Teacher Training Guide: Problem-based Learning in STEM

UNIVERSITY of HAWAI'I®

MAUI COLLEGE

Project STEMulate

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Project STEMulate

Project STEMulate utilizes a Problem-based Learning model and approach to stimulate STEM interest, knowledge and skills of Hawai'i's high school students. Specifically, providing a STEM curricula that actively engages students in real-world, technology-based problem solving and learning. Project STEMulate seeks to transform the learning experience for high school students to motivate and prepare them for the STEM careers of tomorrow by supporting today's teachers.

Funded through the National Science Foundation* ITEST (DRL# 1657625), Project STEMulate created, implemented, and iterated the design of a *Problem-based Learning in STEM Professional Development and Teacher Training.* Over the course of three-years (2018-2020), University of Hawaii Maui College Faculty and Staff iterated the curriculum design to support high school teachers in expanding their ideology and repertoire to include Problem-based Learning.

Project STEMulate TEAM

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*Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation

TABLE OF CONTENTS

Preface

According to the 2018 Program for International Student Assessment[1], U.S. students ranked 37th out of 78 countries for math and 18th in science. Nationally, Hawai'i students test among the lowest in the nation in math and science with Maui students scoring lower than the state averages in math and science. Moreover, low-income students continue to score lower on achievement tests[2,3], with the achievement gap widening between low-income and high-income students[4]. Native Hawaiian families have higher rates of poverty (18.5% for Native Hawaiians compared to 9.8%; US Census Bureau, *S1701*, 2016) and Hawai'i holds the highest per capita of homeless persons (US HUD, 2017). Hope for the future lies in STEM jobs, which are projected to grow at nearly twice the rate of the U.S. labor force[5,6] with a growth of almost one million from 2018 to 2028[7]; in contrast, 2 million STEM jobs are estimated to be unfilled in 2025[8]. Hawaii is predicted to have 31,965 STEM positions by 2026[9].

In response to these needs and projections, the University of Hawaii Maui College (UHMC) has created the Project STEMulate - a STEM Problem-based Learning (PBL) approach designed to develop STEM interest and motivation among underserved and underrepresented high school students. Specifically designed for Native Hawaiian and other underrepresented, low-income, potential first generation-to-college high school students, Project STEMulate utilizes PBL as an avenue to honor student voice and culture alongside STEM learning outcomes. Early on, the Project STEMulate model acknowledged that in order to impact students, teachers need innovative teaching strategies and resources to connect science learning with students' lived experiences. Teachers play a key role in cultivating the PBL student-driven environment in which students thrive. Yet, implementing PBL and creating a student-driven environment goes beyond the traditional teaching skill set and requires teachers to look beyond the textbook.

Funding provided by the National Science Foundation, allowed UHMC to further refine, implement, and research the effectiveness of Project STEMulate. Research findings revealed that students participating in the STEMulate PBL curriculum increased science motivation and self-efficacy, mathematics motivation and self-efficacy and STEM career interests. Project STEMulate found that through PBL training teacher dispositions improved in most dimensions, including teaching inquiry-based approaches, integrating technology, and STEM career knowledge and awareness.

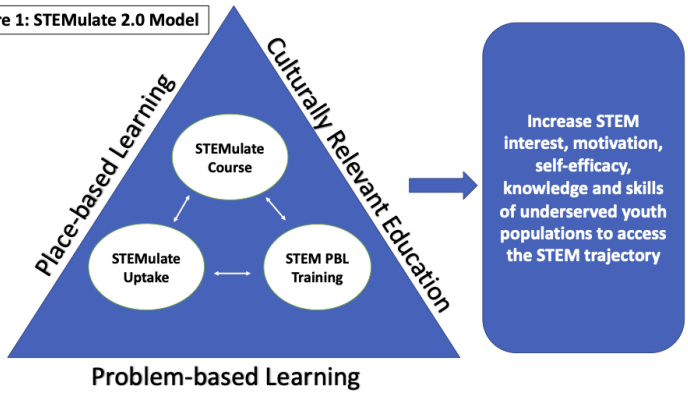
This Teacher Training Guide provides teacher trainers, directors, program coordinators and others supporting teachers a sequence of activities used to shift teachers' mindset to include PBL approaches. Over the course of three years, the Project STEMulate team led by Dr. Amir

Amiraslani and Mr. Derek Snyder iterated and evolved the *Problem-based Learning in STEM Professional Development and Teacher Training* to the set of activities provided in this guide.

Introduction

Teachers need innovative teaching strategies to connect science learning with students' lived experiences. Project STEMulate proposes an innovative STEM Problem-based Learning Model that is multifaceted and multilayered aimed to connect students, teachers, STEM Industry, practitioners, institutions, and organizations (Figure 1). Problem-based Learning (PBL) is the foundation of the STEMulate Model and draws on Culturally Relevant Education (CRE) and Place-based Learning (PLBL) to create a community of support for underrepresented and underserved students towards STEM aspirations. The STEMulate Model leverages students' cultural identities and geographic locations as a foundation of strength and knowledge towards STEM self-efficacy and interest. By transforming students' experiences, teachers empower students to act and impact their surroundings and their place therein for the better (Nieto & Bode, 2007). The STEMulate Model uniquely combines the foundation of PBL with CRE and PLBL to broaden STEM participation to include Native/Indigenous, remote, and low-income students, while simultaneously engaging teachers and STEM Industry personnel in the learning process.

Figure 1: STEMulate 2.0 Model



Problem-based Learning (PBL). PBL is an innovative learning and instructional approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem (Savory, 2006). Essential tenets of PBL include: 1) student-driven and student-centered design; 2) real-world focus; 3) collaboration; 4) open-ended outcomes; and 5) interdisciplinary approach (Savory, 2006). In a PBL setting, students actively participate in their own learning to address real and relevant problems contributing to their own understanding and achievement outcomes (Barrows, 1985; Blumenfeld, Soloway, Marx, Krajik, Guzdial, & Palinscar, 1991; Gultek, 2005; Marx, Blumenfeld, Krajik, Soloway, 1997; Moursund, 1999; Hmelo-Silver, XXXX).

