Pre-Service STEM Teachers and Their Enactment of Community-STEM-Project Based Learning (C-STEM-PBL)

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Effective K-12 STEM teachers are essential to the critical analysis of real-world issues and can contribute to the democratization of our society. Thus, we engage pre-service math and science teachers in community-focused STEM project-based learning (C-STEM-PBL) so they can integrate community assets, voices, and needs into their pedagogical practice. In this context, pre-service STEM teachers engage K-12 students by connecting STEM-related issues to their personal and community experiences. Further, this place-based, high context approach creates opportunities for critical analysis; so, students might push against the injustices that affect the community. This model presents access to the third space of teacher development, one with the potential to engage urban situated STEM teachers in the community.

Keywords: teacher education program, STEM education, community, urban schools

RESEARCH QUESTION

How do pre-service STEM teachers enact community-centered project-based learning pedagogy in urban marginalized settings?

THEORETICAL FRAMEWORK

Humanizing pedagogy (Bartolomé, 1994), culturally relevant pedagogy (Ladson-Billings, 2009), and what it means to be a community teacher (Murrell, 2000) anchor the work of C-STEM-PBL. Teachers practice humanizing pedagogy by interacting with their students with care and fostering independence, resilience, and persistence. Thus, teachers see, hear and integrate student voices into their classroom community (Bartolomé, 1994). Culturally relevant pedagogy is grounded in 1) supporting student learning through pedagogy, 2) cultural competence, 3) socio-political consciousness that has potential for critical reflection and action (Ladson-Billings, 2009). Murrell (2000) defines a community teacher as the following. "A community teacher develops the contextualized knowledge of culture, community, and identity of the children and their families as the core of their teaching practice…. A significant part of this context is the candidate's own cultural, political, and racial identity. These determine how central or peripheral they are concerning the core practices of a group or community that result in the successful development of children and youth" Murrell, 2000 pg. 340.

Given these theoretical frames, we support teacher learning through *enactment* and critical reflection tied to theory. Engerström (2001), notes that learning takes place in the doing and the tensions that exist in that space. Preservice teachers learn when they enact and reflect within the complexity of the university and field spaces. Kretchmar and Zeichner (2016) propose the 3rd generation of teacher preparation, one that connects the framework of a community teacher with theory, critical reflection, and practice in authentic, collaborative, and responsive ways. This allows for the democratization of teacher education in a third space of deep learning (Zeichner, Payne, and Brayko, 2015). Darling-Hammond and Oaks (2019) characterize deep learning in teacher education by the following: 1) learning that is developmentally grounded and personal, 2) learning that is contextualized, 3) learning that is applied and transferred, 4) learning that occurs in productive communities of practice, and 5) learning that is equitable and grounded in social justice. Thus, C-STEM-PBL has the potential to deepen both pre-service teacher and K-12 student learning.

STEM and PBL

PBL is grounded in cognitive theory and stems from an instructional approach identified as the project method, developed by Kilpatrick (1918) and Dewey (1938). In this case, students are active investigators. Larmer, Mergendoller & Boss (2015) define the gold standard of PBL as having key knowledge and understanding and key success skills at the center, with the following elements supporting that larger goal: 1) challenging problem or question, 2) sustained inquiry, 3) authenticity, 4) student voice and choice, 5) reflection, 6) critique and revision and 7) public product.

STEM-PBL has demonstrated positive results in self-efficacy, self-confidence and interest in learning was also improved, specifically given collaboration and tasks rooted in students' experiences (Baran & Maskan, 2010). Kaldi, Filippatou, & Govaris, (2011) noted that hands-on learning and field-based experiences were foremost in increasing content knowledge and attitudes for learning. Further, learning, collaboration, and communication were positively affected (Dominguez & Jaime, 2010; Kaldi & Filippatou & Govaris, 2011). There is emerging evidence that PBL improves both math and science achievement in low-performing youth (Geimer, 2014; Han, R. Capraro & M. Capraro, 2014). More specifically, increased achievement levels were found among underrepresented minorities, specifically Hispanics (Han, Capraro, & Capraro, 2015; Han, Capararo, & Capararo, 2016). The gold standard of PBL, the principles of deep learning, and how people learn complement C-STEM-PBL. Further, Weissmann, Ibarra, Howland-Davis, & Lammey (2019) argue that high context learning vs. low context learning might be more effective for URM. This work is centered in urban settings in school-wide Title 1 schools. We focus on how pre-service teachers connect a community component to PBL that fosters greater authenticity, place-based context, and purpose to a driving task.

METHODS

Program Context

This study is situated within a teacher education program rooted in social justice. It exclusively places student teachers in the socioeconomically challenged areas and engages and learns with the community through targeted assignments, reflection, and humanizing pedagogy. Developing an asset-oriented community focused on humanizing STEM teachers embodies the values of the teacher education program. Pre-service math and science teachers engage in this work concurrently as a STEM cohort.

The length of the teacher preparation program is 24 months. Pre-service teachers attain their credentials the first year of the program and complete a Master's in Education during the second year. The study occurs within the context of a first-year seminar course focused on the intersection of theory and practice with families and the community. The implementation of C-STEM-PBL predominantly occurs in a large urban school district with a majority-minority population and a district-wide Title 1 population of 75.7%, where more than 25% of the students are second language learners. This study articulates pre-service teachers' initial design and implementation of C-STEM-PBL and what they learned from the process.

