FRAMING, REFRAMING, AND TEACHING: DESIGN DECISIONS BEFORE, DURING AND WITHIN A PROJECT-BASED UNIT

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This design case follows the instructional planning and decision making before and during a nine-week project-based unit co-taught by three of the authors at a not-for-profit charter high school in the American Southwest. The school serves students who have not been well served by traditional schooling. The teachers partner with industry professionals to create authentic learning projects. The project detailed in this design case aimed to have students design and test temporary shelters for people who were homeless, and later learn about semi-permanent shelters. Students consistently sought to design longer-term solutions to homelessness, rather than shorter-term solutions for individual homeless clients. An embedded researcher documented project implementation and design conversations—including formal planning prior to and emergent conversations during teaching. Analysis of these conversations reveals that many design decisions made prior to instruction were guided by learning objectives, constraints and opportunities, whereas those made during teaching practice were focused directly on supporting learning. Analysis also made clear that students played a role in steering the project to focus more on solutions to long-term homelessness; based on student interests, the final project included writing letters to government representatives about their ideas for solutions. The design case concludes with reflections by the teachers on the design decisions and attendant learning. This case helps to clarify how context and timing influenced design decisions and provides an exemplar of teacher-designed complex instruction, illustrating how learners might take part in reframing a problem about which they are learning.

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INTRODUCTION

Commonly, when researchers design with teachers, it is to advance a particular curricular agenda or theory of learning. This approach to designing instruction with teachers has surfaced a number of challenges. Teachers may struggle to think like designers, in part because although lesson planning may be a component of pre-service teacher education, more robust forms of instructional designing seldom are (Bencze & Hodson, 1999; Penuel & Gallagher, 2009). Teachers may design based on curricular standards, omitting problem analysis and evaluation (Hoogveld, Paas, Jochems, & Van Merriënboer, 2002). Teachers also tend to make design decisions grounded in their practice-based experiences, rather than on theory or data (Roschelle & Penuel, 2006); this can present a challenge when there is a mismatch between the teacher's experiences and the goals of the researchers. Yet, this same practice-based experience and understanding of context is valuable in designing (Keys & Bryan, 2001; Luehmann, 2002). Thus, some challenges could be seen as stemming from power imbalances between researchers interested in advancing a particular curricular vision and the teachers who are responsible for implementation. In this scenario, the success of educational innovations is seen to be in the hands and on the shoulders of the teachers implementing them (Barab & Luehmann, 2003; Keys & Bryan, 2001).

Others have investigated teachers' instructional decision making as designing, viewing teachers *as* designers (Brown & Edelson, 2003; Clandinin & Connelly, 1992; Schön, 1983, 1987; Svihla, Reeve, Sagy, & Kali, 2015). Here, teachers make myriad design decisions within instruction, adapting previously designed materials to address emergent needs. In many cases, they design their own lesson or unit plans.

Yet, little is known about the kinds of design work teachers *choose* to engage in, especially at schools where they design most or all of the curriculum. Little is known, for instance, about the impact on teacher learning and practice when designing extended project-based units (Thomas, 2000). This design case documents such a project, following the origins, planning, implementation and evaluation of a nine-week project-based unit on homelessness.

CONTEXT

The setting for this design case is a public, not-for-profit charter high school that carries a social justice mission of serving students who have been poorly served by traditional schools. Most students come from low-income homes, are Latino/a, and are off-track to graduation. A day program serves students who have transferred or matriculated from other schools and an evening program re-engages adults (aged 18-24) who have previously dropped out of school. The school partners with industry professionals, primarily from construction and architecture, to ensure students are

learning curricular standards through industry-relevant projects. Projects are co-taught by two to four teachers over 12 weeks, beginning with a "groundbreaker" and culminating in a public exhibition of student work.

This design case follows an abbreviated nine-week project, Waste Land II, in trimester two. The project was co-taught by three of the authors—two teachers (Mr. Lane and Mr. Field, abbreviated as Mr. L and Mr. F) and an embedded researcher (Dr. Svihla, abbreviated as Dr. S). A student teacher also helped teach the project. Teachers at this school design and implement their own projects. They commonly collaborate with industry professionals and community partners to create projects that engage the community and authentically reflect industry practice. The teachers have a three-week professional development session during the summer and week-long professional development sessions between trimesters to provide time for designing, as well as time during the week to refine their designs. Ideas often emerge during informal conversations and/or during brainstorming sessions.

Rather than allowing curricular standards or specific disciplines (e.g., art, chemistry) to drive project design, teachers are encouraged to create industry-relevant projects that are likely to engage the students they serve. Only once a project has been conceptualized are teachers asked to identify curricular standards that will be addressed.

We describe the origins of the project idea, design work leading to its enactment, redesigning that occurred during implementation—both during teaching and outside of class time, and detail some of the designed learning experiences. We conclude with reflections on how the design process unfolded and differentiate between design decisions made during enactment and those made before or after enactment.

Teacher Voices in a Research Study

The design case was documented as part of a larger research project. Our purpose here is not to argue *whether* teachers can design, but rather to bring their designerly voices and choices forward. Because the research study aimed to document many aspects of the school culture and practices, we have a very rich record to draw upon to depict how we designed.

