but will fail to apply the learned skills in new settings and/or be unable to explain why the observed phenomenon occurred. We believe that emphasizing student reflection on 'why is an experiment being performed' and 'why am I observing a specific phenomenon,' is more conducive to student learning. This was achieved via allowing learners to form their own hypotheses; questioning the learners in their small groups during their investigations and having them build on or tailor their routes based on their thinking pattern; group jigsaws for brainstorming; and poster presentations to summarize findings. By having learners discuss experimental details not only with their own lab mates, but also with various others in small groups (jigsaws), learners worked towards developing their skills and confidence in scientific communication. This was also reinforced with a chalk talk as a culminating assessment task where the learners had to summarize their findings to a larger audience, something that is rarely taught formally in undergraduate courses.

Figure 1: ChemistryWEST. Facilitators demonstrate an "unknown phenomenon" to the learners during the Raising Questions portion of ChemistryWEST**.** The learners then propose their own hypothesis to investigate during the activity.

Physical representations were also incorporated to help promote STEM Identity. For example, each learner was provided their own lab notebook, and personal protective equipment (PPE) appropriate for wet-lab work. At the beginning of the activity, it was stated that this PPE - lab coats, safety glasses, and gloves – will be worn by all for protection against hazardous materials. While this was also done to protect the learners from potential harm in the lab, the specifically incorporated discussion of why chemists use PPE and the connection to students' own experience in this activity was meant to foster the feeling of "I can be a scientist because I can don the tools to do so." For example, part of our instructional prompt was:

> "It's your responsibility to keep not only yourself safe, but others around you. As a chemist, you'll be working with materials that most people find 'intimidating' and part of being a great chemist is knowing how to properly handle materials and keep those around you safe."

Additionally, our role as facilitators was crucial not only for learners to properly understand material and achieve the desired STEM content goal, but also to encourage safe and inclusive learning environments. For example, we made sure to clearly state that the activities were designed to mirror authentic research. With this, we constantly explained that there could be times of uncomfortableness or frustration with the lab, but that it is part of the process. We ensured the students knew that it was ok to feel overwhelmed and challenged; it was ok to work at their own pace; and that it was ok for everyone not to be at the same skill level. To show our authenticity at the end of the activity, we (facilitators) shared personal anecdotes where we had felt very discouraged with our own work and how we were able to overcome those obstacles.

Overall, entrusting the students to design their activities, handle the chemicals, and be safe towards themselves and their peers heightened students' sense of STEM Identity. The overall goal was for the learners to leave the activity feeling like independent and competent scientists who had ownership of their own work.

2.1.2 Perceived effectiveness and room for improvement

A section of the activity was designed for learners to reflect on their work, summarize their results, and gain experience presenting to their peers. Our first cohort of learners were required to present their findings via a chalk talk, which unfortunately was a source of stress, as this was the first time most of the learners had given this kind of presentation. They were mostly unsure how to structure the presentation and were very nervous speaking, and while we had time allotted to discuss oral presentations, it was not sufficient given the venue's limited time. With our second cohort, we did poster presentations instead, with small jigsaw groups of students as opposed to learners presenting to their entire cohort. The ability to have these smaller groups was aided by the fact that we had two additional facilitators, (which also allowed us to pour more of our time into individual groups). Since each learner in a group was separated from their lab mates, each learner was required to talk, which helped shyer learners speak up. The smaller groups also allowed much more time for conversation, which led to very deep discussion about what was going on between the compounds electronically, even if the jargon was not there. This time for reflection allowed learners to learn from their mistakes, as by the end of the discussion, they discussed how they would have rethought and set up experiments differently, which was a good sign of continued learning.

2.2 ClimateScienceWEST

The "ClimateWEST" activity was facilitated for twenty-four learners who were pursuing majors in diverse STEM disciplines, and it was led by four facilitators. Although no prior formal background or experience in climate and climate variability was expected, some learners had prior research experiences. As in other WEST inquiry activities, the ClimateWEST inquiry activity had two main learning outcomes. The content outcome of the ClimateWEST inquiry activity was that "Learners will use the concept of climate variability to analyze and evaluate global and regional climate differences at different timescales in the present and in future climate". Teaching the concepts of climate variability and climate change is important because there are frequently some misconceptions. Learners frequently confuse weather with climate (Gowda et al., 1997). While related, climate is not the same thing as weather. Weather is the minute-by-minute variable condition of the atmosphere on a local scale. Climate is a conceptual description of an area's average weather conditions and the extent to which those conditions vary over seasons and longer time spans. Related to climate, people tend to use the terms climate change and global warming interchangeably, but global warming is just one aspect of climate change. "Global warming" refers to the rise in global temperatures due mainly to the increasing concentrations of greenhouse gases in the atmosphere. "Climate change" refers to the increasing changes in the measures of climate over a long period of time – including precipitation, temperature, and wind patterns. Because of these confusions, it is important to clarify: (1) weather events occur over minutes to hours to weeks, while climate happens over months, seasons, years and into millennia. (2) The climate has changed throughout the history of Earth, over different time periods and due to different causes. (3) Climate change is different from global warming. ClimateWEST was focused on disentangling these misconceptions, by focusing on the following core dimensions of climate variability: (1) Climate varies on both shorter timescales (e.g., seasonal or annual cycle) and on longer timescales (e.g., climate change); (2) Both climate and climate trends vary spatially/geographically and are different from global climate; and (3) Climate is complex and includes not only temperature but also other key variables such as precipitation, ice, wind, ocean circulation, etc.