Stalker, Cullen, and Kloesel (2015) found that Problem-based Learning (PBL) effectively engaged participants in exploring weather-related impacts. PBL is effective for teaching critical thinking, communication, collaboration, and applying knowledge to real-world situations (Walker & Leary, 2009; Darling-Hammond, Barron, & Pearson, 2008; Strobel & Barneveld, 2009). Promising results of several high school studies indicate PBL is *as or more effective* than traditional teaching, especially with low-income students (Mergendoller, Maxwell, & Bellisimo, 2006, Strobel & Barneveld, 2009). Furthermore, adolescents are an ideal population for self-directed problem-solving curriculum (Halper, Heckman, & Larson, 2013). Yet, few opportunities exist for high school students to experience PBL curriculum (Atkinson & Mayo, 2010). Teachers with the skills to facilitate PBL, content knowledge in environmental science, and resources will provide students with meaningful learning experiences.

Teachers are a critical component in providing a PBL experience for students (Merritt, Rillero, & Kinach, 2017; Mergendoller, Maxwell, Bellisimo, 2006). Yet, studies point to teacher reluctance towards PBL due to curriculum standards, lack of PBL training, and discomfort with the unstructured PBL method (Subramaniam, 2014; Pagander & Read, 2014; Liu, Wivagg, Geurtz, Lee & Chang, 2012, Ertmer, 2010, Asgnar, Ellington, Rice, Johnson, & Prime, 2012; Nowak, 2017). Bound and Feletti (1997) stated that PBL fails to achieve anticipated learning outcomes when staff is not fully committed to PBL.

Culturally Relevant Education (CRE). CRE enables equal opportunities for students from diverse cultural backgrounds (Ladson-Billings, 1995) by creating meaningful connections between students' background knowledge (i.e., culture, language, and life experiences) and what they learn in class to increase relevancy towards academic success (Banks, 2017; Gay, 2010; Ladson-Billings, 1995). Aronson and Laughter (2016), draw from Gay and Ladson-Billing, to define CRE as teacher practice and disposition that 1) connects students' cultural references with academic skills and concepts, 2) engages students in critical reflection, 3) facilitates students' cultural competence to learn about their own and others' cultures, and 4) critiques discourses of power and finds opportunities to pursue social justice. Aligning with PBL, CRE demands student-centered instruction (Irvine & Armento, 2001) where teachers act as facilitators with high expectations of students and create a learning environment within the context of culture (Ladson-Billings, 1995). PBL strategies support students in recognizing, acknowledging, and applying their own cultural identities, strengths, backgrounds, and knowledge.

Place-based Learning (PLBL). PLBL is grounded in leveraging local structures and opportunities to contextualize the learning experience for students (Nadelson, Seifert, & McKinny, 2014). PLBL starts with vital community issues and links curriculum to students' lived experiences. By emphasizing the local community as one of the primary resources for learning, PLBL encourages learning that grounds students in their own history and culture (Sobel, 2004). According to Buxton (2010), "*When a topic of study is too far removed from our direct experience, it seems unlikely to inspire us to action. In contrast, topics that affect us physically, socially, and emotionally may call us to action and result in the need for new knowledge and skills*" (p. 125). Bennett (2016) found PLBL created a sense of relevancy among

middle school students. Likewise, the extent students were connected to the material increased motivation and their ownership of learning (Appleton, Christenson, & Furlong, 2008; Hadre & Reeve, 2003).

STEM PBL Teacher Training Course Curriculum

This training course is a part of a larger NSF Funded project, entitled Project STEMulate. Project STEMulate aimed to build STEM motivation and interest among underserved and underrepresented (including low-income, first-generation-to-college, and Native Hawaiian) high school students through STEM Problem-based Learning (PBL). To reach high school students, Project STEMulate included a teacher training component that prepares and supports teachers in implementing the STEMulate PBL student course curriculum. Project STEMulate recruited middle and high school teachers from the State of Hawaii with representation from five Hawaiian Islands. The following description of the training curriculum is a culmination of lessons learned over the course of three years.

The 9-week STEM PBL Teacher Training Course seeks to shift teachers' mindset and ideology from traditional teaching practices to include the role and skills necessary to facilitate a culturally relevant PBL environment. Particularly, supporting teachers in creating an environment that allows students to take control of their learning process in order to motivate and instill a deep interest in the study topic. During this training, teachers were provided with knowledge in the foundational theories, skills, and methodologies of PBL as well as Culturally Relevant Education.

This training course is intended to support the professional development of middle and high school teachers to adopt and/or design a curriculum using a Problem-based Learning (PBL) approach. Course objectives include:

1. To prepare teacher participants to serve as PBL mentors for high school or middle school students.
2. To have participants apply PBL techniques both at a macro level (i.e. the central thematic problem of the course or program), and a mico level (i.e. day to day lesson plans).
3. To expose participants to some interesting and exciting ideas and practices in PBL.
4. To use PBL techniques combined with their prior knowledge to adopt and/or design engaging STEM curricula.
5. To prepare participants to incorporate opportunities within PBL to participate in/learn about Hawaiian culture.