Participants, Reflections, and Coursework

31 pre-service math and science teachers have participated in at least 7 courses as a STEM cohort with 2 faculty advisors. In the third quarter of the program, the pre-service teachers were asked to develop and implement a community-focused STEM- PBL (Appendix A). C-STEM-PBL presents a culmination of pedagogical development that results from a critical examination of race, class, gender identity, and privilege as it relates to their positionality. Further, in the third quarter, pre-service teachers have engaged in extensive planning and assessment development as well as having completed the edTPA process. Within the C-STEM-PBL assignment, pre-service teachers constructed a PBL lesson plan, a graphic organizer depicting C-STEM-PBL, a final reflection, and K-12 student artifacts. Both the C-STEM-PBL reflections and the C-STEM-PBL graphic organizers were coded for themes. Categories of information were developed from the text (open coding) and then connected (axial coding) into generative themes (Corbin & Strauss, 2014). We are currently analyzing, through the same process, another cohort of 28 STEM preservice teachers that we will include in the study.

Data Sources

1. C- STEM-PBL - graphic organizer that includes the driving question, task assessment, technology, audience, and how the community will be embedded. (Appendix B)
2. Reflections on implementation (see Table 1 and Appendix C)
3. Student artifacts (see Table 1)

RESULTS

Community-Centered and Authentic Learning

According to the work of Ziechner, Payne & Brayko (2015), who conceptualize a third space in teacher development, the learning must be authentic and community-centered. While there were many examples of learning that were contextualized, there were fewer examples of tasks tied to the community in authentic meaningful ways. Although, 41% (Figure 1a) of candidates constructed driving questions that were tied to the community such as the following: (Table 2)

1. *How does where you live affect how you live?*
2. *How can we reduce our carbon footprint?*
3. *How do GMO's affect our food, our community, and our environment?*
4. *How can we use Geometry to help solve the needs of our community?*
5. *How can statistical inference help understand issues in our community we care about?*

However, the predominant form of **community engagement** consisted of presenting to families/community (Figure 1c) at 57%. More authentically, 22% of these accessed family/community feedback, and only 8% tied their project to a form of advocacy (Figure 1c). These projects involved connections to issues in their communities (Table 1).

Pre-service candidates were able to implement contextualized learning, at 87% (Figure 1a and Table 2). In science, connections to human impact on climate change and biodiversity were more prominent, and in math, connections to functions and their visibility or application in real life were evident (Table 2).

Deep Learning

Deep learning by pre-service teachers and community teachers involves reflection on self, identity, and ties to social justice. 70% of candidates or more saw implementing as a worthwhile experience that benefited their students, Figure 2a, and themselves, Figure 2b. More specifically, a candidate noted that this pedagogical approach renewed their purpose and vision in teaching.

> *"Reminded of why got into teaching and what they hoped teaching would be like. Would like to do more." S1 - Table 1*

Preservice teachers noted it was possible to connect content to Social Justice issues and to create a C-STEM PBL tied to student interests. Over 80% of participants plan to implement this pedagogy as first-year teachers (Figure 2c).

General Learning

A characteristic of PBL is making the presentations public (Larmer et al., 2015). Figure 1b depicts 67% of students presenting to the community, families, including school functions. Similar to Demirel, & Dağyar. (2016), pre-service teachers learned that students enjoyed this approach.

About enjoyment and engagement, some teachers noted the following:

> *"...how invested students were in the project" "I was so surprised by how much my students enjoyed doing the PBL! They wanted to do more and take on the biggest challenges." "What surprised me about implementing my PBL was how excited students were to do the assignment one they began" (Pre-Service Teacher comments - Reflection)*

Additionally, pre-service teachers noted that their K-12 students learned both content and skills such as collaboration and were more comfortable with greater autonomy. Developing greater autonomy among students aligns with tenants of PBL. Learning to be more autonomous and self-manage and is a life skill.

Further, although planning and implementing PBL was a challenge regarding time and being in a guiding teacher's classroom, a positive was that some pre-service teachers noted that the checkpoints inherent in the PBL structure were great opportunities for feedback and formative assessments. Having planned and embedded formative assessments as checkpoints in the PBL process relieved some stress and provided greater direction in the course of implementing PBL.

Challenges and Implications

The logistics related to implementation proved the most challenging for most pre-service teachers. Getting a sense of timing as it relates to when for how long and how to implement the C-STEM-PBL in someone else's classroom with a specific pacing plan was difficult. In the cohort interdisciplinary seminar course, we ameliorated some of the challenges by planning, sharing, and reflecting on the C-STEM-PBL task and analysis of student work artifacts. The seminar became a space for professional reflection and learning among peers where learning is applied and transferred in a productive space. As a program, we can support the development of more effective formative assessments during the PBL process, introduce the C-STEM-PBL approach sooner and push toward more critical engagement with the community for transformative change.

SCHOLARLY SIGNIFICANCE

The enactment of C-STEM-PBL offers a pedagogical vehicle that aligns with the characteristics of a community teacher focused on culturally responsive and humanistic pedagogy. Greater connections to specific tools and scaffolds are necessary to better bridge to practice as well as more structured reflective support. Further, C-STEM-PBL allows pre-service teachers and their students to connect to the richness of assets that are inherent in the people, cultures, and institutions of a community. C-STEM-PBL is a concrete pedagogical approach that can challenge K-12 students to think critically and act in community grounded circumstances. Our teachers have the amazing privilege to work with and stand with youth, their families, and their communities so that together, they can work towards transformative possibilities and where all of us can contribute toward our educational responsibility for a greater societal good.