The main practice outcome from ClimateWEST was that "Learners will construct an argument based on the interpretation of the data". The core STEM practice we focused on with learners had these three dimensions: (1) Stating an argument/claim that addresses the content prompt; (2) Relevant data are used to support the argument; and (3) Reasoning that links evidence to the argument. Constructing arguments or claims from data is a key and an everyday practice in science and engineering. We chose to focus on this STEM practice because learners usually struggle to understand what evidence is, what counts as appropriate evidence, and how to use this evidence to support their claims, which is connected to the learners' understanding of the content. When not using evidence, learners usually make conclusions from their own personal beliefs and other knowledge (McNeill et al., 2006). In addition, reasoning is the most challenging part of this practice. Learners often link their arguments to the evidence, but they fail in articulating why the two are linked, or stating the scientific principle that allowed them to make that connection. (McNeill et al., 2006; Ryu & Sandoval, 2012).

To summarize the ClimateWEST activity, we began with an introduction about climate and scales of climate variability. Then we presented the learners with some facts and climate information about different major cities in the world, that were used by learners to define their climate investigations. An example of a possible question for investigation is "In the city of San Francisco, how would the mean summer conditions change in the future with respect the present summer conditions?". Learners were then put into regional climate groups, and within each group, each learner was designated as a climate variable expert. The variables available were sea surface temperature, precipitation, and sea level rise. They gained their regional and variable expertise through jigsaw discussions. Finally, learners presented a poster based on what they found out about the climate variability of their regions to the rest of the class. Details about the ClimateWEST activity, outcomes, and assessment, are described in Pozo Buil et al. (this volume).

2.2.1 E&I design elements and rationale

The ClimateWEST activity was designed focusing on the Equity and Inclusion (E&I) approach of **developing a STEM Identity** (Carlone & Johnson, 2007; Hazari et al., 2010) through the lens of recognition and the **growth mindset** (Dweck 2007; Blackwell et al., 2015). This design emphasizes that, as noted in Section 1.2 above, recognition is an important factor for building a science identity, especially if this recognition comes from meaningful people (parents and teachers that are close to learners). ClimateWEST's components that were most influenced by these ideas were the learners' investigations, the jigsaw discussions, and the culminating assessment task (Pozo Buil et al., this volume). In addition, ClimateWEST also considered **learners' goals, interests, and values** during the first steps of the activity. The ClimateWEST activity was also designed taking into account marginalized learners in that no background knowledge was necessary to succeed in the activity and no statistical software was necessary, since a visual software was provided.

ClimateWEST incorporated multiple opportunities for learners to build competence and also to perform as their mastery increased. As first steps, learners chose a region of interest to study, and in groups they formulated a question about climate and decided on the time scale that they would work on. In this way, every team became experts of their region, and within each team, each learner became the expert on their variable of interest because they chose the variable they would focus on. This gave them two kinds of ownership, individually as a climate variable expert and as a group as region experts. At the beginning of the investigations, each learner studied the variability of their own variable, and then they shared their knowledge within their group. This helped them to individually build competence and prepare them for a jigsaw discussion with other experts in the same variable who were studying different regions. In the jigsaw discussion, learners were grouped by variables (i.e., all learners investigating the variability of temperature in different regions come together for discussion), where they were recognized by variable experts from different groups. After the jigsaw, learners came together as an expert group on a region where they shared what they learned and together prepared for the final poster presentation where they presented and explained the climate of their region using all the variables. In this way, they gained recognition in the same process that real scientists go through: working individually on a small section (i.e., variable), and gaining collaborative skills by coming together to work on a bigger project (i.e., explain the variability of the climate of the region). With the jigsaw and the poster presentation, they got feedback from meaningful people (i.e., other peers and facilitators). Spending time and giving feedback to each learner can promote their identity in STEM by showing them a meaningful person (facilitator, teacher) is interested in their work. In addition, with the poster presentation, they had the opportunity to practice their “soft”' scientific skills like oral communication.

2.2.2 Perceived effectiveness and room for improvement

In the ClimateWEST activity, we incorporated E&I elements during the design and the facilitation of

Figure 2: ClimateWEST. Snapshot of Climate WEST workshop during investigation time. Both pictures illustrate learner groups working together to investigate their proposed regional climate and time scale questions.

the activity. We planned facilitation moves to enable equitable and inclusive collaboration by encouraging engagement and recognizing all the learners’ contributions. Facilitators checked with all the learners and asked questions during the investigation process to all the learners in the region groups, to be sure all were on the same page, and then to all the groups during the poster presentations to manage any dominant learners. In contrast to many undergraduate courses, where in many cases instructors only care about the final result, and that the presentation/work is done, ClimateWEST focused on and fostered individual and group work, and learners’ interactions to produce the final product. In addition, ClimateWEST facilitators made sure to learn at least all the names of the learners that they facilitated, which also helped the learners get to know each other while promoting the collaboration and the interactions between them. Knowing learners' names and using their names during and outside of class is a way of recognizing that a student is important (Glenz, 2014).