This training course centres around activities, discussions, and instructional approaches that exemplifies the PBL process and introduces Hawaiian culture. First and foremost the training course begins with an 8-hour face-to-face orientation session. The orientation session

builds community amongst teacher participants and instructional staff, provides a sampling of PBL process, and provides hands-on cultural learning activities and field experience. Following the orientation session, teacher participants engage in an asynchronous online learning community. Through the online learning community teacher participants engaged in:

1. ***PBL Mini-Activities*** are assignments that allow teachers to participate in carefully selected aspects of the PBL process as a student. As PBL participants, teachers gain an appreciation for the challenges and benefits of PBL curriculum from the students‘ perspective. Teachers utilize this insight as they design classroom lessons or programmatic activities.
2. ***Discussion Questions*** develop teachers' understanding of key concepts through viewing, reading, and listening and reflecting upon PBL readings and videos. Teachers respond to interactive discussion question prompts derived from the PBL readings, PBL videos, and live PBL presentations to arrive at a better understanding of PBL and PBL approaches in the classroom.
3. ***PBL Lesson Plan Activities*** supports teachers in designing and implementing classroom lesson plans that integrate PBL knowledge and best practices.

Finally, the training course ends with a culminating face-to-face session where teacher participants present their lesson plans and final reflections. Specifically, this culminating reflection describes what was learned, utilization of PBL, and impacts on overall pedagogy.

Training Course Calendar

The following training course calendar outlines a suggested timeline to assign the various activities for teachers to engage in. The training course is proposed as an asynchronous online learning experience that practicing teachers can engage with while working full time jobs. The online learning experience is designed to build an online community where teacher participants can uncover new knowledge, reflect upon their understanding, and respond to others‘ statements.

PBL Mini-Activities: Mini

Discussion Questions: DQ

PBL Lesson Plan Activities: Lesson Plan/LP

Orientation Week 1						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
			Meet & Greet Posting		Orientation Day Assign: DQ#1	Meet & Greet Posting Response
Week 2						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**

Assign: Mini #1 Assign: LP #1	Due: DQ#1 - Initial Post		Due: Mini #1		Assign: DQ#2	Due: DQ #1 - Response Post Due: LP #1
Week 3						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Assign: Mini #2 Assign: LP #2	Due: DQ#2 – Initial Post		Due: Mini #2		Assign: DQ#3	Due: DQ #2 - Response Post Due: LP #2
Week 4						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Assign: Mini #3 Assign: LP #3	Due: DQ#3 – Initial Post		Due: Mini #3		Assign: DQ#4	Due: DQ #3 - Response Post Due: LP #3
Week 5						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Implement PBL Lesson Assign: LP #4	Due: DQ#4 – Initial Post		Reflection Paper Prewriting Activity			Due: DQ #4 - Response Post Due: LP #4
Week 6						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Implement PBL Lesson			Reflection Paper Rough Draft			Reflection Paper Final Draft
Week 7						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
					Final Presentation Day	

STEM PBL Teacher Training Activities

The following activities are written from the perspective of the PBL training instructor providing assignments to teacher participants.

Highlighted in yellow are "**Teacher to Teacher**" comments on the rationale for the activities within the curriculum. This rationale will provide teachers with an opportunity to consider if the activity shared could be slightly altered for the specific context/audience to achieve the same learning outcomes.

In the blue boxes is the verbiage utilized in the prior course. This verbiage can/should be revised according to context/audience.

Orientation Week 1						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
			Meet & Greet Posting		Orientation Day Assign: DQ#1	Meet & Greet Posting Response

Teacher to Teacher:

Meet & Greet Posting: One of the most important aspects of our class is that we become a connected and interactive community of learners. The first step towards that development is for us to get to know each other better. A meet & greet posting exchange can help establish an initial connection between participants and begin the formation of an interactive learning community.

Part 1:

Meet & Greet Posting - Within your bio, consider sharing with everyone where you work, what you teach, family life, hobbies, interests, etc. You are free to include as many pictures in your bios as you would like. Sometimes, it is very effective to have visual references to accompany your words.

Part 2:

Response Post to Another Meet & Greet Posting - Respond to a colleague's post in any way you would like to further enhance our connection to each other. Consider how you might have something in common with others. You are encouraged to respond to a post that has not yet received a response.

Week 2						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Assign: Mini #1 Assign: LP #1	Due: DQ#1 - Initial Post		Due: Mini #1		Assign: DQ#2	Due: DQ #1 - Response Post Due: LP #1

Teacher to Teacher:

Discussion Question Forums allow participants to take a deeper dive into the content of the course as a collective. Sharing in an asynchronous forum about readings, videos, etc. regarding the content creates an opportunity for increased insights, negotiation of meaning, and greater understanding for participants.

The first Discussion Question in the course centered on helping participants understand some of the essential tenets of Problem-Based Learning. This could be achieved utilizing various resources, but the key will be to establish a shared foundation of understanding regarding Problem-Based Learning.

Discussion Question #1: Read the article titled "Overview of Problem-based Learning: Definitions and Distinctions" to gain insight into Problem-based Learning.

After reading the article, respond to the following question. DQ reaction posts should be between 150 to 300 words. Additionally, engage in discussion with your peers by responding to one of their posts. Try to move the discussion forward with your own insights, questions, or examples. It is okay to disagree, but please do so in an academic fashion, respectfully.

- What is one thing you learned from the article about PBL?
- What do you think is the most essential characteristic of PBL (listed on pp. 12-14)? Why?
- The article concedes that "PBL in public education is a complicated undertaking" (p. 17). Why do you think this is true? What is a possible work around the challenge?

Teacher to Teacher:

PBL Mini Activities allow for participants to actively engage in *doing* Problem-Based Learning as learners. Participating in these mini activities as learners, participants can experience what their students will experience and therefore gain empathy for the challenges and opportunities that exist within the PBL framework. Understanding the student perspective will allow teachers to be better informed curriculum creators involving PBL and also allow for teachers to better understand how PBL aligns with and also differs from other teaching methodologies.

PBL Mini-Activity #1: The PBL Practice Activities are your group activities where you will participate as PBL students examining one of the STEM topics presented by real-world STEM partners.

For this activity, we want you to take on the role of students, doing some initial research into your STEM partners prior to contacting them to learn more about their real-world problems that could be explored by students. Important: These activities are not designed to result in resolutions of a problem, complete with extensive research, experimentation, or some particular written final product; rather, these activities are merely thinking exercises that allow you to experience PBL as your students might experience PBL in your classes.