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APPENDICES

FIGURE 1A
C-STEM-PBL DRIVING QUESTIONS PATTERNS

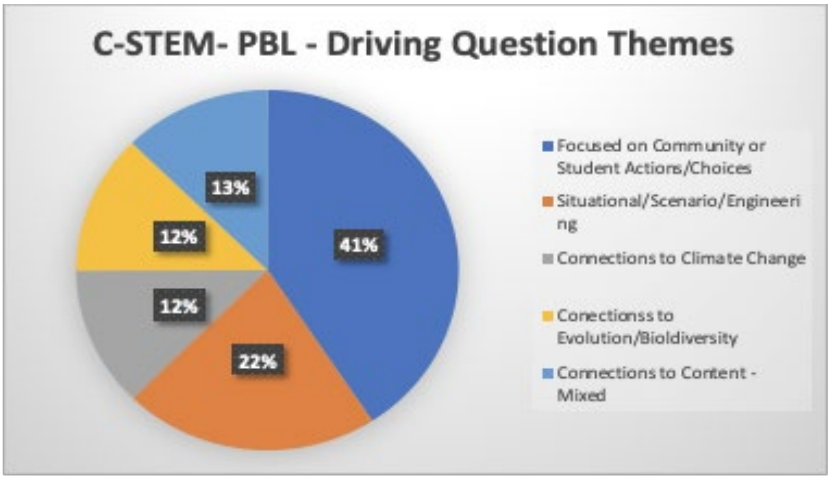


FIGURE 1B
THE AUDIENCE FOR THE C-STEM-PBL

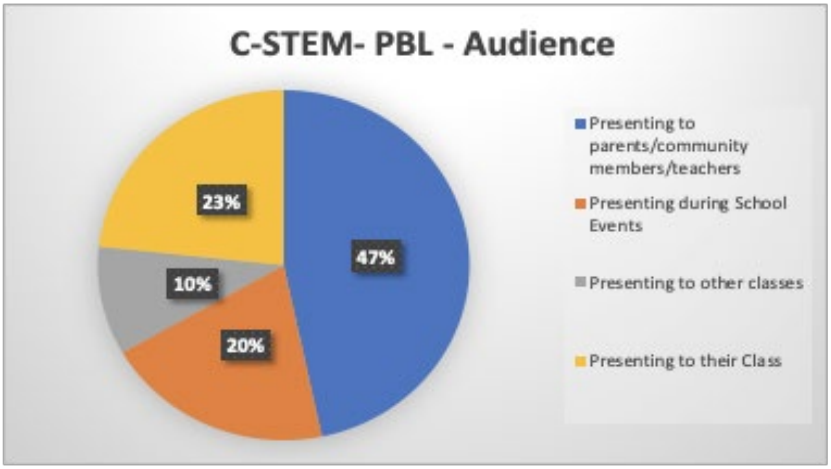


FIGURE 1C
HOW PRE-SERVICE TEACHERS ENGAGED COMMUNITY AND FAMILIES

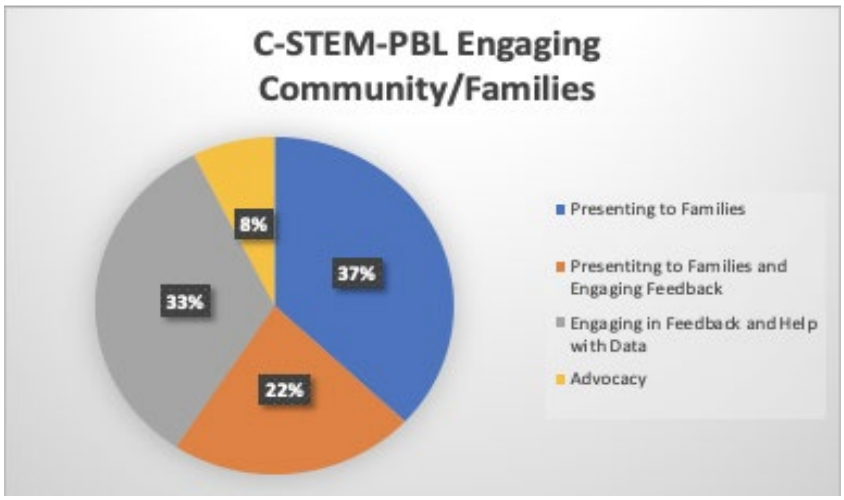
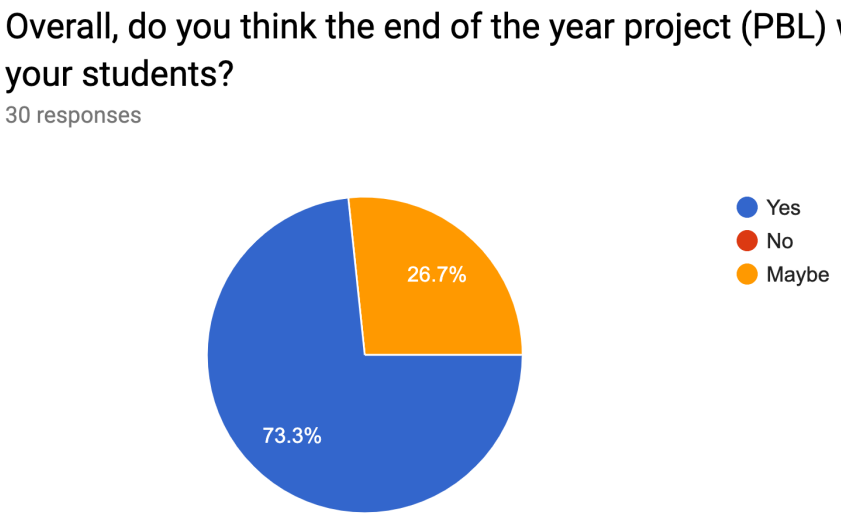
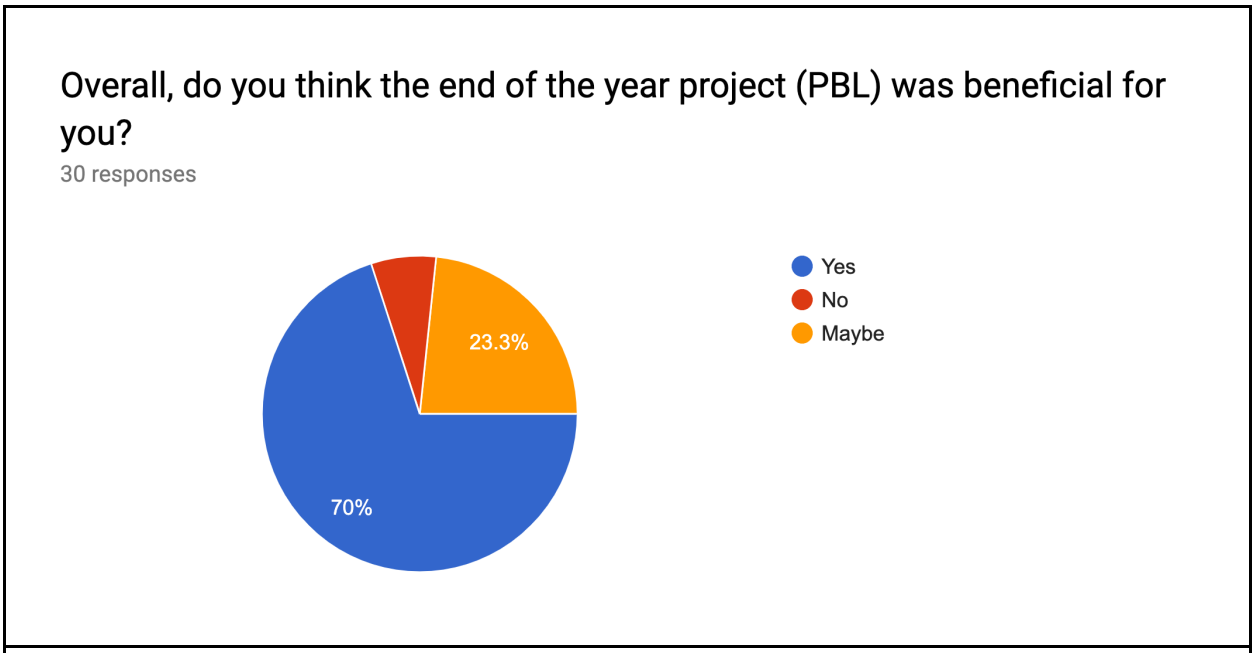
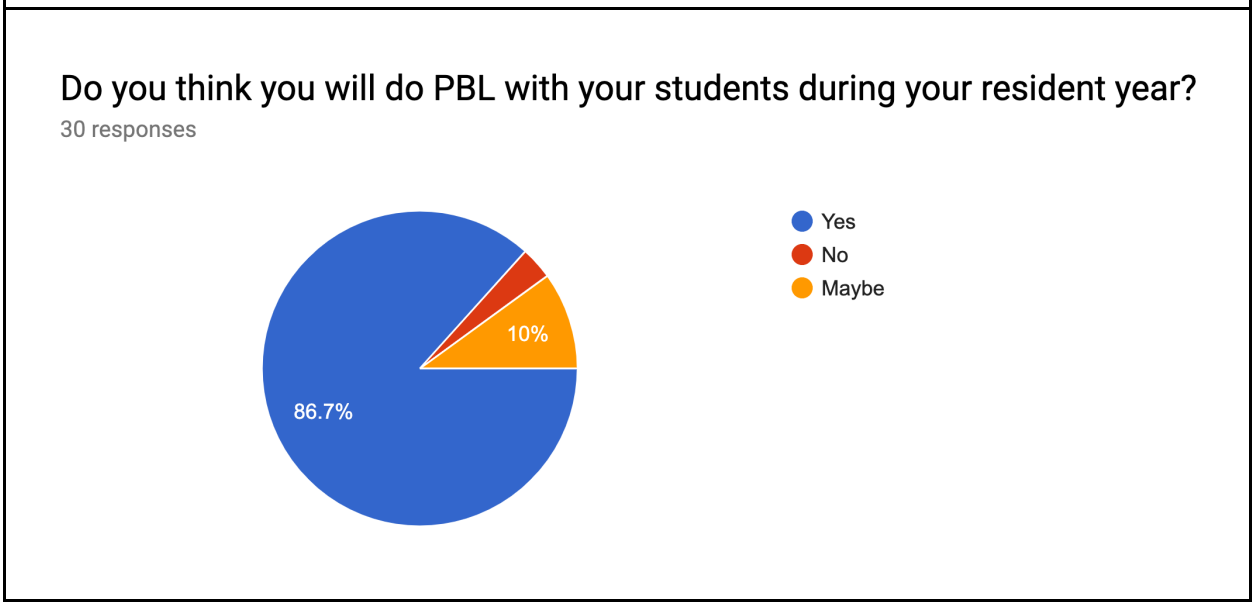


FIGURE 2A, 2B & 2C

2a. Overall, do you think the end of the year project (PBL) was beneficial for your students?

2b. Overall, do you think the end of the year project (PBL) was beneficial for you?



2c. Do you think you will do PBL with your students during your resident year?



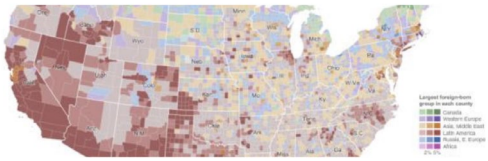
Figures 2a, 2b, 2c. Figure 2a depicts pre-service teacher responses to the perceived benefits of implementing PBL for k-12 students. Figure 2b depicts pre-service teacher responses to the perceived benefits of implementing PBL for themselves. Figure 2c depicts pre-service teacher responses if they would implement PBL the following year as first year teachers.