The ClimateWEST activity was designed to take into account those learners with no background knowledge in the content and in the statistical manipulation of the data. For the latter, ClimateWEST facilitators provided a graphical user interface (GUI) developed specifically for the activity (see Materials section in Pozo Buil et., this volume). The GUI helped students that were not proficient with Excel or other software to analyze and plot the data easily. By the end of the activity, ClimateWEST learners commented about how they appreciated the use of the software and the opportunity to manipulate the data, since when they read papers in other classes and contexts they were not able to "play" with the data and to create the figures they wanted.

2.3 PhysicsWEST

Twenty-five learners majoring in a variety of science and engineering disciplines participated in the 2019 PhysicsWEST learning activity led by three graduate student facilitators. The focus of the learning activity was simple harmonic oscillation (SHO). SHO is a general scientific model used for many STEM applications, including the vibrational behavior of molecules, the movement of electrons through a circuit, and the gravitational interactions between two astronomical binary stars. The goal of this learning activity was for learners to use experimental and mathematical evidence to describe the relationships between the variables (mass of pendulum, length of pendulum, stiffness of spring, etc.) that affect the oscillation of a simple harmonic oscillator. Learners often find it challenging to understand the mathematical parallels and analogies between the different systems, as well as to find the solution to the equation of motion since it involves differential equations.

Figure 3: PhysicsWEST. Small groups of learners investigating various types of simple harmonic oscillation with the guidance of one of the workshop facilitators.

After introducing ourselves and the concept of SHO to learners, we briefly demonstrated half a dozen different experimental apparatuses involving SHO. Most apparatuses were pendulum-like or spring-like. We gave learners a few minutes to engage with the experiment while they wrote down any questions that they were curious about, such as: "Is the period affected by the angle at which the pendulum is released?" or "How does spring length affect oscillation?". Learners formed groups of two or three based on which question they wanted to investigate during the first part of the activity. The small groups then investigated their chosen scientific question, while facilitators engaged with each group by asking guiding questions. Example learner investigations are shown in Figure 3. Afterwards, learners spent a few minutes writing down a summary of their findings individually before discussing their results with peers who worked on the same experiment. During the second part of the activity, learners switched groups and formed a new question to investigate. To focus on the practice learning goal of **using models to design investigations**, they then designed a new experiment for a second type of SHO apparatus based on the results from their first experiment. Using results from both of their investigations, they then looked at a circuit with a resistor, inductor, and capacitor (RLC) to expand their

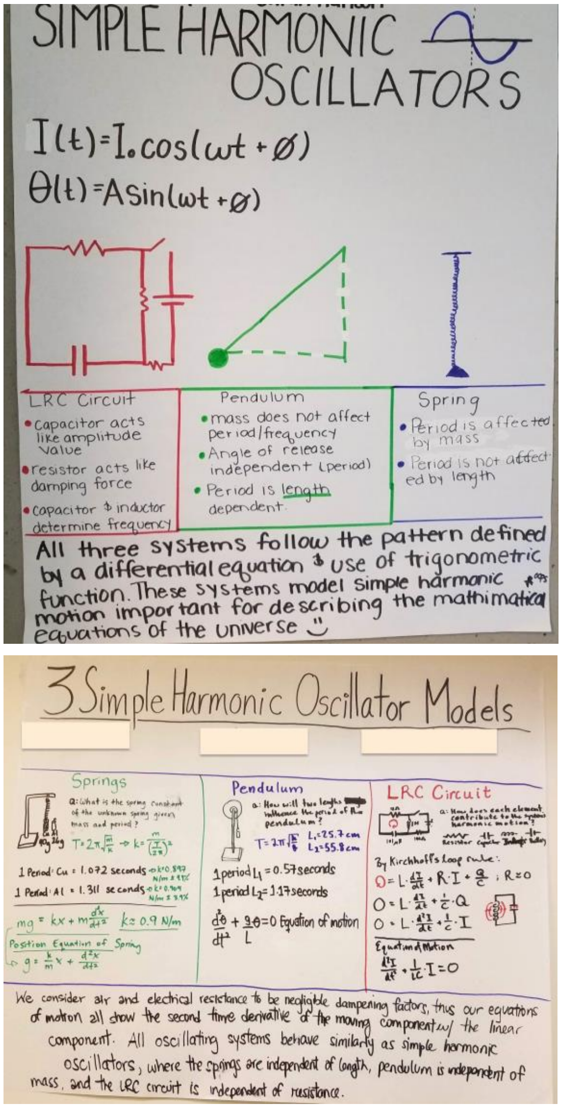

Figure 4: PhysicsWEST. Examples of learners' posters following the Investigation Time portion of the activity. Each poster demonstrates their new understanding of harmonic oscillator models.

SHO model further. Finally, learners who did different experiments formed jigsaw groups to make a poster and present a summary of their overall findings on simple harmonic oscillators to their classmates and facilitators. Group members spent half the time presenting their group's poster, and half the time visiting other groups' posters. Examples of student posters are shown in Figure 4.

In their posters, learners demonstrated their knowledge of SHO through diagrams of their experimentation, plots relating period to various parameters, energy considerations, and a written explanation that summarized their findings. Some groups struggled with the solution to find the equation of motion due to the differential equations involved, though these students saw the qualitative similarities between the systems. They were able to identify the variables that affected the period of a SHO, but were still working to understand how these variables were mathematically represented in the SHO model.

2.3.1 E&I design elements and rationale

Several elements supporting Equity and Inclusion were designed into the activity, including (1) connecting SHO to learners' everyday lives, (2) having learners reflect on the activity as scientists, and (3) encouraging growth mindset while facilitating.

