Eco-STEM Tools: Changing the Culture of Teaching and Learning in STEM

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***Abstract*—The authors present a Work-In-Progress paper in the Innovative Practice category on the ongoing development of tools for faculty in STEM higher education to construct supportive educational environments within their classrooms. The tools consist of a peer observation form and the associated process, a resource repository, and a student survey. They are components of the Eco-STEM project that aims to initiate institutional change through the embrace of a metaphorical "ecosystem" model of education.**

Together, the Eco-STEM Tools support an integrated system of pedagogical reflection and growth for the development of healthy STEM classroom-based ecosystems. While the project team is developing these tools within the context of a majority-minority institution, we believe they would be impactful at any institution that strives to support its marginalized students – as well as support the thriving of every actor within the ecosystem.

***Index Terms*—Professional development of faculty, peer observation, reflective teaching practice, teaching resources, student survey.**

I. Introduction

Hispanic Serving Institutions (HSI) play a key role in the important mission of diversifying the science, technology, engineering, and mathematics (STEM) workforce within the United States [1]. California State University, Los Angeles (Cal State LA), a very high-Hispanic-enrolling HSI, provides broad educational access to the local community in which a large proportion of students have been under-served and under-prepared by their K-12 experiences. At Cal State LA, 72% of undergraduates are Hispanic/Latinx and 83% are first-generation college students, meaning that neither of their parents has at least a 4-year college degree [2].

A recent report from the National Academies [1] recommends seven practices and strategies that are important for minority-serving institutions to ensure they are not just minority-enrolling. The report recommends institutional responsiveness to "meet students where they are" by supplying supportive campus environments as well as tailored academic and social support systems [1, p. 5]. To enhance student success, the College of Engineering, Computer Science, and Technology at Cal State LA has created many successful student support programs, such as a summer-bridge program, a first-year experience program, and supplementary instruction. Also, the Department of Mathematics redesigned all first-year mathematics courses to include built-in support for students that enter the university under-prepared. Additional support has been provided to STEM faculty through the Teaching and Learning Academy [3]. While there are documented successes of these student support and faculty development programs (e.g., [4]), it has also become clear that more profound change is needed to create a culture that "meet[s] students where they are" [1, p. 5].

The Eco-STEM project was initiated in 2020, with the support of a grant from the National Science Foundation (NSF) of the United States, to drive systemic changes in STEM education at Cal State LA. Informed by the theory of community cultural wealth [5] and employing an ecosystem-based model of education [6], the Eco-STEM project embraces an asset-based mindset and focuses on creating a healthy educational environment that helps all students to thrive in STEM [7]. The project objectives are to be accomplished through three complimentary prongs:

1) A community of practice for STEM faculty to support the creation of healthy classroom ecosystems in which all students thrive regardless of their backgrounds [8];
2) A community of practice for STEM department chairs and program coordinators to create a healthy ecosystem at the department/program level;
3) A comprehensive redesign of the teaching evaluation system to promote reflective faculty growth.

This paper presents the Eco-STEM team's progress to date on the third prong. During the first year of the project, we designed a set of tools to help instructors review and reflect on their own teaching practice. These tools, namely, the Eco-STEM Peer Observation Tool, the Eco-STEM Resource Repository, and the Eco-STEM Student Experience Survey, will be discussed in the following sections. We also report on initial feedback on the Peer Observation Tool and Process from the Eco-STEM Faculty Fellows. By sharing our work-in-progress with the broader community, we hope to engage STEM educators beyond our own institution to provide feedback on the tools as well as to contribute to the repository, further improving resources that will be valuable to instructors everywhere.

II. The Eco-STEM Peer Observation Tool and Process

As indicated in a faculty survey conducted by the American Association of University Professors in the U.S. [9], multiple institutions have carried out research to reform teaching evaluation processes in recent years [10]. The Eco-STEM Peer Observation Tool and Process were developed by adapting the University of Arizona "Peer Review of Teaching Protocol" [11], leveraging knowledge generated by other research initiatives, including "Revising Teaching Evaluation" at the University of Oregon [12] and the multi-campus "Teaching Quality Framework" (TQF) initiative that focused on reflection and formative assessment [13].