TABLE 1
PRE-SERVICE TEACHER REFLECTIONS ON PBL, STUDENTS, AND SOCIAL JUSTICE TEACHER IDENTITY

The driving question, reflection responses, and student work artifacts are depicted. These examples are characterized by more authentic connections to the community and/or families. For S5, student artifacts were not included due to identifiable images of k-12 students.

Questions			
What was your biggest worry/need as you began this assignment?	**What surprised and/or challenged you about implementing/planning the PBL?**	**What do you feel your students learned and what might you modify? Why?**	**What have you learned about yourself as a social justice educator during the planning and implementation phases of this project?**
(S1) Driving Q: How can statistical inference help understand issues in our community we care about?			
Fitting it in at the end of the year.	Integrating instruction as the assignment unfolded was the hardest part. Creating a need for instruction along the way. My assignment ended up being more of an application of all that my students learned in class.	I feel like my students were able to apply what they knew to something they care about. That was the power of my PBL. In terms of skills, my students learned a lot about writing about statistics and the writing process. I would try to do smaller PBL assignments the whole semester. I wish i scaffolded the writing a bit more. I wish i structured the time a little more rigidly.	This project reminded me of why i entered teaching. It was exactly what i hoped teaching would be like. I want todo more and more PBL. As much as i can fit in while addressing content and can plan with out going insane.

STEM VS NON-STEM: A study of wages and unemployment between majors



Immigrants Do Not Harm Our Communities. Can We See Immigrants As Assets Now and In The Future?

DO MALE DOMINATED MAJORS MAKE MORE MONEY THAN FEMALE DOMINATED MAJORS?

DOES ATTENDING A HIGH SCHOOL WITH 70% OR MORE BLACK AND LATINO STUDENTS INCREASE THE LIKELIHOOD OF DROPPING OUT IN...

Too Social to Sleep: Does socializing and doing homework cause more or less sleep?

Student work in https://medium.com/@lsutcher

(S2) Driving Q: How can people make better choices to live healthier lives?			
How to fit this project into an already overloaded curriculum map. I had already planned out what we were doing for the entire spring and moving it around would be a huge effort.	It was very challenging to me having the PBL embedded into the entire curriculum, I felt like I didn't do a good job of making it clear that each lesson was giving them a piece to the PBL project puzzle	I would modify how much time I spent on each topic to give more time to healthy relationships or remove it as a possible topic to choose if i dont teach it enough. I would also include a few activities/lessons on critical media literacy to on ramp the making of PSA's as media.	A major takeaway I have is you need to create the product on your own as a teacher before you try to implement it because otherwise you wont have a clear idea of what you need to do.

Coming Out PSA

We all fall on a spectrum. As we know more about ourselves, our place on the spectrum may change. "Coming Out" is telling people that you are LGBTQ+ (Lesbian, Gay, Bi, Trans, Queer, and more)

Why does this topic matter?

-We are all human we should be able to express ourselves freely
-Everyone's life matters, including their sexuality
-Whoever they love doesn't affect you at all, love is love ❤
-Their gender identity doesn't affect you either. It's their life
-500,000 LGBTQ +lives attempt suicide each year

Advice

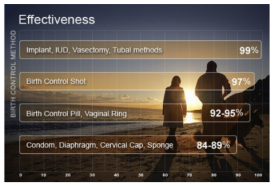
-Plan out what you will say
-Get ready for questions
-Try to be as calm as possible
-Don't do it abruptly so they aren't confused
-Ask a friend for help (someone who has come out before)
-Make sure you won't get hurt by it, go to a safe place :)

Safe Sex

By Kevin A , Joshua F, Kenshin V

Did you know, having sex can lead to unplanned pregnancy & getting Sexually Transmitted Infections(STIs)? But there are things that can help,called contraceptive like condoms to block the sperm to going in the female genitals and also protects from STIs.

Chart of how ------> effective different contraceptives are for birth control



STIs

People with STIs can also go to doctors to have check up to see if they have STIs. STIs can be slowed down and might be cured. But some cannot be cured and if left unchecked it can damage your body.

Unplanned Pregnancy

Having sex without a condom can sometimes lead to unplanned pregnancy but this can be slowed down or stopped like using birth control pills can slow it down or abortion which takes the ovum or zygote out of the female organism so it wouldn't grow into a baby.

(S4) Driving Q: How can we use Geometry to help solve the needs of our community?

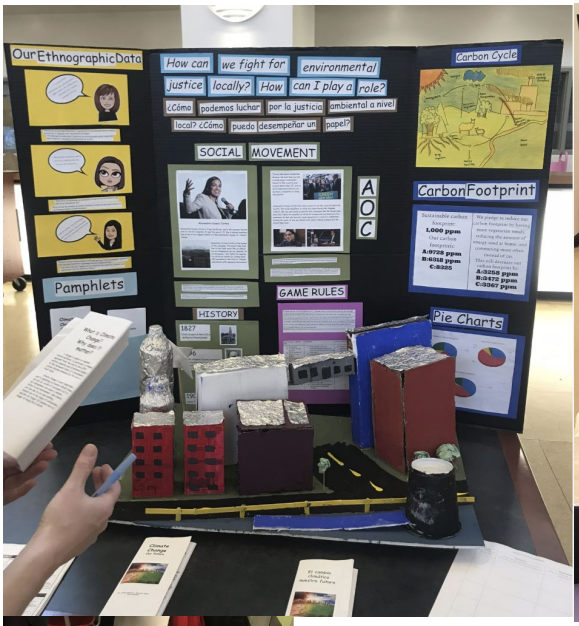
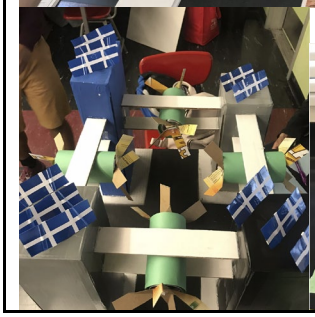
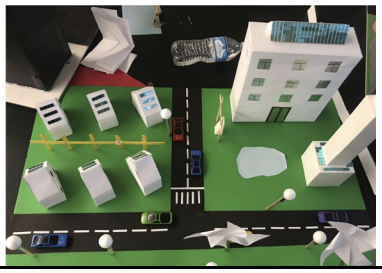
My biggest worry as I began this assignment was that students would not be interested or would find the assignment difficult and therefore not do it.	What surprised me about implementing my PBL was how excited students were to actually do the assignment one they began. What I found challenging was motivating my students to do and calculate the math aspect behind this project.	I feel like my students learned how Geometry can be used to solve real world problems within their community. Since they love art they also got to understand how math can be used in art. Students said they like the project, but wished they had more time because they felt rushed.	That it might take awhile and lots of planning, but the end result is worth it. Students actually enjoyed going out in their community and learning how to apply their mathematics knowledge.