Connecting physics to real world experiences is essential for involving underrepresented students, in order to show that dedicating time to studying physics is as relevant and worthwhile as time spent studying disciplines addressing the socioeconomic difficulties that those students often face. Studying physics purely due to curiosity and as a quest for knowledge is a luxury less justifiable to someone facing more pressing issues (Hazari et al. 2010). For this reason, we thought it was important to spend time during the activity having students identify the relevance of simple harmonic oscillation and other oscillatory motion in their everyday lives. Learners successfully identified several examples of SHO in their personal lives, such as moon phases and tidal patterns, or pushing someone on a swing. (Humorously, the love lives of celebrities came up as well).

Since many transfer students were from underrepresented groups, we thought it was important to have them think about their own identities as scientists and engineers. Hazari et al. found that there is a strong correlation between a student's "physics identity" and their persistence in studying physics. Hazari et al. found that recognition from friends, family, and teachers of being a "physicist" has a large influence on a learner's physics identity. We designed our activity with this in mind, explicitly discussing in a group how they defined a "scientist" and pointing out the scientific practices that they were participating in during the activity. This included coming up with their own question to investigate, planning their own procedure, collaborating with peers to investigate their question, using their results to create a model and expand their investigation, and analyzing the similarities and differences between results from different systems. Finally, students presented their results to their peers in a poster session so that students could gain recognition from their peers and facilitators. While presenting, each student had the opportunity to take ownership of their work.

In terms of facilitation, we emphasized that learners were participating in an inquiry activity, where we as facilitators prompted them but did not give them the answers so they could earn ownership of what they were learning. While facilitating, we promoted a growth mindset by prompting them to discover answers on their own, to questions they initially found challenging.

We also designed the activity so that students would be rotating into different groups a lot, so they would get to meet a lot of different STEM people who they would be working with in their classes at UCSC. We encouraged all students to participate in group discussions by reminding them at the beginning of each discussion of the E&I ground rules (described in Section 1.3).

2.3.2 Perceived effectiveness and room for improvement

Learners said the PhysicsWEST activity was a much more engaging experience than any lab course they had taken, since they got to design the investigation instead of following a lab manual.

Learners successfully found the harmonic motions parallels between spring, pendulum, and RLC circuit models. Future improvement is needed to better describe the mathematical models involved in SHO, specifically involving differential equations (though it was debatable if physics concepts or math should be the focus). Teaching the mathematical model could include more detailed discussion of the derivations for students unfamiliar with differential equations. In a future activity, we would also collect students' individual notes (this time students wrote individual notes, but we did not collect them) so that we could get a better sense of each individual's understanding of the concepts. Assessing individual understanding was limited to talking to students during facilitation and during the poster session.

In future activities, more options for harmonic oscillator experiments could be included. This could include harmonic motion apparatuses that are not as easily identified as a spring or pendulum system, such as fluid dynamic systems, for students who already have a strong prior experience with spring and pendulum systems.

2.4 ToxicologyWEST

Twenty-three community college transfer students from diverse backgrounds participated in our "ToxWEST" workshop, which was led by three graduate student facilitators. Our main content goal for the ToxicologyWEST workshop was to address the misconception that the more you increase the dose of a chemical the more biological response you will have, typically a negative response. This phenomenon is known as the "dose makes the poison" and has been well ingrained in society as many chemicals we are exposed to on a daily basis do produce a variant of this linear response, such as the amount of coffee someone drinks making a person more alert or more years of cigarette smoking increasing the likelihood of developing cancer. Although these observable linear dose-responses happen, there is a greater complexity in the factors that are important for predicting a dose-response, as not all chemicals and contexts will produce a linear response. We wanted learners to recognize and understand non-linear dose-responses including (1) a U-shaped or nutritional curve, in which low or high levels of a chemical lead to negative health outcomes but intermediate levels are beneficial, and (2) a hormesis curve, in which low levels of a chemical produce beneficial effects but higher levels cause negative health outcomes. We also wanted our learners to come away with an understanding that there are factors outside of the level of exposure that are important for predicting a dose-response. These factors include an organism's biological relationship (nutrient or toxin) to a particular chemical, life-stage, exposure time to a toxin/toxicant, route of exposure, sex, size, metabolism, and many other factors. Dose-response is a core concept in a broad range of environmental toxicology and health related fields, so it is important for learners to have an increased understanding of the complexity of dose-response, so that they may apply and build upon this foundational knowledge in their courses, experiments, field observations, and even in their own health and nutrition. Details about the Toxicology-WEST activity, outcomes, and assessment are described in Santiago et al., 2022 (this volume).

To summarize our activity, we began by showing learners a pre-recorded video in which we (the facilitators) discovered three toxins present in the local river. Then we presented the learners with some plants grown in such a way that they represented different dose-response curves (linear, hormesis, and nutrition) in response to the three different chemicals. Students generated questions based on the observed phenomena and were then put into groups based on which chemical and organism of interest they wanted to investigate. The groups then designed and carried out an experiment testing how their chemical affected their chosen model organism (either *Daphnia magna* or *C. elegans*) at different doses. Finally, learners presented a poster on their findings to "community members" and peers.