The Eco-STEM Peer Observation Tool is a key mechanism of our proposed reformation of the teaching evaluation system, which plays a critical and systemic role in establishing a culture that promotes continuous growth. Since our goal is to help faculty create asset-based ecosystems within their classes, the Peer Observation Tool was designed to solicit a peer's formative assessment of the current state of the classroom ecosystem. We identified three primary indicators based on our understanding of the ecosystem paradigm as described in the literature [6], [14], [15]:

- **Climate**: supportive, inclusive and recognizes cultural assets
- **Structure**: facilitates the learning process
- **Vibrancy**: solicits activity and high levels of engagement.

Each key indicator was subdivided into four or five principles, which are shown in Figure 1. Each principle was distilled to several observable behaviors that demonstrate the implementation of the principle within the classroom setting. The existing observable behaviors from the University of Arizona's "Peer Review of Teaching Protocol" tool [11] were then organized around these three indicators. For example, Figure 1 shows the observable behaviors associated with promoting healthy and productive dynamics between students, which is one of the principles of a vibrant classroom. We also added several observable behaviors to the tool, inspired by the framework of Community Cultural Wealth. This framework leverages marginalized students' assets within the classroom space [5].

The goal of the Peer Observation Tool is to help faculty make intentional changes to their pedagogical practice. Peer observation can either be implemented by a pair of instructors who observe each other or as a component of the retention, tenure and promotion (RTP) process with a single observer.

We adapted the Peer Observation Process from the University of Arizona's "Peer Review of Teaching Protocol" [11], emphasizing reflective dialogue between the observer and the observed instructor. The resulting Eco-STEM Peer Observation Process is shown in Figure 2. In our proposed procedure, the faculty member to be observed first selects the behaviors they want to be the focus of the observation. The Peer Observation Tool lists 54 observable behaviors in total, but it would not be practical to observe all of them in one class session. Thus, we recommend an instructor select about 10, or at most 15, of the behaviors to be the focus of an observation. As part of the reflective process, an initial meeting between the instructor to be observed and the observer takes place. The two instructors discuss the goals of the observed faculty member and the selection of observable behaviors in support of that goal. The discussion with the observer might refine the selection or change which behaviors to focus on.

The Eco-STEM Peer Observation Tool is publicly available at *ecostem.calstatela.edu*. The observer can use the tool flexibly by either just reporting how evident a behavior was (very evident, evident, limited evidence, not evident) or by also providing more detailed qualitative feedback in the available text boxes. How the form is used depends on the training and abilities of the observer. The quantitative response alone provides some helpful feedback to the instructor, but it is desirable to provide more detailed feedback.

After the classroom observation(s) is (are) conducted, a second meeting takes place to debrief. This meeting provides another opportunity for reflection on teaching practices by discussing the details of the observation. It not only provides a reality check for the observed instructor, but also allows the observer to provide input on potential ways to improve the observed teaching practice as well as reflect on their own practice. The observer may decide to share their own teaching experiences and/or point to some additional resources and examples of ways to implement certain behaviors (e.g., from the Eco-STEM Resource Repository, which is described below).

We tested the Eco-STEM Peer Observation Tool and Process during the Fall 2021 semester with the first cohort of Faculty Fellows in the Eco-STEM Community of Practice [8]. Initial feedback consisted of suggestions regarding the structure of the form (e.g., more space for notes and a mechanism to create a form that only contains the behaviors selected for observation instead of the full list) as well as reflection on the impact of the observation. The Fellows noted that the initial selection of observable behaviors and discussions before and after observation facilitated valuable reflection on their teaching practice. We will pilot a revised version of the tool with the next cohort of Eco-STEM Fellows and other interested faculty members, and we are curious to hear feedback from faculty at other institutions as well.