Task 1: Complete some initial research into your respective STEM Partner. Be sure to review more than one source for your information. Note that you do not need to reach out to your contact for this initial research stage. This individual contact will occur later after you have

done some initial and general research into the STEM Partner and are more prepared to talk with them about their respective organization and real-world problems they are facing that need solutions.

Task 2: Craft a single paragraph succinctly synthesizing all that you learned about the STEM Partner. Be sure to cite your sources according to APA citation guidelines. Don't worry if your citations are not perfect.

Task 3: Post your paragraph as a group in the PBL Practice Activity #1 thread in the Forums section of Laulima. In addition to your paragraph, speculate and list out 3 possible problems you believe the STEM partner might be facing. (Don't worry if your speculations are correct or not. In the near future, you will learn directly from the contacts what are the actual problems they are facing and you can determine if your speculations ultimately align with those real-world problems or not.)

Only one post for the entire group is required. All individuals should try to contribute in some manner to the objectives for the assignment. You might consider assigning tasks to each group member. Communication for successful completion of this activity can occur in the forum or outside of the forum via another communication means if preferable.

Think of the assignment as having three primary goals:

1. To succinctly teach the rest of our class what the STEM partner is all about through your short paragraph post.
2. To begin speculation about what type of problems the STEM partner might face.
3. To prepare you to begin talking with the STEM partner next week regarding what they do and what real-world problems they face that need solutions.

Refrain from speculating about any solutions to the problems at this stage.

Teacher to Teacher:

Lesson Plan Activities are a series of activities that build toward participants building a PBL lesson for their respective classroom context. The activities are designed to be scaffolded so that participants can spend time planning, revising with feedback, implementing, reflecting, and ultimately refining the lesson. The ultimate goal for the lesson plan activities is not necessarily for instant success in PBL implementation, but rather to allow for participants to build high-quality PBL curriculum that is relevant and meaningful for their contexts, and to pilot the lesson in order to create the opportunity for deeper understanding for the potential PBL can have for their student audiences. The hope is that participants will be able to then transfer the lessons learned from the Lesson Plan Activities to future contexts when they might plan and implement PBL lessons again.

Lesson Plan Activity #1: Pre-Planning

Read over and review some key aspects of PBL adapted from Overview of Problem-Based Learning: Definitions and Distinctions (Savery, 2006). As you start out thinking about your lesson plan, keep in mind some important aspects of PBL:

In PBL, students are engaged problem solvers, seeking to identify the root problem and conditions needed for a good solution and in the process becoming self-directed learners. PBL is focused, experiential learning organized around the investigation and resolution of messy, real-world problems.

1. PBL is a learner-centered approach. Students must have the responsibility of their own learning.

2. The teacher is a mentor/facilitator who guides the learning process and conducts a thorough debriefing at the conclusion of the learning experience.

3. PBL must be ill-structured and allow for free inquiry.

4. Collaboration is essential.

5. Learning should be integrated from a wide range of disciplines or subjects. (Multiple perspectives lead to a more thorough understanding of the issues and the development of a more robust solution.)

6. A critical skill developed through PBL is the ability to identify the problem and set parameters on the development of a solution.

7. Self and peer assessment should be carried out in PBL.

8. What students individually learn during their self-directed learning should be shared with their group to inform the group's decision-making process in relation to the problem. Individuals accept responsibility for seeking relevant information and bringing that back to the group to help inform the development of a viable solution.

9. A closing analysis of what has been learned from work with the problem and a discussion of what concepts and principles have been learned are essential.

10. The goals of PBL are both knowledge-based and process-based. Students should be assessed on both dimensions at regular intervals. Students need to be able to articulate what they know and what they have learned.

Lastly, remember:

The reality is that learners who are new to PBL require significant instructional scaffolding to support the development of problem-solving skills, self-directed learning skills, and teamwork/collaboration skills to a level of self-sufficiency where the scaffolds can be removed.

Briefly reflect and answer **the following questions:**

1. Who is your student audience? What are their current characteristics as learners that align well with a PBL approach? What are their current characteristics as learners that will present challenges with a PBL approach?

2. What is your content area? What kind of topics can be explored in your content area that align well with a PBL approach? What kind of problems might the students arrive at from within these topics (importantly, this is merely speculation, as you may find that students arrive at problems to explore that you did not think about)?

3. How will you students collaborate with each other in this PBL approach? What will be some of the potential challenges? How will the collaboration groups be determined?

4. How will you ensure that students can have access/exposure to a wide range of disciplines and subject experts? Are there other teachers in this PBL in STEM class or other teachers at your school that you might be able to collaborate with? How might you collaborate with them? If not, what other resources / who else could you seek out?

5. How will you allow for assessment of both knowledge and process with a PBL approach? How will you allow for self-assessment and peer assessment? What will a closing analysis look like for your students? How do these assessment goals align with the student learning objectives for your class?

Week 3						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Assign: Mini #2 Assign: LP #2	Due: DQ#2 – Initial Post		Due: Mini #2		Assign: DQ#3	Due: DQ #2 - Response Post Due: LP #2

Teacher to Teacher:

Discussion Question Forums allow participants to take a deeper dive into the content of the course as a collective. Sharing in an asynchronous forum about readings, videos, etc. regarding the content creates an opportunity for increased insights, negotiation of meaning, and greater understanding for participants.

The second Discussion Question in the course centered on helping participants envision how PBL might be infused into a school context. There are many ways to invite participants to think about PBL in a formal school context, but the important aspect is to allow for participants to begin this journey of thinking about PBL in their own classrooms.

Discussion Question #2

Task 1: Watch the short video below from Maastricht University in the Netherlands discussing the implementation of Problem-Based Learning in their school.

https://youtu.be/cMtLXXf9Sko

Task 2: Read over the article "12 tips for effective lecturing in a PBL curriculum" by Malik & Malik (Univesiti Teknologi MARA, Malaysia).