Plan parenthood shelter

Floorplanner (living room)

Images of my room digital 3D model

(S5) Driving Q: How do GMO's affect our food, our community, and our environment?			
PBL is a big project and I think it was hard to implement PBL without exposure in both fall and winter quarters. PBL requires different skills (research, social, planning, etc.) and it would have progressed better if I focused on these skills with PBL as the final assessment in mind.	I enjoyed how PBL check-in's were a form of assessment. Also, sharing the check-in dates and requirements to the students allowed them to easily reach these goals.	Students learned how to apply their learning by creating an action plan. Students have experience in collecting and analyzing data/evidence. However, PBL took their learning a step further and encouraged them to create a solution that can address what they found in the analysis.	The planning stage was difficult because we created an interdisciplinary PBL project at UCLACS. It was difficult to find where Geography and Biology overlap but we finally decided on GMO's and globalization. In terms of social justice, PBL implementation allowed me to be very explicit in how science can be a tool to explain and address social inequities and injustices in the community and in the world.
(S6) Driving Q: How can we reduce our carbon footprint?			
My biggest worry was the students' being able to meet the deadlines I was going to set because I hadn't been very consistent about making them meet deadlines before this project. They	What surprised me was how helpful it was to plan and set the deadlines before the project even started. I think it definitely reduced my stress and I could use	I think my students learned what the carbon cycle was, what carbon is, how human impact affects the carbon cycle, how the carbon cycle plays a role in climate	Students really appreciated me consistently checking in and making sure they were on track or had all the time they need. They were also really grateful that we didn't add on any

definitely had gotten used to being able to make up work but I was intentional about making it clear that the deadlines had to be met if they were to finish their final project on time with as little stress as possible.	it to hold them accountable. It was challenging that it was a interdisciplinary project because the history teacher gave them SOO much work & I think it affected the quality of the work they did for our side of the project. They were really overwhelmed.	change, and what they can do to reduce their carbon footprint. I would want to include more chemistry concepts that are more specific and that they would have to understand to show us that their learning from the year. Specifically about the chemical reaction combustion, gas laws, kinetic molecular theory.	extra work or concepts as they were trying to finish up the project the last few weeks.
			
			

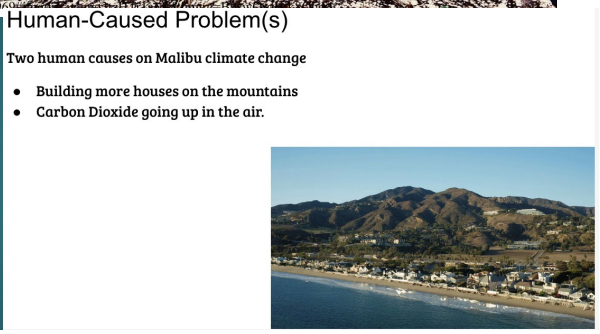
(S7) Driving Q: What can we do to mitigate climate change?			
I was concerned about the community involvement aspect because my students are not that involved in their communities yet, nor are their parents very involved.	I was so surprised by how much my students enjoyed doing the PBL! They wanted to do more and take on the biggest challenges.	I think my students learned how to proactively plan their own projects and pace themselves. I think they learned how to reach out to community members as well.	I have learned that I can talk on and on about the importance of thinking of the environment. I gave a lot of background on this topic and really scaffolded this for my students and learned that not all students will be aware of the problem from the start.
 	HELP MAKE THE WORLD A BETTER PLACE FOR YOU, ME AND ALL FUTURE GENERATIONS FIGHTING WATER POLLUTION		
(S8) Driving Q:What changes can we make to our lifestyle to limit negative anthropogenic effects affecting our oceans?			
Since I created my PBL as a project for the entire unit, I was worried that my students would lose interest in the project since it stretched over the course of SIX weeks.	I made a project management log for the project, so that students can be responsible for small pieces of the project and keep each other in check. Yet, there were many times where students came up to me and complained how they did not receive a grade for a section because their group-mate did not complete	My students now have a greater understanding for the importance of clean water, and the role of different bodies of water in Los Angeles. I plan to show the next group examples of each part. Additionally, although every part of the project was public throughout the process, I will show students how to	Localizing the project really helps with motivation and engagement. It is important to share with students reliable sources for information and realistic actions they can do to benefit themselves and society.

	it. I wish I knew resources to share with students to contact and communicate with their peers? Maybe giving them time to communicate with each other? I don't know...	access others' project to self evaluate and give each other feedback.	

S(9) Driving Q: How do humans affect biodiversity?