III. The Eco-STEM Resource Repository

The Eco-STEM Resource Repository is an additional tool for pedagogical support. The repository was created to accompany and support the Peer Observation Tool and Process. The Resource Repository is structured in the same manner as the Peer Observation Tool (see Figure 1) and provides a centralized trove of resources. For each indicator, principle, and observable behavior, a general description defines and explains the item. Additional resources are provided in the form of examples, activities, and references for further reading. Figure 3 shows an excerpt from the Resource Repository in its current

CLIMATE	STRUCTURE	VIBRANCY
C1: Knows students as individuals	S1: Provides clear goals/ outcomes	V1: Communicates passion for the discipline
C2: Encourages questions	S2: Organizes class effectively	V2: Uses active learning to engage students
C3: Expresses belief in students' capacity and potential	S3: Employs instructional design based on knowledge of how people learn	V3: Promotes healthy and productive dynamics between students
C4: Creates an inclusive environment		V4: Stimulates a high level of student engagement
C5: Recognizes cultural assets	S4: Structures activities to develop effective learners	V5: Promotes the growth of motivated and deep learners

- V3.1: Encouraged students to answer each other's questions
- V3.2: Encouraged groups to ensure that all students have an opportunity to speak and are listened to
- V3.3: Enforced respectful behavior and kindness between students
- V3.4: Facilitated effective group work through assignment of roles and group selection
- V3.5: Intervened as necessary to hold class to pre-agreed-upon community norms

Fig. 1. Overview of a healthy classroom educational ecosystem and example of organizational structure of Peer Observation Tool

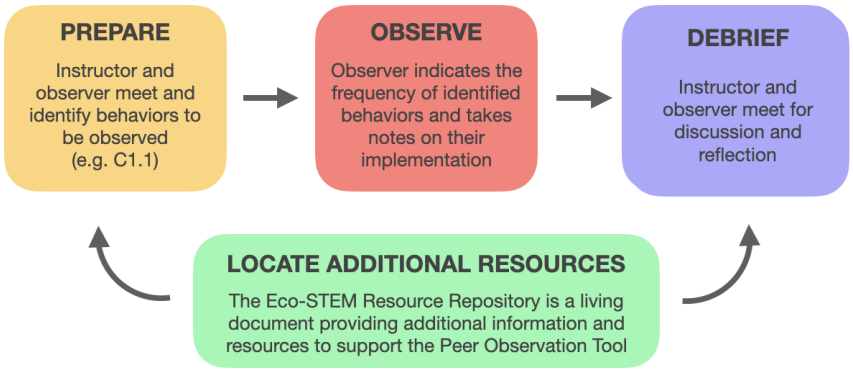

Fig. 2. The Eco-STEM Peer Observation Process

C1: Knows students as individuals

Every student brings their unique history, personality, and interests into the classroom. Knowing your students as individuals allows you to better connect with them both instructionally and personally. Instructors should tailor classroom activities to meet the needs and interests of students, which will never be identical between two groups of students. Here are some sample icebreaker/community-building activities that an instructor can use to get to know students as individuals.

- Check in: a ritual we have used in collaboration and class meetings is to start each meeting with a check in. This has a specific form and reason. We all have busy lives going from one thing to another. We sit down in a space with all that we have done and all that we have to do in our heads, yet we are still in this space together. As a way of turning our attention to the moment we practice listening. Each person shares what is distracting them from being together. There are two rules for check in: 1) you don't have to check in and 2) we don't comment on another's check in. The reason we don't comment is that this then will turn into a conversation and this is not the purpose of check in. We have found this practice to be life-giving and an excellent method of building trust and community.
- Partner questionnaire activity: Details and instructions are included after the linked questionnaire.
- Meet-and-greet activity:
  - Part 1: Introduction slides. Instructions for use and an example are provided.
  - Part 2: Jamboard. Instructions can be found on the last slide here.