The embedded researcher and three other researchers documented design work and implementation through audio and video recording and photographs. Design conversations that occurred in the mornings prior to instruction, as well as those that occurred spontaneously during instruction were audio recorded. The teachers were interviewed individually about their design decisions as a means to triangulate where real-time documents were not available (Smith, 2010). This

provides a window into their perceptions and memories of designing.

We present transcripts from design conversations, teaching practice, and interviews to reconstruct the design case through the teacher voices. The embedded researcher was a participant observer, meaning she co-designed and co-taught with the teachers to gain an emic perspective of their work.

Who is a Designer in this Context?

We present the design of *experiences* in a project-based school that typically engages students in learning to design. When considering the design work that occurred prior to the project being implemented, it is clear who the designers were: two teachers and an embedded researcher. Once the project began, however, the answer to “who is a designer” became less clear. When we made the design decision to engage students in framing the problem, and when we then honored the students’ reframing of the problem, the students became co-designers of the experiences. Our focus here is on how we designed the experiences, rather than analyzing student learning of designing. Yet, we note that the students learning to design influenced our design decisions.

ORIGINS OF PROJECT WASTE LAND II: UPCYCLING WASTE

The design was first inspired by an upcycling project the evening teachers were planning for trimester one, in which they made lawn furniture for community members by upcycling waste. Mr. F recalls during summer professional development “everyone was brainstorming what sort of projects they wanted to do.” As the evening teacher and Mr. L discussed it, Mr. F “wandered over and was like, ‘Ah! I wanna do that.’”

Mr. F and Mr. L considered doing the same project as the evening teachers. According to Mr. L, it “diverged from there” into Waste Land I, a study of recycling focused on “Do we really have a problem with waste? If we do what is it? What can we do about it?” They investigated the mathematics of how many water bottles were thrown away each day (volume of whole versus compacted water bottles) and history (e.g., waste reuse during World War II to make battleships).

In their search for materials and ideas for Waste Land I, they came across resources that inspired them to do another project (Waste Land II). Mr. F recalls finding a documentary about a landfill in Brazil and the people who live and work in it, salvaging recyclables from the refuse (Muniz, 2010). He explained this was the “the seed that started” the project, intended to focus on upcycling waste materials into living spaces.

Mr. L recalled learning about an architect “who was coming up with, uh, designs for people living in *la maquiladora* or a slum could, um, you know, use, use scrap material. [...] His vision is to give them designs where, to provide designs where people can build something and they don’t need any equipment or heavy machinery” (Cruz, 2010). Trimester one wasn’t long enough to include all of the interesting ideas and materials they found; thus, Mr. L and Mr. F decided to do a similar project—Waste Land II—in trimester two.

DESIGN DECISIONS MADE BEFORE WASTE LAND II BEGAN

Dr. S joined the team during the planning week preceding trimester two, and soon became engaged in ideation. One week before the project was set to begin, *Waste Land II* included three phases: homelessness, slums, and high-end housing made from shipping containers, with upcycling as the main focus across phases. We present excerpts from one of our design conversations in which key decisions were made:

- Narrowing the focus to homelessness and slums
- Reframing an interview as a *needs assessment*

The design conversation was ideational, surfacing many possible ideas for the project (see Figure 1), only a few of which ended up in the project as implemented. We will refer back to this conversation throughout the paper as the *early, ideational design conversation*. In this 45-minute audio-recorded conversation, Mr. L and Mr. F explained their plans for the project.

Mr. F:	What do you do if you’re homeless? So that’s gonna be like—our groundbreaker is, “Well, you don’t have money, you don’t have a place to stay, so how’re you gonna problem solve that?”
Mr. L:	Where’re you gonna sleep tonight?
Mr. F:	Where’re you gonna sleep tonight?
Mr. L:	In [our city] and in January.

Mr. L explained the project would include a focus on government, guided by a sub-question, “Where *can* you sleep?” He expanded on this, “What’s property law? Who controls what land, right? Who has jurisdiction?” This explanation suggests—even at this point, the focus of the project had already shifted away from the upcycling theme, though it was still present.

FIGURE 1. A depiction of parts of the early ideational design conversation focused on content. The conversation began with the introduction of the driving question, shown in the upper left. The colored bars indicate approximate number of speaking turns for each topic. Gaps are present, indicating times when the conversation focused on ways to support learning or ways to engage students in designing. Color indicates speaker. An asterisk indicates the idea was intended to be in the project, when the project began. A minus sign indicates the idea was omitted after the project began. A plus sign indicates an idea that was added after the project began. Thus, when the project was reframed from focusing on temporary solutions (where to sleep tonight) to longer-term solutions (to homelessness), some ideas were omitted and others added.

As the conversation continued, we discussed the other foci: slums and high-end upcycled housing made from shipping containers (see Figure 1). For example, we discussed the boutique shops and hip cafes that are being built in various cities using upcycled shipping containers. The government focus on jurisdiction made sense with building temporary shelters and slums, but was less clear for high-end upcycled housing.

In the transcripts, we have used a few conventions to better convey the tone and cadence of the conversation:

- A WORD in all capital letters indicates that it was spoken in a loud voice. Capital letters used WITHin a word indicate that a syllable was spoken in a loud voice, but the rest of the word was not.
- A wo:::rd with colons indicates the sound was drawn out
- // indicates overlapping talk
- (.) indicates a noticeable pause
- [...] indicates an omission or edit for clarity

Narrowing the Focus

A bit later in the discussion, Mr. L raised the concern that three foci might be too much. Collectively, we struggled to find common ground for the three foci.