One challenge was pacing/fitting the project into the busy spring schedule. Another worry was the parent/community involvement aspect. My guiding teacher and I haven't been in the practice of sharing work with parents except for during open houses and parent conferences, so I'm	Timing was a challenge. Students got really fired up about the project the first day, but I think they needed more time to actually work through it. I was also challenged to think about how the project could be more community-based. The assignment was	I focused on having students develop group norms at the beginning of the project. I think this was a positive learning experience as group members were more accountable to each other. I would scaffold the technology piece of the project more. I	I am seeing how feasible it is to connect science topics to social justice. With this project, there were many connections between human-caused impacts (climate change/habitat loss/overpopulation) and social justice. However, I also see how social justice can be implemented in many

thinking about how next year I can put these structures in place from the start so that sharing student work with parents is more routine.	to research a human-caused impact on ecosystems, and I encouraged students to research areas in the community but did not require it. Some groups did, and some groups chose to research areas from their home countries. Many decided on other areas, but I think this was okay as it provided a great range of content.	encouraged groups to use alternative media. Some did videos, wrote poems, etc but most went with Google slides. Perhaps more scaffolding of specific technologies would have encouraged them to use other tools.	other ways besides the actual content. The ways I differentiate, group students, develop norms, and support their research skills are also parts of being a social justice educator.



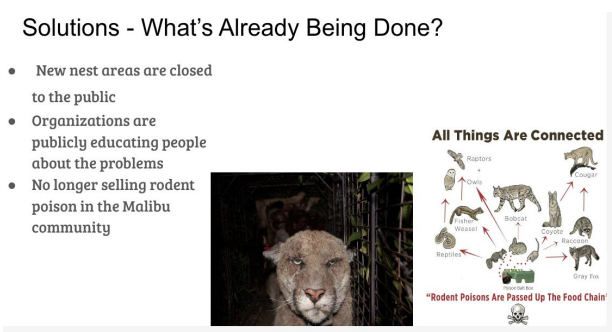


TABLE 2
C-STEM- PBL DRIVING QUESTIONS, AUDIENCE AND COMMUNITY ENGAGEMENT

C-STEM - PBL Driving Questions	
Math	**Science**
Focused on Community or Student Actions/Choices (20%) 1. How can we use Geometry to help solve the needs of our community? 2. How can statistical inference help understand issues in our community we care about? 3. How can we utilize quadratics to enhance product design and develop informed decisions? 4. How can we use surveys to analyze an effect of a single event on another?; Students will be creating their own driving question based on their survey question. 5. How are functions represented in my community? 6. Where can I find a parabola in real life? **Situational/Scenario/Build: (10%)**	**Focused on Community or Student Actions/Choices: (23.3%) - Math and Science together - 43.3%** 1. How does where you live affect how you live? 2. How can we reduce our carbon footprint? (Alexa) 3. How do GMO's affect our food, our community, and our environment? 4. How can people make better choices to live healthier lives? 5. What changes can we make to our lifestyle to limit negative anthropogenic effects affecting our oceans? **Situational/Scenario/Build: (13.3%) - Math and science together 23%** 1. How can we design a spaceship to safely explore space? 2. How can we design musical instruments to produce different sounds? 3. How can we apply the law of conservation of energy to create a thrilling roller coaster? 4. How can we design a functioning model of the digestive system that consumes food and produces feces? **Climate Change Leading: (13.3%)** 1. What are solutions for climate change? 2. What characteristics and adaptations lead to the survival of species? How does global warming/ human impact drive evolution? 3. How can species respond to climate change by evolving or going extinct? 4. What can we do to mitigate climate change? **Content: (26.6%)** **1. Evolution/Biodiversity as a focus: (13.3%)** 1. How can evolution help organisms adapt to different ecosystems? 2. What are the effects of evolution on different species and on humans?

1. How can we save the most money? 2. How can we get the most food with our budget? 3. How can we find the equation of a parabola whose graph, when plotted, matches our picture?	3. How do humans affect biodiversity? 4. What causes changes in ecosystems that will ultimately affect populations evolution? **2. General -** motion, body and chemical structures **(13.3%)** 1. How can we use household items to research atomic structure, chemical bonding, and chemical reactions? 2. How will the transformation of energy impact a marble as it travels through a rolling ball sculpture? 3. How does an electric motor work? 4. How does the human body work?

Ways Pre-Service Math and Science Teachers Engage Community

Audience:

Presenting to parents/community members/teachers: (46.7%)

1. Students will present in class to their peers, parents, and other staff members. Audience will fill out a feedback form for each presenter.
2. Classmates, Parents, Teachers, UCLA Professors
3. Fellow classmates. Potential recruitment of fellow teachers. Possibly contact outside staff related in astronomy.
4. Fellow classmates. Music teacher. Parents. Students can record and show a short demo of their musical instrument.
5. Students will present their train tracks and presentations to other teachers
6. Poster, Classmates, UCLA Business and Math Students
7. Students will present their product to invited community members, families, 9~12th grade students, staff, and other invited guests.
8. Present to the class, teachers, and other staff.
9. Present to the class, teachers, and other staff
10. Other teachers of the school, fellow student teachers
11. Community members (friends or family or social media post).
12. Students will present to their classmates and undergraduate students majoring in environmental studies at UCLA (need active roles) (who is giving feedback?
13. Classmates and faculty members will be present at the presentations of 3D models.
14. Publications will be shared within the classroom as well as with adults from the school.