Fig. 3. Excerpt from Eco-STEM Resource Repository

form. The blue text within the repository indicate hyperlinks; some link to activities and templates that can be downloaded and adapted to individual instructors' classroom needs, while others link to references where additional information can be located.

The Eco-STEM Resource Repository is a living document open to any STEM educator to use and to contribute to. Currently, the repository is in the form of an accessible Google document publicly available at *ecostem.calstatela.edu*; in the future, it will be converted to a Wiki-style database. Please contact the Eco-STEM team to include your contributions to the repository.

IV. The Eco-STEM Student Survey

The current student opinion survey at Cal State LA is used as one component in the RTP process for faculty. It consists of 10 questions answered on a Likert scale of 1 to 5, and it often does not provide useful feedback to faculty in terms of how they might improve the classroom environment. After investigating the literature on student opinion surveys [12], [16]–[19] we decided to adapt a survey from the University of Oregon [12], expanding the survey questions and aligning them to the same three key indicators identified in the Peer Observation Tool and Resource Repository. Figure 4 shows an excerpt of the questions related to classroom climate.

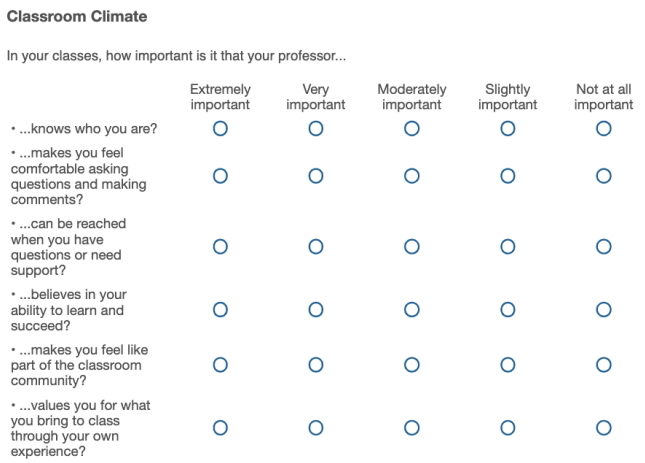

Fig. 4. Excerpt from the Eco-STEM Student Opinion Survey

The Eco-STEM Student Experience Survey will be piloted by interested STEM faculty over the coming academic year. The long-term goal is to replace the current student opinion survey with a version of the Eco-STEM Student Experience Survey in the RTP process at Cal State LA.

V. Future Work

We will continue to test and revise the Eco-STEM tools based on feedback from both students and faculty. Beginning in academic year 2022-2023, with the initiation of the Eco-STEM Leadership Community of Practice, we will work with department chairs and program coordinators to pilot the Eco-STEM tools as alternative or additional feedback mechanisms to facilitate continuous pedagogical improvement. In parallel, project assessment and research studies will be conducted to measure the effectiveness of both the Eco-STEM tools and the reflective evaluation process. Once we have solid evidence to demonstrate the benefit of the Eco-STEM tools, we will move forward to drive institutional changes on teaching evaluation policy and procedure through the following steps:

1) Communicate the effectiveness of the Eco-STEM tools with supporting data to the campus community;
2) Work with faculty affairs to gain broader faculty buy-in to use the Eco-STEM tools as alternative or additional evaluation tools;
3) Initiate conversation among faculty committees and the Academic Senate to discuss ways to improve teaching evaluation;
4) Work with the Faculty Policy Committee to start the policy change process.

The long-term goal of making the Eco-STEM tools part of the RTP process is to create an institutional culture in which continued investment of faculty into their growth as teachers is highly valued. Through the demonstrated valuation of climate, structure, and vibrancy within the classroom, the RTP process can lay the foundation for classroom environments in which students from all backgrounds are supported to thrive.

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