Task 3: Briefly answer all 3 of the following questions:

- What is one thing you learned from the video about PBL?
- What do you think will be the most challenging aspect of implementing PBL in your respective classroom (as it was discussed in the video for the context of Maastricht University)?
- At the end of the video, there is discussion of also having lectures in the class as a part of a PBL approach. The attached article provides some tips for effective incorporation of lecture in a PBL curriculum. What is one tip from the article that you felt was particularly helpful or important as you consider the role of lecture with a PBL approach in your own classroom?

Teacher to Teacher:

PBL Mini Activities allow for participants to actively engage in *doing* Problem-Based Learning as learners. Participating in these mini activities as learners, participants can experience what their students will experience and therefore gain empathy for the challenges and opportunities that exist within the PBL framework. Understanding the student perspective will allow teachers to be better informed curriculum creators involving PBL and also allow for teachers to better understand how PBL aligns with and also differs from other teaching methodologies.

PBL Mini-Activity #2

For this activity, we want you to take on the role of students, exploring a particular topic, and arriving at a focused problem that could be further explored and defined through subsequent investigative processes.

Important: For this activity, you are only being asked to consider this topic as a potential problem to explore, you are not being asked to actually formally and deeply explore the topic through resources, primary or secondary. The practice activities should be seen as thinking exercises more than anything.

Also importantly, as discussed on our orientation day, for your classes, you may want to allow your students to arrive at a topic of their own choosing for further exploration. For the purposes of our condensed timeline in the PBL in STEM course, we have provided you with the topic based on the STEM partner for your geographic area.

STEP 1: Identify and list below 3 different problems that your STEM Partner may be facing? (communicating with your STEM Partner will greatly assist with identifying 3 different problems)

1.
2.
3.

STEP 2: What is the one problem (from your list above) your group would most like to explore for this activity?

STEP 3: Utilizing the questions below as a guide for deeper exploration into your chosen problem, ultimately arriving at a richer description of the particular problem. Some questions below may not be needed; some other questions should likely be added.

Then, craft a single paragraph that more clearly defines and articulates the scope of your problem, including the most important considerations and variables regarding your problem.

Share your paragraph with other participants.

Analysis - Question Prompts

Note: It is not your responsibility to "solve" the problem at this stage. Rather, you should be trying to better define the problem in order to arrive at a more sophisticated understanding of the problem as a complex issue.

- Who is affected by this problem?
- Who is involved with this problem?
- What are the interests we may need to consider as we engage these issues?
- What / Who is causing this problem?
- When did the problem begin?
- Why is the problem an issue?
- What benefits will we hope to accomplish if we can make progress on it?
- What are the (sub) elements and issues involved in the problem?
- Who else might we want to gain input from to understand and reach these interests?

- What areas might we research for help on this?
- What other people or organizations have undertaken similar problems?

Refrain from offering any solutions to the problem at this stage.

Teacher to Teacher:

Lesson Plan Activities are a series of activities that build toward participants building a PBL lesson for their respective classroom context. The activities are designed to be scaffolded so that participants can spend time planning, revising with feedback, implementing, reflecting, and ultimately refining the lesson. The ultimate goal for the lesson plan activities is not necessarily for instant success in PBL implementation, but rather to allow for participants to build high-quality PBL curriculum that is relevant and meaningful for their contexts, and to pilot the lesson in order to create the opportunity for deeper understanding for the potential PBL can have for their student audiences. The hope is that participants will be able to then transfer the lessons learned from the Lesson Plan Activities to future contexts when they might plan and implement PBL lessons again.

PBL Lesson Plan Activity #2 (Planning)

STEP 1: Read over and review some key aspects of PBL on the resource titled "Problem-Based Learning (PBL)" from the Faculty Development and Instructional Design Center at Northern Illinois University.

STEP 2: Read over and review some key aspects of PBL in action with the resource titled "Composting: A Problem, Place, or Project? Using the PBL Trifecta [PBL3] in the Classroom by Mark Williams and Ana Houseal (2018).

STEP 3:

Briefly answer the following questions: Outline below how you may potentially infuse PBL in your current classroom. Keep in mind that your goals with PBL may extend beyond the lesson below, and the lesson below may only be one aspect of a larger consideration of adopting some PBL approaches into your current class.

Our professional development course is designed to simply give you a chance to try out one aspect of PBL in your current classroom - potentially during one class or during multiple classes.

Objective(s):

1. What is/are the objective(s) of your specific lesson? What do you hope to achieve with the students by the end of the class(es)?

Introduction:

2. How will you introduce the lesson to the students? How will you help gain the students' attention and interest?

Activities:

3. What activities will you have the students participate in to assist them in the direction of the lesson objective(s).

4. How will you incorporate individual and group work into your activities? How will you help to ensure some degree of success with individual and group work?

5. How much time will you allot for the activity/activities?

6. How will you hold student groups accountable for staying on task / completing the work during the time allotted?

Closing / Reflection:

7. How will you close the lesson with students? How will you ensure that the closing will be memorable and impactful?

8. In what ways will students be allowed to reflect on the lesson experience (in terms of group work success/lack of success, individual learning, and/or potential next step ideas)?

9. How will this lesson bridge with future lessons and potentially fit into a larger PBL curriculum context? How will you communicate this connection to your student audience?

Alignment:

10. How do the objectives of the lesson align with the objectives of your required class / grade outcomes?

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Assign: Mini #3 Assign: LP #3	Due: DQ#3 – Initial Post		Due: Mini #3		Assign: DQ#4	Due: DQ #3 - Response Post Due: LP #3

Teacher to Teacher:

Discussion Question Forums allow participants to take a deeper dive into the content of the course as a collective. Sharing in an asynchronous forum about readings, videos, etc. regarding the content creates an opportunity for increased insights, negotiation of meaning, and greater understanding for participants.