- Mr. L:** I don't know, I mean, I don't know if it's too big, you know?
- Dr. S:** So, one way to//
- Mr. L:** //with ten weeks, is this too much, you know?
- Dr. S:** One way to narrow it would be to think about, you know, housing for, uh, homeless and for, um, eh::h high density, 'cause like slums and shipping containers, you know, whether you're talking about like rich people or Japan or whatever//
- Mr. L:** //It's high density.

High density housing, while it linked the three foci, did not seem to be an inspiring theme, and didn't fit well with the ideas of jurisdiction, or even the driving question, "Where are you gonna sleep tonight?" We continued to seek ways to fit the three together.

Dr. S: They're small living spaces.

Mr. F: Yeah.

Dr. S: For, you know (.)

Mr. L: And they're all—they have that in common.

Dr. S: And social extremes, to some extent.

Mr. F: That's//

Mr. L: //construction from waste for populations, underserved populations and populations in high density areas

Dr. S: Yeah.

Mr. L: And I guess, is this, are those three products, are those too much in 10 weeks?

Mr. F: I think we'll find out right about week—as we found out—as we always find out, you know, you have lofty aspirations and it takes them//

Dr. S: //Yeah.

Mr. F: Three times as long as you anticipate.

Dr. S: Well, taking [upcycled housing] out brings these two together more.

Mr. L: It does, yeah.

Mr. F: Mmhmm

Dr. S: Uh, 'cause this, but, you know, there's some amazing designs, right?

Mr. L: But this could also be a whole other project.

Mr. F: It could, absolutely. Or I mean, or it could just be a sample as we're looking at the slums sorta situation. Well, would a shipping container be a viable option for that, 'cause they're stackable, they're compact. Well, let's look at some designs. So that could even be like a mini lesson.

In an interview after the project was implemented, Mr. L recalled “pretty quickly we decided that two was more than enough and the shipping container [problem] was, uh, really not connected to the others as much because both of the others were connected to kind of a social justice issue.” While this decision did come early in the early ideational design conversation, the decision remained tentative, as if we were reluctant to abandon the “amazing designs” that had been part of the original concept.

Mr. L explained that when designing, he considers “whether or not the topic seems to be something that’s provocative for kids.” Only then does he begin thinking about the content and how it can be portioned into sub-problems. In this case, finding “architects and designers who are serving

an underserved community kind of gave us a little bit of purchase on a—a concept.”

Once the decision to omit the upcycled housing focus was broached, we were able to delve more deeply into the government aspect of the project.

Mr. L: And then, in each case then, we're, some of our content will be causes [of homelessness], right?

Dr. S: Mmhmm

Mr. L: What, what are the—where do we find these places in the world? Why do we find them in the places we find them? What causes that? What causes this in America? What causes this around the world?

Dr. S: Mmhmm

Mr. L: And, uh::hh, you know, and maybe, maybe along with this sort of government content we're talking about, um, solutions right? Not only just how does government play a role in where can you sleep tonight, right, but how does the government play or not play a role in trying to solve the problem?

This led Mr. L to explore the role of government, asking “Is that an appropriate role for government to play or not?” as a provocation for the students. As we continued to bring new ideas into play, Mr. L became increasingly comfortable with the narrowed but deepened focus.

Mr. L: I think the scenario is a winner, right. It's like, imagine//

Dr. S: //yeah//

Mr. L: Imagine, this is you.

Mr. F: You've gotta find a place to live.

Mr. L: There you go.

Dr. S: Yeah.

Mr. L: And maybe it's not just you. Maybe it's your family.

As we ideated possible topics for students to explore within this focus, we discussed policies in other states: a policy in Utah provides homes for the homeless; various pieces of anti-homeless legislation have passed in cities like San Francisco. Mr. L reflected on the new ideas we were adding to the project, “There is a lot of material that we can cover, for sure, but I think it's, I think it's—what's really cool about it, is most of the content that we can introduce here is pretty

easy to make it engaging, because it's so directly connected." This was the issue with the upcycled housing concept—not that it was too much, but rather that it was not well connected to the other concepts—at least not by “something that's provocative for kids.”

Mr. L further considered the government content, including differences in political philosophies, asking “Where do people come from and how does that translate into their idea about what is an appropriate role for government?” He explained this would depend on the political philosophy one holds. He recognized this as central to understanding government.

Mr. L: So that's a real fundamental governmental question that frames the whole project.

Dr. S: Mmhmm

Mr. L: You know, kind of like, like before you get to the question, 'What should we do about it,' you ask the question, 'Should we do anything?'

Mr. F: SHOULD we do A::N::Ything

Mr. L: And it's a //

Mr. F: //about it?//

Mr. L: //different question, right? You know, individually, what YOU wanna do about it, that's fine, but as a society, should we//

Dr. S: //Yeah//

Mr. L: //cooperate as a society? And that's just government in a nutshell. A society cooperating to solve a problem or not.