2.4.1 E&I design elements and rationale

For our activity we focused on the E&I theme of developing an identity as a person in STEM, with a particular focus on developing learners' competence and performance by providing targeted recognition. Throughout the activity, we built in facilitation checkpoints that would allow us to provide targeted feedback and recognition. These checkpoints included jigsaw collaborations, check-ins with facilitators, a community presentation led by the learners, and a synthesis presentation led by us facilitators. These facilitation checkpoints gave us the opportunity to provide our learners with targeted feedback and recognition related to the concept of growth mindset. For instance, when a learner successfully troubleshooted their experiment or made a creative decision in their experimental design, we were able to provide words of encouragement, recognize their use of an authentic STEM practice, and highlight their ownership of their contributions to the experimental design of their group. One example of targeted feedback and recognition of authentic STEM practices was when we observed that one learner group was struggling with how they should quantify the activity level of their model species, *C. elegans*, in a non-biased and reproducible manner. We engaged with and encouraged them to make their own thinking more transparent to themselves and their teammates. We asked them to consider what parts of quantification were more important to their experimental design and to have all their teammates weigh in on it. We were able to provide targeted feedback and recognition of the authentic scientific design elements they were considering and knew when it was time to step away and allow them to continue troubleshooting together. This allowed for them to create a creative system to make sure they quantified the *C. elegans* behavior without knowing the treatment groups and to make sure they had enough replicate counts of each group.

Another E&I related consideration for us was that in toxicology, as well as a variety of other scientific fields that use animal models, it is common for only male animals to be used in research. The usage of only male animals comes from a misconception that the circulating ovarian hormones can make experimental data from female animals more variable than data from males and thus not translatable to human clinical outcomes (Wald & Wu, 2010). From a meta-analysis of 293 articles, this misconception has been shown to be largely incorrect (Prendergast et al., 2014). Despite this incorrect ideology, one study found in the field of neuroscience that male animals were used almost six times as often as females (Beery & Zucker, 2011). Thus, many inherent cultural beliefs about gender have negatively impacted the existence and efficacy of clinical developments to treat disease in humans (Beery & Zucker, 2011; Shansky, 2019). Having these gendered science examples, or knowing that some fields of research focus mainly on male animals, may make women and non-binary identifying learners feel like the research is not applicable, relatable, or important to them. Thus, gendered science examples were important for us to consider when designing our workshop, especially because >80% of our participants were women-identifying.

2.4.2 Perceived effectiveness and room for improvement

We incorporated initiatives of developing an identity as a person in STEM into our activity using two approaches. The first approach was to design our content lesson plan based on an E&I framework, and the second was to include targeted facilitation methods in our design.

Every decision we made about the content of our lesson was examined from an E&I perspective, and thus each component of our content was included to promote the STEM Identities of our learners. First, we framed the entire activity as a role-playing exercise in which learners experience a real-life problem (toxicants in their river), and then design an experiment to test a hypothesis about these toxicants, carry out this experiment using legitimate scientific tools and methods, and finally present their findings and conclusions to other scientists and community members. By framing the activity as a real-world problem, the students could relate to the topic and feel interested and passionate about the creation and outcome of their experiment. From our experience facilitating the activity, we saw that this

Figure 5: ToxicologyWEST. Learners actively engaged in the Investigation Time section of the activity. Learners are using pipettes to make and deliver their chemical treatments in their *Daphnia* and *C. elegans* experiments.

environmental toxicology role-playing scenario opened up many different avenues for learners to achieve the same content and practice understanding. We knew we were going to create multiple ways for learners to participate that engaged their personal interests and fostered their STEM Identities, but we thought we were going to have more control in the pathways they would take, especially with regards to experimental design, to ensure that they would all reach these goals. Instead, they surprised us and were more in charge of and excited for their own learning, designing experiments that were different than any we had envisioned, which was exciting to see.

We wanted learners to take ownership of their learning, so we designed many aspects of the activity to promote this ownership. For example, we gave them the opportunity to choose an organism system that is personally interesting to them. We included *Daphnia magna* (a small crustacean) to represent aquatic toxicology, and *Caenorhabditis elegans* (*C. elegans*) to represent terrestrial toxicology, and allowed them to choose which organism they were more interested in working with. We also gave them control of scientific tools including pipettes, microscopes, etc., and let them determine an effective way to use these tools to answer their driving question. We tried not to steer them too much in what they would actually do for their experiment, but rather focused on getting them to give rationales for why they were making specific choices. The learners really tapped into their own creativity because they were able to design their experiments. In addition, jigsaw group discussions of experimental plans also gave learners the opportunity to take ownership of their experimental designs and interpretations. These discussions allowed us (facilitators) and other learners to recognize the scientific capabilities of all learners. Jigsaw group discussions also functioned as an authentic scientific collaboration experience and provided opportunities to reflect on growth mindset principles.