The third Discussion Question in the course centered on helping participants consider the importance of incorporating traditional knowledge and practices into PBL curriculum. There are many ways to introduce this important aspect to participants, but the key is to ensure that the traditional knowledge and practices are relevant to the context of the participants' place of

teaching.

Discussion Question #3

Task 1: Watch the "Introduction to the Scientific Method of Inquiry" video (11:48)

Note: This presentation (created by Hawai'i Community College faculty Michelle Phillips and Jessica Gonzalez) will be available as part of a larger series of modules designed to support the PBL process.

STEP 2: Watch the TEDxMaui Talk "Lessons From a Thousand Years of Island Sustainability" by Biologist and Cultural Practitioner Sam 'Ohu Gon III, PhD:

Note: The video link is intentionally designed to begin at 5 minutes and 7 seconds into the TEDxMaui Talk.

STEP 3: Review the attached worksheet related to the "Introduction to the Scientific Method of Inquiry" and the TEDxMaui Talk "Lessons From a Thousand Years of Island Sustainability"videos.

STEP 4: Briefly answer both of the following questions:

- How could you incorporate the above material and accompanying worksheet into a PBL lesson plan for your particular classroom?
- One of the integral themes of both the "Introduction to the Scientific Method of Inquiry" presentation and the TEDxMaui Talk "Lessons from a Thousand Years of Island Sustainability" was the importance of traditional knowledge and practices. How are you ensuring that you include in your current PBL lesson plan for your particular classroom the same emphasis of importance regarding traditional knowledge and practices?

Teacher to Teacher:

PBL Mini Activities allow for participants to actively engage in *doing* Problem-Based Learning as learners. Participating in these mini activities as learners, participants can experience what their students will experience and therefore gain empathy for the challenges and opportunities that exist within the PBL framework. Understanding the student perspective will allow teachers

to be better informed curriculum creators involving PBL and also allow for teachers to better understand how PBL aligns with and also differs from other teaching methodologies.

PBL Mini-Activity #3

For this activity, we want you to continue to take on the role of students, and further explore potential solution pathways for the problem you isolated in PBL Practice - Activity #2.

Important: For this activity, you are only being asked to consider solution pathways that would be potentially worthwhile to explore as ways to address the problem. You are not being asked to do any research or to actually formally explore the solutions through experimentation and/or resource data collection, primary or secondary.

Task 1: Discuss more deeply the problem your group collectively arrived at for further exploration. Have each individual in your group consider a unique solution pathway to the problem.For example, if after exploring the overall issue of Student Success Rates at UH Maui College, your group arrived at the specific problem that some UHMC students have limited internet and technology access off-campus which creates an inequitable situation for these students in being able to successfully complete their Internet-based assignments for classes, then each member of your group might arrive at different solution pathways that could potentially help improve this problem for students.

Important: There should be a recognition that the problem your group is exploring is complex. Therefore your group should:

1. Try to get the overarching issue narrowed down to a specific problem (manageable enough in scope) to be able to explore particular solution pathways (Goal of PBL Practice - Activity #2)
2. Recognize that any single solution will not necessarily resolve the problem, but rather a single solution will contribute to a multi-faceted, sophisticated strategy to address the complex problem in some manner, ultimately contributing to improving the overall status of the problem.

Thus, one of the learner objectives in participating in PBL curriculum for students is this deeper appreciation of the complexities inherent in problems and potential solutions to those problems. The transference of this understanding and appreciation of any problem's complexity will allow students to be less likely to fall into the trappings of oversimplification of problem and subsequent solutions often purported in popular

media.

What are the unique solution pathways for your group's problem? (one for each member - place the name of the member behind each solution)

- Note that at this stage all solution pathways are welcome and seen as important in the brain storming stage of solution seeking.

1.
2.
3.
4.
5.

Task 2: What is the one solution pathway (from your list above) your group would most like to explore for this activity?

Task 3: Utilize the questions below as a guide for deeper exploration into your chosen solution pathway, and arrive at a richer understanding of the type of information your group would need to seek out to further explore this particular solution pathway. Remember, you do not need to actually do this exploration for the purposes of this activity for our class. This type of exploration however would be expected of your students. Some questions below may not be needed; some other questions should likely be added.
Then, craft a single paragraph that more clearly defines and articulates your group's strategies and challenges for seeking out further information aligned with the single solution pathway your group is focused on for this activity.

<u>Analysis - Question Prompts</u>
Note: It is not your responsibility to actually gather the information you think would be important in order to prove the viability of the solution your group is focused on for this activity. Rather, you should be trying to better hone a plan for seeking out key information that will inform the solution's viability and impact on the problem.

- What knowledge do your group members already possess regarding your solution pathway?
- How would you organize your group and the various tasks that need to be accomplished in order to explore this solution to your problem?
- What disciplines do you anticipate needing to explore with your solution pathway? Will any of these disciplines present a particular challenge? Why?

- What type of information would you need to find for your solution pathway?
- Where might this type of information be found?
- How might you arrive at this information if it is not currently available?
- Which individuals / entities would be most important to partner with to assist your group with this solution pathway?
- What might be some of the challenges in partnering with these individuals/entities?
- Has this type of solution been implemented in similar / different contexts? What were the results?
- How will you assess the viability of your solution as it relates to the problem?
- What are some checkpoints you could set up in this process to ensure your group is moving forward and progressing toward an outcome?

Refrain from actually gathering the empirical evidence for your solution pathway at this stage.

Teacher to Teacher:

Lesson Plan Activities are a series of activities that build toward participants building a PBL lesson for their respective classroom context. The activities are designed to be scaffolded so that participants can spend time planning, revising with feedback, implementing, reflecting, and ultimately refining the lesson. The ultimate goal for the lesson plan activities is not necessarily for instant success in PBL implementation, but rather to allow for participants to build high-quality PBL curriculum that is relevant and meaningful for their contexts, and to pilot the lesson in order to create the opportunity for deeper understanding for the potential PBL can have for their student audiences. The hope is that participants will be able to then transfer the lessons learned from the Lesson Plan Activities to future contexts when they might plan and implement PBL lessons again.