Presenting during School Events (Open House/Exhibition) (20%)

1. Parents will see and hear their child's instrument at Open House.
2. Parents, Family, Peers at HTMMA's Exhibition Night
3. Fellow Classmates, Teachers (English, Geography, and Biology), Parents during Open House
4. Parents for back to school/parent night and their own classmates, as well as their communities if they choose to do so
5. Students will present their findings in class and will post their PSAs to a larger audience, depending on the type of media they create. For example, if it's a social media post, they can share it on Schoology or on their social media. If they create a poster or policy proposal they will hang it in the school hallway.
6. Published article and community member comments

Presenting to other classes (10%)

1. Students will present to freshman pathways class
2. Students will present to others in the class
3. Pathways Presentation

Presenting to Class (23.3%)

1. Classmates
2. Student videos will be projected in class for critique
3. Groups are presenting in front of the class while students write down what they understand and the questions they have about that body system.
4. Students will present in front of the class, other teachers, and attending parents.
5. Present in front of the class.
6. Classroom Presentations
7. Students will present their roller coaster to the class and to the "board of directors" (Guiding teacher and I)

Engaging Family/Community:

Presenting: (37%)

1. Students will have opportunity to present to a family/ friend members and be able to have feedback from their family/friends.
2. Parents will be potential audience members for these presentations.
3. Exhibition Night
4. Family & Friends during open house
5. Students can present to their parents at one of the parent conferences
6. Parents will be seeing students' models at Open House
7. Parents will be invited to the presentations of the new species.
8. Invited into the classroom to view presentations
9. Students will be sharing their PSA with their friends and families, including their parents.
10. Parents in the parent center will also be invited to the presentations.

Presenting and/or Feedback: (22.2%)

1. Have parents give feedback on student explanation and presentation
2. Students can practice their sales pitch to their parents.
3. Parents will have a conversation with their student(s) about the needs in their community. Come to student presentations. Parents will sign project information page.
4. Parents will be asked to look over students' presentations and give feedback. They will also be invited on presentation day.
5. Parents from the parent center will be present in the audience of presentations.
6. Parents aware of deadlines. Projects presented during the next open house.

Feedback and Help with data -sometimes tied to presenting: (33.3%)

1. Gathering or looking up restaurant menus
2. Students will practice presentation with parent & give feedback. Parents are helping students collect recyclables from home for their city build and will be helping students answer questions about their home when calculating their carbon footprint will be invited to Presentation Day.
3. Students may talk to parents about ideas for objects. Parents may drive students to places to find objects
4. Student families will be invited to the presentation. In addition, students are encouraged to learn more about GMO farming by interviewing relatives with farming experience.
5. Parents can help students over break to create their media and do research as well as be their community member interview if the students choose that.
6. Students will be encouraged to talk with their parents when choosing an area to research, and to use parents/siblings/community members as primary sources (via interviews). PSAs will be shared with parents at next CHALC.
7. Parents are encouraged to help students design and build roller coaster. Parents are also encouraged to attend presentations and serve on "board of directors"
8. Parents commenting on the published stories
9. Parents are encouraged to support students with supplies to construct models, students are asked

to present videos to parents.

Advocacy: (7.4%)

1. Students can advocate for better lifestyle choices to their parents
2. They teach their parents and incorporate something they learn from class to limit their negative effects to the ocean at home.

Appendix A - Assignment Description

PBL: END OF THE YEAR PROJECT ASSIGNMENT

In one or both of the student teaching placements, pre-service teachers will plan and implement a C-STEM PBL (Project Based Learning) using elements of PBI (Project Based Instruction) gold criteria from the Buck Institute in an end of the year project. Preservice teachers will use this following book as a resource for planning and implementation:

Larmer, J., Ross, D., Merendollar, J.R. (2017) *Project Based Learning (PBL) Starter Kit* second edition. Buck Institute for Education.

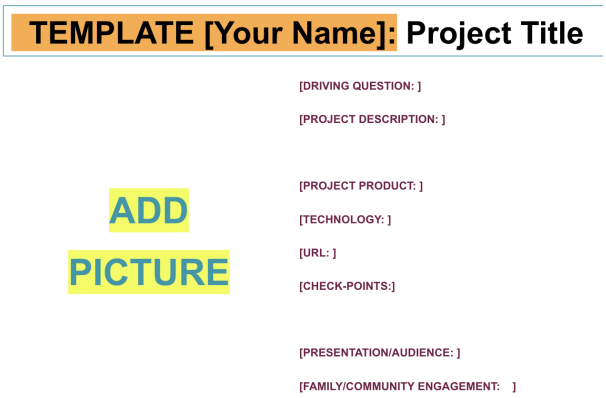
Your C-STEM-PBL Task should include the following components:

- Student presentation on culturally responsive and/or real life application topic to an audience
- Parents/family/community component
- Technology component
- Rubric and Feedback

Pre-service teachers will have opportunities in seminar to research, plan, edit, and present aspects of the project. Pre-service teachers will complete the Planning Sheets in the PBL Starter Kit Book. Pre-service teachers will upload artifacts and pictures throughout the quarter on Box and Classting.com

Pre-service teachers will submit final project description (planning template in the PBL Starter Kit book*), 3-5 student work artifacts, 10-minute video clip on student presentation, and reflection (using template provided) for a Passing Grade.

Appendix B- Planning - C - STEM-PBL Graphic Organizer



Appendix C - Reflection Questions

1. What was your biggest worry/need as you began this assignment?
2. What surprised and/or challenged you about implementing/planning the PBL?
3. What do you feel your students learned and what might you modify? Why?
4. What have you learned about yourself as a social justice educator during the planning and implementation phases of this project?

K-12 STEM teachers are essential to the critical analysis of real-world issues and can contribute to the democratization of our society, especially in urban contexts. We engage urban based pre-service STEM teachers in community focused STEM project-based learning (C-STEM-PBL). STEM teachers were challenged by time, scaffolds, and context in their implementation of C-STEM-PBL and noted increased interest and engagement by their students; further, C-STEM-PBL provided opportunities for intentional formative assessments. STEM teachers, through the STEM-PBL process, facilitated opportunities for K-12 students to connect STEM related issues to their personal and community experiences. This place based, high context approach creates opportunities for critical analysis; so, students might push against the injustices that affect the community.