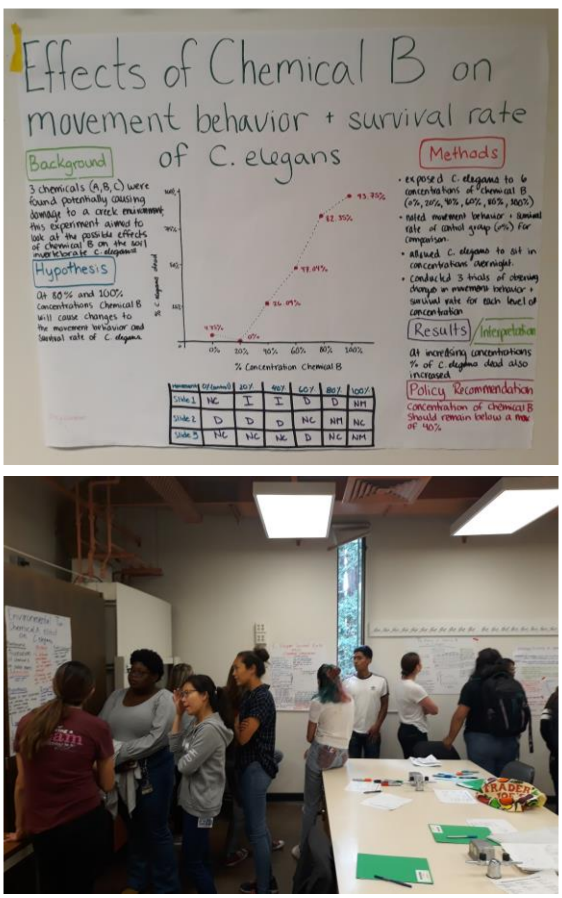

Figure 6: ToxicologyWEST. Example poster of learner experimental findings with C. elegans and Chemical B, and learners presenting at the Community Member Presentation with graduate student guests.

We also planned the poster presentations of their results such that learners would present not only to us and their fellow learners, but also to community members (volunteers who we recruited to come talk to learners about their experimental outcomes and implications for the health of the community). We wanted to model authentic science communication, in which researchers need to communicate their experimental results to a variety of audiences including those who will be impacted by the findings. This allowed learners to view themselves as the experts, and they seemed to have a great time talking with the community and demonstrating the work and thought they had put into their experiments. Additionally, the Community Presentation component of our activity promoted an authentic practice of communication of scientific findings to not only other scientists but also to a community of people that may be affected by the research implications. This allowed learners to see their experiments in a larger context of being able to help the community they are now a part of as new UCSC students. This is important for many students' STEM Identity, as some learners are community driven when it comes to their view of themselves as scientists.

The second approach we used to promote STEM Identity in our activity was to design targeted facilitation methods. We planned to start the facilitation process at the WEST Welcome Dinner, prior to the start of our toxicology activity, by introducing ourselves and telling our learners a bit about our research and personal lives to show our diverse interests and help them relate to us as peers rather than superiors. We also asked all the students to "Tell us one thing you are excited about and one thing you are nervous about now that you're transferring to UCSC." We ended up hearing many similar things learners were excited about and nervous about, which seemed to begin to promote a sense of community with our learners as they were actively engaged and related their comments to one another. At the start of the following day, we discussed the E&I ground rules for our activity, emphasizing that we wanted everyone to feel respected and heard throughout. We discussed the concept of growth mindset and how this concept could be applied in our activity and used in their classes and research after WEST. We also attempted to address stereotype threat by talking with students before the activity and stressing that they were a group from diverse science backgrounds and some learners may have more prior knowledge than others. We emphasized that our expectations were only that they put effort into designing an experiment, and that their background and experimental outcome were not relevant to their success.

Additionally, during facilitation we tried to provide the learners with authentic recognition based on growth-mindset principles by acknowledging them when they had a good idea or were working hard on a task. For many students they may often receive recognition for being correct but not necessarily for making a good effort, so we tried to do the opposite. We feel we could have personally provided more recognition to the learners, but we tried to be careful and only give meaningful, personalized recognition (versus generic recognition: "you're working so hard!" etc.). It was also a challenge to focus on providing recognition while also making sure learners were actually discussing experimental design and interpretation and reaching their content and practice goals. From our training in the ISEE PDP we learned to enter every facilitation interaction with a purpose. We tried to do this, but it was easier said than done, and sometimes the purpose got lost as we tried to make sure we attended to every group. In future facilitation scenarios, we will try even more so to step back and determine a clear goal for each interaction rather than trying to make sure we get lots of face-time with each group. Additionally, by assigning one facilitator to each group instead of all of us spreading our time between all the groups we could better improve our facilitation efficacy. This assigned facilitation would make sure the learners can get more personalized attention and not have information repeated to them, as well as allow facilitators to get a better sense of the strengths of each learner. Overall, we feel that through our personal facilitation interactions, discussions at the community poster session, and through reading the content understanding assessment sheets we conducted towards the end that our E&I designed practices provided an effective contribution to clarifying toxicological dose-response misconceptions and to strengthening STEM practices and identity.

3. Workshop E&I elements and implementation lessons

In each of the four workshop strands, transfer students worked towards developing their STEM Identities by participating in activities as scientists, connecting the content to their own lives, and by networking with others in the UCSC STEM community. Learners focused on one or more STEM practices, such as forming hypotheses and choosing their own question to study, using models to design investigations, explaining results and solutions based on evidence, and presenting findings to peers, facilitators, and other community members in the field with poster sessions. We designed all components of our activity (Raising Questions, Investigation Pathways, Culminating Assessment Task, Poster Sessions, Synthesis) with our content and practice goals in mind, during which we ensured opportunities for authentic recognition from instructors, peers, and even community members. Having the opportunity to make their own experimental design decisions and investigative discoveries gave learners substantial ownership of their experiments and presentations. Facilitation strategies emphasizing growth mindset and E&I ground rules, scaffolding the amount of guidance learners needed throughout the activity, and opening multiple ways for learner participation were also an essential part of learner ownership necessary to build a STEM Identity. In the following sections we will discuss the literature on how promoting STEM practices supports learner development of STEM Identity and then give examples of how our incorporation of these practices can be applied to other teaching and mentoring settings.