PBL Lesson Plan Activity #3 (Assessment Considerations)

STEP 1: Read over and review some key aspects of PBL assessment considerations from the following link:
https://www.facultyfocus.com/articles/course-design-ideas/problem-based-learning-six-steps-to-design-implement-and-assess/

STEP 2: Read over and review some key aspects of PBL assessment considerations from the following link:
https://www.edutopia.org/blog/pbl-civic-engagement-student-reflection-melissa-seideman

STEP 3: Briefly answer the following questions:

As you prepare to implement your lesson plan, an important consideration will be how you think about assessment pieces within your lesson plan, as well as your own self-assessment of your lesson plan.

Remember, our professional development course is designed to simply give you a chance to try out one aspect of PBL in your current classroom - potentially during one class or during multiple classes.

Student Assessment

In the Faculty Focus article, there is a mention of the following formative and summative assessments to measure student learning:

- Group contracts
- Self-evaluation forms
- Peer-evaluation forms
- Learning reflections
- Writing samples
- Rubrics
- Other potential PBL assessments

1. Choosing from one of the strategies above, draft below an assessment strategy for your lesson plan.

2. What is the reason that you chose this particular strategy? Why will this strategy be useful for you to better understand the learning that is taking place with students?

3. One of the key aspects of PBL is that it is cyclical in nature. How will your assessment strategy above lead students back into a PBL pathway? See below for context.

From Faculty Focus article:

"Although we presented PBL as steps, it really functions cyclically. For example, you might teach an economics course and develop a scenario about crowded campus sidewalks. After the groups have read the scenario, they develop initial hypotheses about why the sidewalks are crowded and how to solve the problem. If one group believes they are crowded because they are too narrow and the solution is widening the sidewalks, their subsequent research on the economic and environmental impacts might inform them that sidewalk widening isn't feasible. They should jump back to step four, discuss another hypothesis, and begin a different research path" (Genareo & Lyons, 2015).

Teacher Assessment

From the Edutopia article:

"Effective PBL incorporates student reflection into the learning process. After the legislative project, students were asked to share these thoughts:

- What is the most important thing you learned in the project?
- What do you wish you'd spent more time doing?
- On what part of the project did you do your best work?
- How could your teacher change this project to make it better next time?

Students need time to reflect on and assess their own learning, because reflection is the key to a meaningful learning experience" (Seideman, 2015).

4. One type of assessment that is essential in the classroom is students' feedback on our approaches as teachers. Considering this aspect, what question(s) might you incorporate into your assessment of how your students perceived your role in the PBL process. You can look at the last question, "How could your teacher change this project to make it better next time?" in the above list as an example.

5. How will you self-assess your lesson plan after implementation? Draft below the way you will self-assess your lesson plan. Keep in mind that this might evolve, but you should have a general sense of how you will be determining success with your lesson plan. (Be sure to keep in mind that successful lesson plan implementation is not dependent on the overarching learning goal being achieved in that one lesson. We are always trying to move the learning forward in the classroom incrementally, and learning is longitudinal.)

Week 5						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Implement PBL Lesson Assign: LP #4	Due: DQ#4 – Initial Post		Reflection Paper Prewriting Activity			Due: DQ #4 - Response Post Due: LP #4

Teacher to Teacher:

Discussion Question Forums allow participants to take a deeper dive into the content of the course as a collective. Sharing in an asynchronous forum about readings, videos, etc. regarding the content creates an opportunity for increased insights, negotiation of meaning, and greater understanding for participants.

The fourth Discussion Question in the course centered on helping participants reflect on the actual or potential success or challenges of the PBL lesson plan they developed for their respective classroom context, as well as considerations for distance applications. The key aspect is to help participants take a deeper dive into their own lesson plan with the opportunity for discussion and feedback from peers.

Discussion Question #4

Before the COVID-19 pandemic disrupted our collective academic calendars and how we are currently delivering our curriculum, you were expected to carry out your lesson plan in your respective classroom. Your lesson plan was shaped from the three lesson plan activities that you completed during the first 3 weeks of the course.

The ability to deliver your lesson plans has evolved, and we want to continue to provide everyone the opportunity to continue forward with considering implementation aspects in meaningful ways.

Therefore, as you answer the discussion questions below, consider your lesson plan activities.

Note: Slightly different than your first 3 discussion questions, your first DQ #4 - Initial Response should answer the first set of questions, while your DQ #4 - Second Post should answer the second set of questions.

Questions - Set 1: *(to be answered by Thu, 2-Apr)*

Briefly answer both of the following questions:

- If you had been able to implement your lesson plan, what aspects of your lesson plan do you think would have been the most successful? Why?
- If you had been able to implement your lesson plan, what aspects of your lesson plan do you think would have been be the least successful? Why?

Questions - Set 2: *(to be answered by Sun, 5-Apr)*

Briefly answer all 3 of the following questions:

- What aspects of your lesson plan originally incorporated distance aspects? Be specific.
- How could you shift your lesson plan to entirely distance delivery? What would be the greatest challenges? What would be the greatest opportunities?
- What aspect of your lesson plan could you practice with our SCI 214 class participants via distance?

Teacher to Teacher:

PBL Mini Activities allow for participants to actively engage in *doing* Problem-Based Learning as learners. Participating in these mini activities as learners, participants can experience what their students will experience and therefore gain empathy for the challenges and opportunities that exist within the PBL framework. Understanding the student perspective will allow teachers to be better informed curriculum creators involving PBL and also allow for teachers to better understand how PBL aligns with and also differs from other teaching methodologies.