By making the decision to move from upcycling as the common thread across weakly-related topics, we were able to shift the project to include a fundamental understanding of government. This occurred near the very end of the early ideational design conversation (see Figure 1).

Shifting Interviews from Gathering Feedback to Assessing Needs

After introducing the project, Mr. L explained that students would design a temporary shelter made from waste and then interview someone from a homeless shelter to get feedback. The interview was conceived as an opportunity for evaluating design solutions. We planned to work with a local day shelter, where students would interview clients who were homeless. Dr. S introduced the idea of a needs assessment.

Dr. S: And what are the needs? I mean having them do that needs assessment to really think//

Mr. L: //Yeah//

Dr. S: // like, though, what are those needs? That might be part of the—you could have two interviews, you know. You could have an interview earlier to do a needs assessment or if you're a little worried you might just have a couple students do a needs assessment

Mr. L: Instead of an interview that gets right to 'Where do you sleep?' and 'What would you build?'

Dr. S posed topics for assessing client needs and the potential for this to influence students' design work.

Dr. S: So that when they're designing, they're really designing for their needs. They're thinking about, you know, is the bigger issue, um, staying warm? Is it staying hidden? Being camouflaged?

Mr. L: Exactly.

Mr. F: Oo::h, Nl::ce.

As Mr. L considered the potential of this idea—assessing needs—he spoke in affirming yet hesitant language, suggesting he was still considering its potential impact on the project, “That's a great idea, um, and, and we were sort of talking about, um, I mean, I guess—the thought I had when you were saying that is, it's gonna depend on who they are and what they are up to.” This hesitation indicates that he was contingently evaluating how needs assessment could fit in the project. Mr. L then suggested this would let students explore the *causes* of homelessness. Mr. F liked the idea of providing students with various client profiles to “get them really empathizing. I think empathy is hu::ge.” Dr. S connected this back to the purpose of needs assessment.

When discussing the products to be designed—scale models, full-size prototypes—and how to evaluate them, Mr. F revisited the idea of client needs.

Mr. F: So, I guess the prototype is gonna be really influenced by what their needs are and then maybe another sort of free write morning sorta situation would be like, well, here's what your needs are, now what are (.) you propose to address those needs.

Mr. L: Yeah.

Mr. F: Staying warm versus staying cool, versus having ventilation. Um, okay.

Mr. L: And then, and then not only what they are gonna stay in, but where're they gonna stay. So something that might come up in needs assessment is proximity to services.

Mr. F: Yeah.

Dr. S: Yeah.

Mr. L: To busses.

As we finalized the decision to have students assess needs, Mr. L presciently noted "I think they'll learn so much from the interviews, you know, that I think it'll probably take off in a lot of other directions that are hard to anticipate."

Linking the Project to Curricular Standards

Once a project is conceptualized, teachers at this school use the school's learning outcomes guide—which includes industry-relevant connections to the state standards—to choose learning outcomes. For Waste Land II, we identified the following:

- **WORLD/US HISTORY:** Use critical thinking skills to understand and communicate perspectives of individuals, groups and societies from multiple contexts.
- **ECONOMICS AND GOVERNMENT:** Analyze and evaluate how economic, political, cultural and social processes interact to shape patterns of human populations / natural systems and their interdependence, cooperation and conflict.
- **LANGUAGE ARTS: READING:** Determine the meaning of words and phrases as they are used in the text including figurative and connotative meanings.
- **LANGUAGE ARTS:** Listening and Speaking: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on other's ideas and expressing their own clearly and persuasively.

More broadly, because of the school's social justice mission to serve students who have been marginalized by traditional methods, projects also include aims to support professional skills, such as collaboration, communication and learning

how to work with clients. Thus, these also served as learning goals.

THE DESIGN, AS IMPLEMENTED

At the beginning of the project, the experiences planned for the first few weeks were clearly defined, and those in later weeks were loosely and openly planned. Early in the project, we introduced a design process model, inviting the students to define the problem. Doing so led the students to join the overall design process; by engaging them in learning to design, they reframed the problem, which we had narrowly cast as temporary solutions to homelessness. They reframed the problem as a social justice mission to solve homelessness more broadly. This changed many of the experiences, and we view the students as co-designers of the overall experience.

We illustrate the overall design as a sequence of time lines (see Figure 2). Each activity is mapped to the particular stage of design work it most supported, using the design process model that was given to the students in the first week. The design process model included defining the problem, collecting information, brainstorming, developing solutions, and getting feedback. We categorized each activity by its main purpose (e.g., collecting information) but many activities lead to multiple stages of designing (e.g., upon learning some new information, students might redefine the problem or begin brainstorming).

The first week of the project had an agile approach to designing, with a number of short activities that took students quickly through various design activities. Many of the topics discussed in the early ideational design conversation (see Figure 1) did not find their way into the project. This was partly to allow for greater depth of exploration of the topics that were covered, but was also in response to reframing of the problem by the students.

We next present an overview of the project, including samples of student work to illustrate the design, then contrast design decisions made during and outside of instructional time.

Defining the Problem

In the first minutes of Waste Land II, Mr. L introduced the students to the design problem, "The basic idea here is that we wanna focus on building with waste materials. [...] We're gonna be focused—focusing on designing stuff for people who maybe can't afford to buy anything, right? Who have no resources or very limited resources. How can they build something with stuff that they can just find or that they can just take?"