3.1.1 Promoting STEM Practices supports development of a STEM Identity

An unfortunate phenomenon has been reported that although students from multiple ethnic and racial groups have had an increased interest in pursuing STEM degrees compared to interest measured a decade ago, less than 40% of students that originally intended to graduate with a STEM degree end up completing their degree. This rate was determined to be even lower for students from underrepresented backgrounds (Higher Education Research Institute [HERI], 2010; National Science Board, 2016). Thus, in relation to how important developing a STEM Identity can be for learner persistence in STEM, especially in marginalized groups, it is important to determine how we can design workshops and courses to improve STEM degree completion. Studies have shown that one way to strengthen learners' development of STEM Identity, and as a result influence STEM persistence, is by concretely **designing opportunities for recognition of learners' performance of authentic scientific practices**. These scientific practices may lead to learners developing science self-efficacy, identity, and motivation to continue pursuing a career in a STEM related field (Hunter et al., 2007; Lopatto, 2007; AAAS, 2011; Chemers et al., 2011; Graham et al., 2013; Hernandez et al., 2013; Trujillo & Tanner, 2014; Syed et al., 2018; Starr et al., 2020). Furthermore, performing authentic science practices has been shown to increase retention of members of underrepresented racial and ethnic groups as well as White women (Dirks & Cunningham, 2006; Hazari et al., 2013). One reasoning behind how this works is that being recognized for performing science practices by either their peers or their instructors led students to have positive classroom climate experiences, which further influenced their confidence, interest, and sense of belonging. These experiences also correlated with student achievement and an increase in STEM motivation and identity (Starr et al., 2020).

What is important for contributing to STEM Identity is that the scientific practices be authentic to advancing science and can be genuinely **recognized by the science community**.

3.1.2 Teaching applications to promote community building and learner's goals, interests, and values

The E&I principles used to design and facilitate the different WEST strands can apply to other teaching settings as well. Here, we discuss some of those applications.

All the WEST activities offered **multiple ways to participate** such as using interactive tools, small group activities, informal discussions, and poster presentations. Incorporating different types of activities, teaching methods, and assessments can make learning settings more inclusive for those with different prior experiences (Suskie et al., 2018). For example, lessons may include different formats and types of learning activities, like paired and small group activities and discussions, instead of whole-class discussions. This can help reduce inadvertent bias and give all learners opportunities to cultivate and demonstrate learning. Moreover, small groups can feel like safer and more productive spaces for intellectual exploration. These small group activities/discussions can also occur before whole-class discussions and be beneficial for learners who prefer to develop a script and refine their ideas internally before sharing them out loud (Sanger et al., 2020).

One additional goal of WEST was to promote learners' success in their STEM studies. WEST offered multiple STEM strands that learners chose depending on their own interests and backgrounds. In other teaching settings, encouraging academic success can be achieved by **incorporating learners' goals, interests, and values** in the design of a course, a class, or even a lesson as showed by our workshop designs. When designing a course, some units may offer some flexibility in the content of discussions, activities, or projects; and those interests and values can be collected through a preliminary course survey. Proactively diversifying the syllabus and course content will help students feel that they belong, especially in classes with learners from different countries and cultural traditions (Sanger et al., 2020).

Another important aspect of WEST was the idea of keeping all the activities focused on **real world contexts and learners' real world lives**. Building connections between scientific learning and examples, experiences and issues, can increase not only learners' interests in a topic, but also help transfer their learning and skills such as collaboration, independence, and communication to other real-life situations (Wuolle, 2016). In teaching settings, multiple pedagogic strategies can be used to connect with the real world, such as teaching with real case studies and field experiences, using local data or problems, and connecting with global challenges. In the WEST activities, the real-world connection was made through multiple strategies, with the commonality being that all learners applied STEM practices for 2.5 days as scientists. All the activities were designed with a scientific aspect that was related to the diverse areas of real-world research of the facilitators. This inclusion of our research in the design of the activities is a personal connection that can motivate and inspire learners (Daniels & Arapostathis, 2005). Other real-world connections can include using multimedia activities. For example, bringing material to life through news feeds, podcasts, and streaming videos opens the teaching environments up to a wider world where learners can start to see the value of learning (Wuolle, 2016).

The workshop strands also were important in **bolstering a sense of belonging** in the UCSC Science and Engineering community, which was of particular importance in our activities given that our participants were all students transferring to UCSC from community colleges. For many learners, WEST served as the first introduction to the UCSC community. Each of the activities included rotating group interactions that helped transfer students meet other students who they might be taking classes with, as well as graduate students and postdoctoral researchers. This group interaction was essential for building students' sense of belonging — having classmates and friends in their major is a type of "approval" from meaningful others in the field. The interactions with graduate students and postdocs also informally introduced learners to other opportunities in the department. Many transfer students asked facilitators about academic organizations at UCSC (i.e., Society of Physics Students, Women in Science and Engineering), what graduate school is like, as well as how to get involved in research groups with professors during the activity breaks. There was even an example of a student joining the same research lab that their WEST activity facilitator was a member of.