PBL Lesson Plan - Activity #4 (Next Steps)

Briefly answer the following questions:

Now that you have implemented your lesson plan in one way or another, you can begin to reflect on what worked well (or what you think would have worked well) and what did not work well (or what you think would have not worked well). We want you to begin thinking about not only ways to improve this particular lesson plan, but we also want you to begin thinking about ways to continue forward with potentially more robust implementation of PBL in your classroom.

Classroom

1. How can you potentially build off of this one lesson plan into a more longitudinal curricular PBL approach for your classroom? In what ways could you create additional lesson plans to compliment and continue the PBL approach for your single lesson plan? Note: You do not need to draft the lesson plans, you only need to discuss some early planning ideas around those lesson plans.

2. How could you ensure that your PBL approach in your classroom would still meet (or even potentially exceed) the student learning objectives for the class if you built even more PBL curriculum into your classroom? What kind of assessment mechanisms and outcomes could you incorporate into this more robust approach to ensure compliance with the curricular standards for your classroom?

Institution / Community

3. How could you collaborate with other teaching faculty across disciplines, as well as community partners (entities/individuals) to ensure that your more robust PBL approach would be sufficiently multi-disciplinary and real-word based?

Reflection - Prewriting Activity

The primary objective of the Reflection Activity is to have you reflect on your PBL Lesson Plan and determine in more depth what seemed to work (or what could have worked), what did not seem to work (or what might have not worked), and potential next steps regarding future

PBL approaches in your classroom.

For the Prewriting Activity, answer the following 5 questions:

1. What have been your biggest takeaways regarding Problem Based Learning thus far as it directly relates to PBL implementation in your classroom?

2. What do you think are the most important considerations regarding successful implementation of PBL in your classroom? Why?

3. What do you think are the biggest obstacles / challenges regarding successful implementation of PBL in your classroom? Why?

4. Moving forward, how can you continue to grow your PBL approach in your classroom? Be specific.

5. What community partner(s) / colleagues might you be able to collaborate with in the future regarding your PBL approach in your classroom?

Week 6						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Implement PBL Lesson			Reflection Paper Rough Draft			Reflection Paper Final Draft

Teacher to Teacher:

The **Reflection Paper** allows for participants to bring the entire experience in the course together into a culminating paper. The goal of the paper is designed to be reflective and serve as an opportunity to consider what was learned in the course and how PBL might continue to be utilized in the future by participants.

Final Reflection Paper

Complete a culminating reflection describing what was learned in the course, how PBL will be utilized in a future classroom and/or program, and how learning about PBL has impacted overall pedagogy.

Your Reflection Paper should be:2 Times New Roman font

- Double-Spaced
- 3 to 5 pages
- Include Headings for each of the paper's parts
- APA Formatted Citations (Author's Last Name, Year of Publication)
- In addition to the 3 parts below, include:
    - A short introduction section
    - A conclusion section

Part 1: What Was Learned in the Course (minimum one page)

Discuss key course information that you found helpful in better understanding Problem-based Learning. When applicable, please cite any sources.

Part 2: How PBL Will Be Utilized in a Future Classroom and/or Program (minimum one page)

Discuss the PBL strategies you already designed and implemented in the classroom as well as how PBL will be further utilized in your classroom. Share how to run and manage a successful PBL class.

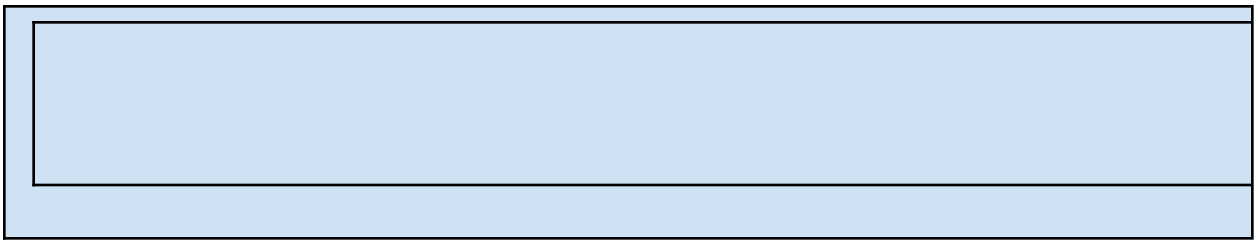
Part 3: How Learning PBL Has Impacted Overall Pedagogy (minimum one page)

Discuss the impact learning more about PBL has impacted your overall approach to teaching, and how this impact will transfer to your classroom methodologies. Share specific ways that PBL will influence the experiences of your students in your classrooms.

Self Assessment Worksheet

Name:

1 The Reflection Paper's introduction successfully engages and introduces the paper's content and purpose to the reader. An appropriate title is included to help introduce the paper.	15	
2 The Reflection Paper includes a section that adequately discusses what was learned in the course, discussing key information that was helpful in better understanding Problem-Based Learning. When applicable, sources were cited.	25	
3 The Reflection Paper includes a section that adequately discusses how Problem-Based Learning will be utilized in a future classroom and/or program, discussing PBL strategies already designed and/or implemented in the classroom. Strategies of how to run and manage a successful PBL class were shared.	25	
4 The Reflection Paper includes how learning Problem-Based Learning has impacted your overall pedagogy, discussing how this impact will transfer to your specific classroom methodologies. Ways that Problem-Based Learning can influence the experiences of students in your classroom were shared.	25	
5 The Reflection Paper included a conclusion section that successfully engages and concludes the reflection piece.	15	



Week 7						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	
					Final Presentation Day	

Teacher to Teacher:

The **Final Presentation** allows for participants to bring the entire experience in the course together into a culminating presentation. The goal of the presentation is designed to be reflective and serve as an opportunity to share with peers how participants implemented PBL in their respective classrooms, along with their success and challenges. The presentation allows for synchronous sharing of the paper's main elements with an opportunity for Q&A and feedback from peers.