FIGURE 2. A depiction of Waste Land II, with the activities categorized into stages in the design model that was presented to students. Note that they are organized by the primary function, but in many cases served more than one function. For instance, activities that involved collecting information often led students to (re)define the problem.

Mr. L and Mr. F also helped the students understand their roles as designers, and specifically, how to design for a client.

Mr. L: What do you gotta think of as a designer? [...] Who are you designing for? A homeless person, right? So really, what we are looking at here//

Mr. F: // So, that's your client guys. So who is the client, right? You can't sit down and—you can start designing something, but until you know who you are building that for and what their specific needs are, you're gonna probably be pretty far off the mark as far as what your end product looks like, right? If you know these questions, maybe come up with questions to begin with, right, and use that to inform the design you create. What do you guys think, is that gonna end up being a better design or is your design gonna be worse.

Mr. L: So that means that step number one in this process is gonna be what we call a needs assessment.

there—that—it just gets the ideas flowing and you start coming up with better ideas. Yeah, so your goal, for the next little bit, in your groups is to come up with the worst possible solution you can imagine." Mr. L expanded on this, "We talked about needs assessment. So one way to approach this, is like, 'What do they NOT need?' [...] Or how can I make sure that I don't meet their needs?"

The students came up with a broad range of bad ideas (e.g., termite-infested tree house, pile of twigs in the middle of the road next to an active volcano) and voted on whose was the worst.

They then returned to sketching four possible designs, but as they did so, they reframed the problem, with many students including plans to address needs other than a place to sleep, such as a needle exchange, counseling, providing food and water, and even a way to carry family photos. We held a gallery walk in which students provided feedback to one another (see Figure 4).

Needs Assessment

A guest from a local day shelter talked to the students about challenges people who are homeless face. We asked her how we might help, and she suggested writing letters to

We asked the students to envision a client. After they spent time writing their ideas of what their client would need, Mr. F asked them to begin designing temporary shelters that could be made from waste, "rough sketches, right. Don't make this perfect because it's gonna go through a lot of transition, and updating, and—and using each others' input, as well as what we get from whoever it is we interview to make it different, make it better, right?"

Most of the students sketched simple box designs, similar to the one in Figure 3. This sketch, like many others, was modified to include wheels and other details as the students refined their design ideas.

Brainstorming

Because most of the students had initially sketched boxes, we wanted to get them to think out of the box, literally and figuratively. We decided to introduce *wrong theory*, an approach to designing where the designer deliberately creates something bad (Dadich, 2014).

Dr. S introduced wrong theory, "Sometimes when you come up with the worst possible idea—you really try to get a bad idea out

FIGURE 3. A student's early design, modified to include wheels and an opening.

FIGURE 4. Students' designs for temporary shelters.

FIGURE 5. Students created Venn diagrams to compare and contrast the experiences of Larry, Frank, and one other client they interviewed (names are pseudonyms).

FIGURE 6. Whole-class discussion identified themes from the interviews with clients who were homeless.

representatives. We prepared the students to interview their clients, refining their questions to ensure they were respectful and likely to help the students empathize with their clients. They conducted the interviews at the day shelter. Dr. S transcribed two interviews that students recorded (with permission) and we guided students to analyze these to identify needs (see Figures 5 and 6).

Collecting Information: Shelter Designs

We provided the students with images of 38 existing shelters and asked them to categorize them (see Figure 7). They chose four of these designs to evaluate, attending to the needs they had identified (see Figure 8).

FIGURE 7. One group's categorization of existing temporary shelter designs for a fake website.

FIGURE 8. One group's evaluation of an existing temporary shelter design.

Collecting Information: Jurisdiction & Laws

To bring the government aspect of the project into focus, we planned a series of activities on laws that affect those who are homeless and on jurisdiction. Many of these laws were discussed in the early ideational design conversation. Each student read about a different law, such as laws about food stamps, park benches, and camping. In a whole-class discussion, they described the law, how they thought it might affect someone who was homeless, and whether it was a federal, state, or city/municipal law (see Figure 9). They then applied this understanding to a larger set of laws (see Figure 10).

FIGURE 9. Whole class discussion of various laws affecting people who are homeless.

FIGURE 10. Mr. L guiding a student to classify various laws that affect those who are homeless according to jurisdiction.

Evaluating: Insulation Lab

We incorporated a relatively traditional science lab, taught by a student teacher as part of his preparation. Mr. L framed the lab to connect it to the project.

Mr. L: So you guys are gonna do your own experiment. You're gonna design your own insulation and test it and see how it works. So as you write in your journals here, you should start thinking about what kinds of insulation, what different types of insulation might be more effective for different types of heat. [...] So let me—let me ask a question. So if we're designing a shelter for someone to sleep in, in the winter, are we worried about inside the shelter? Are we trying to design something to keep the outside temperature from coming in? Or the inside temperature from going out?

The students were given waste materials (leaves, Styrofoam, bubble wrap, foil) to test as insulators (see Figure 11). They did not test individual materials, but rather created layers of materials and compared these to a control with no insulation. Their insulation designs were so effective—the ice took longer to melt than expected—they ran out of time to complete the lab.