To build a community of learning, WEST activities emphasized supporting peer-to-peer learning by using different versions of **jigsaw activities or discussions.** These jigsaw discussion groups provided learners the opportunity to serve as an expert in a part of the workshops to obtain recognition from one another throughout their discussions and plans for future next steps with their experimental findings. As discussed previously, this peer-to-peer recognition is important for promoting a STEM Identity and positive workshop community (Starr et al., 2020). In WEST's activities most of the jigsaw groups were formed through random selection or allowing learners to choose their own groups, based on which questions learners were interested in investigating. However, in other teaching settings, where facilitators have more time and information about learners' backgrounds and skills, it is recommended that facilitators intentionally create groups with multiple aspects of diversity in mind (Curseu & Plutt, 2013), and that they disclose how the group membership is selected in the interest of transparency (Sibold et al., 2017).

3.1.3 E&I mentoring and facilitation applications

The E&I principles used to design and facilitate the different WEST strands can be also applicable to other mentoring settings. Here, we discuss some of those applications.

Mentoring is one strategy for **cultivating STEM identity**, as mentors link students to career resources and research opportunities, provide emotional support, foster mentees' confidence and science self-efficacy, and facilitate their valuing of scientific research (e.g., Atkins et al., 2020; Estrada et al., 2018). In leading a relatively short activity, the main mentoring goal was to cultivate learners' STEM Identities through facilitation. During the PDP, we (as facilitators) were trained in design aspects and facilitation moves that, when implemented, helped foster learners' STEM Identity, including **recognition by meaningful others** to facilitate **meaningful events** in our activities to bolster learner confidence in STEM (discussed in 1.2). Additionally, since several of our activity facilitators identified with marginalized groups including first generation college students, people of color, and the LGBTQ+ community, they could help serve as **role models** to learners from similar backgrounds.

Our facilitation training in the PDP further emphasized promoting a **growth mindset** (Dweck, 2015). For a full set of practices, literature and resources about mindset, readers are referred to the website https://www.mindsetkit.org. Specifically, in WEST we focused on giving **positive and constructive feedback**. We suggest that in teaching and mentoring settings, positive feedback focuses on actions and processes rather than the person's abilities/characteristics. In addition, positive feedback should be **specific, rather than generic** - the specificity signals recognition and is harder to dismiss (Gross-Loh, 2016). An example could be that instead of giving direct feedback to learners' questions, which mandate a direct answer on how to address an issue identified by the learners, facilitators provide scaffolding, encouraging, and facilitative feedback to support learners in resolving issues for themselves (Yee et al., 2021). In addition, research suggests that this feedback should occur in iterative observation–feedback cycles, where the emphasis is on growth and learning shared by both mentors (and facilitators) and learners (Hattie & Timperley, 2007; Yee et al., 2021). In each of the WEST activities, we incorporated both formal and informal opportunities for feedback from peers and facilitators. Informal verbal feedback was given as facilitators circulated between groups during the activities. More formal feedback was given, for example, as learners were choosing a question to investigate or while presenting their final poster.

When building a mentoring relationship or program, and to foster a sense of belonging to a community, it is important to keep in mind learners' identities. Pendakur (2016) defines this as **identity-conscious mentoring**, which focuses on identity development and community building without any explicit ties to educational outcomes. These identity-conscious approaches should have a special focus on marginalized and minority learners since they are more likely to experience microaggressions and explicit discriminations (**social identity/stereotype threat**) than their more privileged peers (Murphy & Destin, 2016; Culver et al., 2021). To build equitable and inclusive spaces, a specific practice that can be incorporated in teaching and mentoring settings includes getting to know your learners and mentees as individuals and their participation style early on to be able to guide them to develop or enhance other skills. For example, dominant voices can be encouraged to develop listening skills. This was done in each of the WEST activities. Facilitators explicitly set an expectation that everyone needs to contribute to the classroom climate — by speaking up, but also by stepping back for others to participate when they have found themself talking frequently. Facilitators also intervened if one voice went on too long and amplified contributions from those minoritized undergraduate learners (students of color, women, and LGBTQ+ identifying individuals) whose contributions may get overlooked in STEM fields. At an institutional level, other practices may include creating inclusive spaces that go beyond a single class or course, like specific programs that can make learners feel safe, offer equitable participation, and foster respect for conflicting opinions and appreciation of differences (Culver et al., 2021). Minoritized undergraduate learners who received identity-conscious and culturally aware mentoring report higher research confidence, clearer academic and career goals, and higher commitment to attend graduate school (Haeger & Fresquez, 2016).

4. Conclusion

Even with the completion of our WEST 2019 program, the process of reflecting on our past teaching experiences and developing as educators and mentors is not over. This **self-reflection is an ongoing opportunity for further growth** that will not only benefit ourselves, but also improve our capabilities of supporting future learners. The education field is always advancing with new knowledge, making it critical that educators and mentors have continued training regarding equity and inclusion, STEM Identity, and the impact of STEM stereotypes on mentors and mentees (Kim et al., 2018). Mentees and learners are affected by the signals and words from interactions with mentors and educators, so it is key that we constantly check our implicit biases and how those implicit biases can impact our perception of our students. Furthermore, both our actions and inactions due to our biases can impact learners' subsequent perceptions of themselves. These perceptions create long-standing effects on learners’ STEM Identities and ultimately harm or help their persistence in STEM (Martin-Hansen, 2018). By reflecting on our actions, as well as by promoting and practicing equity, diversity, and inclusion in our teaching and mentoring, we can begin to make a substantive impact creating access, opportunity, and support for contributions of all people in STEM fields.

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