At the end of the class, Mr. F again connected the activity to their designs.

FIGURE 11. Students' designs to test insulation properties.

Mr. F: What we're talking about now is your final product, okay. So it could be just a brainstorm. I don't need you to get specific with it right now, but start talking about, like, what materials might you start thinking of using that have insulative properties, right? [...] There're some people that woke up underneath a mountain of snow on Saturday morning. Think about it, man. See what you guys can come up with. That's gonna be your exit ticket. I need you guys to start talking about how you're gonna update, change your design and include some insulation.

Long Term Solutions for Varied Political Philosophies

We added a final product—a letter to a representative arguing for a long-term solution to homelessness. We introduced the students to political philosophies by having them take a quiz to determine their philosophies, which we graphed as a class (see Figure 12).

Students researched various solutions to homelessness proposed elsewhere, and discussed arguments that would convince people from different political philosophies to consider each solution. Students drafted letters, received feedback on them, and then revised them.

Concurrent to this, Dr. S facilitated a model slum building activity. Each pair had 25 minutes and limited supplies to build into a scale model (see Figure 13).

The activity was supplemented with a podcast about the Kowloon walled city, a former slum in Hong Kong. Students listened and drew pictures of what they imagined it might have looked like (see Figure 14). This was paired with discussion about the economic drivers of slums and poverty

FIGURE 12. Most students were centrist or statist.

FIGURE 13. Evolution of the model slum.

FIGURE 14. Students' drawings of Kowloon.

in general, which fed back into the letters the students were drafting about solutions to homelessness.

Getting Feedback at Exhibitions

The project culminated in a public exhibition of student work. Students showcased the letters they had written to representatives, the temporary shelters they had designed, and other pieces of work of which they felt proud (see Figure 15).

DESIGN DECISIONS MADE DURING THE PROJECT, OUTSIDE OF TEACHING TIME

A number of design decisions were made after the project began but outside of class time. Mr. F explained how such design decisions were made: "Instead of us just trying to force [the students] on a trajectory, we kind of let their engagement and, and their levels of interest sorta guide the project and we, we, you know, we have the oars, we're at the helm, but they may be the winds that—that push the

FIGURE 15. Students presenting their designs to judges at exhibitions.

sails. [...] Maybe we're the wind and they're at the helm." Mr. F's metaphor of helm and sails is an apt description of how students became co-designers of the experiences.

We often met in the morning prior to project time to refine the day's plan. The main design decisions made during the project included:

- minor timing and sequencing adjustments;
- omitting full-size temporary shelter designs and adding a letter to the representative about solutions to homelessness; and
- making the slum model asynchronous and shorter than was planned.

Timing and Sequencing

Decisions about timing and sequencing were often contemplated individually overnight and finalized in the morning before project time. The students' engagement and learning guided our planning and decision-making about how many days to sustain an activity. For instance, the evaluation of existing shelter designs was intended initially to be a much shorter activity, but when we saw that the categories they came up with largely focused on superficial features (e.g., dumpster, on the wall, in the woods; see Figure 7), we knew they were not really connecting these to the needs they had identified. By extending the activity to evaluate a subset of designs with "able" words (e.g., portable, affordable; see Figure 8), we helped them make this connection, achieving the intended learning outcome. Thus, student engagement guided decisions about timing and sequencing, a somewhat common phenomenon in teaching; however, student interest and engagement also steered the content of the project, a much less common phenomenon, particularly outside of project-based classrooms.

Omitting Full-size Temporary Shelter Designs to Make Room for the Letter

Originally, we had planned for students to test their designs by sleeping in them over night. This idea was presented to

the students, but never happened. Mr. F explained, "I think we were probably hindered a little bit by the fact that we didn't get as many materials as we would have needed. [...] It would have been a good idea to, I think, start from the beginning hoarding materials, although our building manager probably wouldn't be too stoked on that." However, more time spent building and refining designs meant less time to engage with some of the economics and government learning outcomes. Instead, we decided to have them create scale models and drawings, supplemented by a sample showing how they would insulate their shelter design. Their insulation designs emerged from the relatively traditional lab on insulation.

Throughout the project, students sought solutions to *homelessness*. Their early designs for temporary shelters often included details about meeting other needs, such as food, clothing, counseling and medical treatment. These same ideas often came up during class discussions. Initially, we sought to bring the focus back to designing temporary shelters, but the students persisted in seeking to solve the larger problem of homelessness. As Mr. L explained, "the students were far more interested, I think, far more interested in, kind of, the social justice issues. They were more interested in that than they were in building something." Thus, when the guest from the local day shelter said writing a letter would be helpful, we knew we had found a good deliverable. Mr. L recalls "we were looking for a way to have a research and writing assignment that was authentic in the sense that they were really gonna write something that was gonna go to a real person that had, you know, at least theoretically had some power to make some changes." The letter connected well to the learning outcomes related to government and economics, but required substantial time for students to investigate possible solutions to homelessness.

In reflecting on the emergent quality of these decisions, we wonder what would have happened if we had initially planned on a letter to the representative. We speculate it would not have been as well received, particularly by students who struggled with writing. By beginning with a much more accessible design product—building a

temporary shelter from waster—students had easy access to the problem space. Supporting them to empathize with their clients opened the problem space to them, inviting them to share in framing the problem, and also engaging as co-designers of the experience.

This openness is the aspect of project-based learning many teachers fear; it can be unpredictable, and teachers must often be opportunistic to find new ways to meet required learning outcomes when a problem shifts. However, we argue that finding an authentic, coherent and “provocative” topic and ensuring that it is accessible to students, can make this less daunting. It would be easy to view the suggestion to write letters to representatives by the guest as simply serendipitous. While there are other authentic products we might have envisioned once we allowed students to reframe the problem (e.g., infographics for voters about particular solutions, an economic analysis of possible solutions presented to lobbyists who work on behalf of those affected by homelessness), it was the commitment to relevance and authenticity from the beginning that made it “safe” to turn the problem space over to the students. Had the problem been contrived, incoherent, or focused on context that was only loosely connected to the content, allowing students to reframe the problem would likely have required greater creativity to still meet the desired learning outcomes.

Shortening the Slum Model

Adding the letter meant less time for building model slums. Mr. L explained “we narrowed it down to two [topics—homelessness and slums] and then we really only did one, [laughs], so we kind of introduced the slum idea there toward the end, but mainly the project became about homelessness and really, that’s what it was about.” Mr. F concurred “we didn’t really get into slums as much as I would have liked, or as much as we had anticipated, um, and, and I don’t necessarily think that’s a bad thing. I think that we, we just studied what we studied in more depth, you know, and really the level of the students and, and their engagement is sorta what drives that.”

Having students asynchronously build the slum model allowed us to explore economics, while also allowing students time to refine their letters. For instance, a student could turn in a draft letter to one of the teachers, take a turn adding to the slum model while the teacher was providing feedback on the letter, and then revise the letter after finishing the model.

DESIGN DECISIONS MADE DURING TEACHING

Teachers commonly make design decisions in the midst of teaching. For instance, Mr. F, upon realizing that a number of students who had missed the previous day of class

happened to be sitting at the same table, sought to reorganize the design teams so these students would be paired with students who had not missed class. These in-the-moment decisions are not trivial, as they contribute, sometimes substantially, to the success or failure of a design for learning. Because the project was co-taught, there were opportunities to make such decisions together, and even to have design conversations *during* class. For instance, we had planned to introduce *wrong theory*, but not how to implement it. During class, we discussed how to do so.

Mr. F:	Are we gonna do a little, uh, post up and commenting on it?
Mr. L:	Well, so I thought that we would just do that one and we would, after they’re done with that one, we would go back to finishing their four
Mr. F:	Ok. Do we want any—like them (.) to::: get input? Do, do we want any, just, ‘cause I mean the wrong theory’s good, right, if it’s in your own mind, but having somebody else maybe point out what’s effective or not effective, that, ‘cause sometimes, I mean, maybe//
Dr. S:	//and//
Mr. F:	//part of it can be effective//
Dr. S:	//having them, like, kind of share.

Mr. F and Mr. L’s suggestions focused on how to support student learning—getting feedback and making thinking visible, both of which are research-based strategies that support learning (Bransford, Brown, & Cocking, 2000; Hattie & Timperley, 2007; Ritchhart, Church, & Morrison, 2011).

As we continued to refine the plan, we negotiated the specifics of how students should share their ideas, as well as what they should share. Mr. L suggested a “mini presentation by group” but wanted them also to present their four good ideas. This latter suggestion was met with a lukewarm response by both Mr. F and Dr. S. She brought the focus back to wrong theory.

Dr. S:	And they could say why they think their idea is the worst.
Mr. L:	Yeah. Yeah. YEAH. RIGHT.
Mr. F:	Whose idea is the worst.
Mr. L:	Let’s DO that. And then we can come back and do critiques on their good ideas.

We agreed that this approach would work, but Mr. F wanted clarity on the suggestion that “we can come back and do critiques on their good ideas.”

- Mr. F:** Well, then, we'll give 'em time for good ideas, right?
- Mr. L:** Yeah
- Mr. F:** And then we'll critique those ones. I think we should post up and then have some sticky notes where they can go around.
- Dr. S:** Yeah
- Mr. F:** And put, uh, feedback for each other.
- Mr. L:** Yeah
- Mr. F:** That way, that'll—they can then have that concretely in their mind as well as on paper.
- Dr. S:** Yeah.
- Mr. L:** That sounds great.

These design decisions were contextual and contingent. We made them in the moment, guided by what we were hearing and seeing in the room, and what we thought would support students' learning. For instance, Mr. F asked “We'll give 'em time for good ideas, right?” in response to Mr. L's plan to “do critiques on their good ideas,” suggesting that he knew the students needed more time to refine these.

During a later class period in which students were drawing their four possible solutions, Mr. F talked to a student and Dr. S about how to get feedback to the students. One of the students, Ben, explained, “I have [a] good idea, but I couldn't put [it] down on paper. I can explain it.”

- Mr. F:** Let's see here, how do we wanna do this? Do we wanna do it gallery walk style? That is where everybody leaves their stuff out, and we::—you guys walk around. That work? Walk around? Okay. We'll do it that way. Give me one second.

He then spoke to Mr. L out of earshot of the audio recorder. The directions Mr. L gave the class moments later indicate this decision was modified.

- Mr. L:** Alright so, we're ready for you guys to explain to us all your ideas, and which one you think is the best idea and why, right? So I know that//

- Ben:** //out of 4 ideas?

- Mr. L:** Out of 4 ideas. So, I know, I know we've looked at a lot of sketches and I know it's, it's gonna be hard to see them at a distance. So this is gonna require some pointing and explaining, right? And really, what we wanna do today, is just go through 'em, right? We're not gonna interrupt you. You can go through it and explain, explain why you chose the one that you chose and then we'll just have a couple minutes in case anyone has any questions to clarify some of your ideas. Then we'll move on to next group. So then when we come back to school on Monday, we'll do this in a more formal way. And we'll take your stuff and put it up on the board, give people a chance to go around and look at [it] closely, ask you questions, right? And provide you feedback in writing on some kind of form, so that you can take that back with you and revise/refine your design.

By giving the students an opportunity to share out informally, we held them accountable for producing designs and gave them an opportunity for formative feedback. Delaying the more formal gallery walk made sense as both students and teachers were not really prepared to ensure the feedback would be useful. Given Ben's comment, for instance, that he had ideas he “couldn't put down on paper,” suggested a need for more time to accomplish this.

Dr. S asked the teachers to reflect on design decisions they made while teaching. Neither could detail a specific design decision made during teaching, yet we had documented many such decisions. Mr. F explained “the three of us would just come together [during class] and say, well, what are we—off the top of my head, I can't think of any of those spur of the moment—I think that's probably by design, because it just happens out of necessity as opposed to, you know, anticipation.” Mr. F's comment suggests a difference between the deliberate design decisions made before or after teaching, and those made during teaching.

Mr. F explained “I remember one specific time and I don't even remember the content that we were specifically working on but it was like the three of us, I think it was, we had done a mini lesson and they were working on some independent stuff and then we kinda got together because we had anticipated doing maybe another mini lesson. [...] I think we just kinda came to the consensus that A. they

were really engaged in what they were doing and, and you know, I don't wanna stop that in favor in starting over with something else completely different, um, and I think they also probably needed more time to focus on the task that they were so engaged with—I really—it's really good to see that engagement and, and when it happens, when it is—is continuous, you're like, 'Alright. Cool. Let it ride.'

CONCLUSIONS

Past research has documented differences in novice and experienced teachers' planning and decision making (e.g., Borko & Shavelson, 1990; Housner & Griffey, 1985); less is known about how such decisions might vary by timing—whether the design decision was made prior to or during teaching. This design case differentiates between the design decisions made prior to the project beginning, those made during the project outside of instruction, and those made within instruction. This helps to make clear how context and timing influenced design decisions, and revealed a tendency, at least for these two experienced teachers, to have limited recall of the design decisions made while teaching.

Prior to the project beginning, the design process had an ideational quality, as we sought topics and activities that would be provocative or engaging for the students. This covered a broad territory, with many of the ideas considered never making their way into the project. This expansive exploration, however, provided a deep well of possibilities that could be returned to as needed. For instance, when the project was reframed by the students to be about solutions to homelessness, we were able to draw upon a number of ideas from the early ideational design conversation. Likewise, just as the initial inspiration for the Waste Land II project came from an abundance of ideas leftover from earlier projects, the expansive exploration of ideas may inspire future projects.

Early design ideas were evaluated for their potential to engage students and for their coherence (e.g., eliminating the third phase focused on upscale designs). This set an initial problem space that was accessible to students, both in terms of entering the space and in reframing it; it also meant that as reframing occurred, it was relatively easy to maintain a focus on the original learning outcomes.

Design decisions made during the project, but outside of instructional time, tended to focus on the learning outcomes and content, but were still distinctly guided by student interest and engagement. In contrast to the very open, ideational design conversations that preceded the project, these decisions were influenced more by constraints. Project-based learning can present challenges in terms of balancing engagement while still addressing required curricular standards. The students at this school typically enjoy building and making activities, so we were opportunistic

when we saw their interest pull them away from building temporary shelters; we decided to shift the focus of the project to researching and writing about long-term solutions to homelessness, as this still afforded opportunities to address the original learning outcomes. Thus, the students played a role in steering the project, echoing Mr. F's insight that "we have the oars, we're at the helm, but they may be the winds that—that push the sails. [...] Maybe we're the wind and they're at the helm." While the teachers are ultimately responsible for ensuring students have opportunities to learn content, the students, in this case, shaped those opportunities.

Design decisions made within instruction were the most contingent and ephemeral. They were made to support learning, drawing upon the observations made in situ, though informed by the teachers' expertise and experiences. Both Mr. L and Mr. F had difficulty recalling specifics of such decisions, though neither teacher is a novice, suggesting there is something different about the design decisions made within instruction. This also suggests that studying such decisions may require methods that allow researchers to be there (Geertz, 1988), and that co-teaching may provide a particularly rich window into teachers' designing within instruction.

Based on these differences, we suggest that pre-implementation ideational designing can play a productive role in teachers' designing, serving them as they navigate implementation. Had the instructional design, instead, been created by researchers or instructional designers, then handed off to teachers, this benefit would have been lost. Alternatively, it potentially could have been recreated by having teachers adapt the instruction to their classrooms (Brown & Edelson, 2003).

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