

RE-IMAGINING TECHNOLOGY EDUCATION FOR STUDENT TEACHERS USING HUMAN-CENTERED DESIGN

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This design case describes the implementation of the Human-centered Design process, developed by the world leading design firm IDEO and Stanford d. school. The process describes the technology integration onto a teaching credential program course at a university in Central California. It reports the thought process to adopting HCD in the course with a focus on a semester-long assignment called Technology Leap Project (TLP). The preliminary design decisions and the design process in depth. Each phase of the HCD process (i.e. Inspiration, Ideation, Implementation) was defined and its manifestation into the TLP was articulated and assembled with samples of students' work. The case also discusses various merits and challenges for the design team of applying the HCD process in engaging student learning and responding to their learning needs. Finally, the revision plan was discussed.

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INTRODUCTION

This paper describes 1) the first author's work as a designer of the CI 100, Integration of Technology in the Classroom course for pre-service teachers in a university in Central California and 2) the first author's effort as the course instructor testing the value of the "design experience" that she engaged the teacher education students. The focus of the design case is on the course design process and reflects the first author's point of view, hence the use of a first-person. The student design experience will be used as supplement when discussing outcomes of the design iterations.

THE DESIGN CONTEXT

In response to the state requirements for the multiple subject teaching credential programs, one of the identified goals of a teaching credential program at a public university in Central California is to guide student teachers to use innovative technologies to promote learning. Integration of Technology in the Classroom (C&I 100) is a prerequisite course that allows students to participate in the teacher education program at the college of education. The course is intended to equip the students with hands-on experiences with emerging technological tools to apply them in defined K-12 instructional contexts.

There were numerous challenges that emerged during the course design process in the past, as it was built for a large group of student teachers with diverse backgrounds and skill sets. The challenges included (but were not limited to): (a) a debate whether the course should focus on tools and applications verses on critical uses of technology, (b) identifying exit technological performance for students with diverse entry technological skill levels and backgrounds, and (c) addressing students' different learning needs when responding to issues of equity or access and students' anxiety with technology. Several syllabi were designed and implemented over the years, yet these challenges remained.

In the effort to improve the situation, a multiple subject teaching credential program committee was formed in fall 2017 and charged for redesigning a master course syllabus

to use across multiple sections of the course. I was one of the committee members and the course coordinator who led the redesign effort. The committee met every two weeks for a semester to revisit the course goals and objectives, course assignments and assessment methods, and concurred these elements needed to be rebuilt to meet new learning requirements.

As each committee member came from a different teaching background in science education, multiple subjects and instructional technology, the knowledge they contributed evoked interesting opportunities and challenges to the designing process. The opportunities involved a great deal of recommendations on the learning outcomes of a technology course and ideas on how to equip students with technological skills to achieve such outcomes. There were also multiple discussions and suggested directions for the course to be constructed. However, it soon became overwhelming to consider merging all of the suggestions into the course goals and objectives. The list of questions remained, if not expanded: should the course be a skills-based course? Or should the students learn to critically use technology and if so, what does it mean and involve? What technological skills to equip the students in this course and how were they selected? How will these technological skills be contextualized in a specific subject area, say science education without turning it into a science education course preview?

The committee met several times to tackle these problems and agreed that a skills-based course would not be an optimal choice for these students who would remain in teacher education for a year or two. The technological tools learned in the course would soon be outdated and replaced by the time they would graduate and practice them in their own classroom. Instead, it would be a technology stand-alone course to serve as a skill progression towards more subject-specific courses in the Liberal Studies program and align with the program goals. We also concurred that the course should be about critical uses of technology that would involve sufficient hands-on experience with technological tools and knowledge of when, where, how and why to use a certain tool. As the course coordinator, I contributed to the ideas, made final decisions on the direction of the course and wrote the course syllabus.

Accordingly, the three course learning goals I identified were: (a) use of multiple applications of innovative technologies to increase subject-matter knowledge; (b) evaluation of technologies as effective tools of learning; and (c) exploration of ethical and social issues related to technology. Listed below are the five themes from the Liberal Studies program used to align the course objectives:

- 21st Century Classroom
- Global Digital Citizenship
- Educational Technology and Social Justice

- Culturally Sustaining Pedagogy
- Universal Access for Learners

My intent for the new syllabus of the existing course was to facilitate the students' development of knowledge, critical thinking, and problem-solving skills with a focus on community service. It was a project-based course in which teaching and learning activities derived from real life situations and were community-oriented in nature. Students in the C&I 100 were supposed to develop a group project, namely Technology Leap Project (TLP), based on their interests and technological abilities. The project would combine 1) learning about new technologies and 2) investigating ways to incorporate the technologies into a K-12 classroom setting to solve a real-world problem that the students would identify. Each project should ideally include aspects of knowledge acquired from personal experience and research, statement of purpose, audience, and the creativity elements. A pure knowledge pursuit was not in the spirit of the project. To enroll in the course, students were expected to have college level skills in reading, writing, collaborating, citation and plagiarism knowledge, as well as basic computer skills including (but not limited to) word processing and Internet browsing. However, multiple levels of technical support were provided should they be requested by the students.

DESIGN OVERVIEW

Preliminary Design Decisions

As the course coordinator, designer and instructor, a great deal of my time and effort were spent on researching how to elaborate the assignments in ways that meaningfully achieved the course goals and objectives. I decided to treat the TLP as the course major assignment in which other assignments and course activities evolved around and supported it over the course of a semester. In an attempt to realize the TLP's mission, I envisioned constructing the assignment as a challenge that would call for ideas and solutions and use technology as a means to solve the problem. To sustain the students' interests and personalize the learning experience, the challenge would need to be organic, have a personal touch, and shy away from being a generic imposing issue on the students. In order to achieve this, the problem would need to be detected by the students, and the desire to arrive at a viable solution and to maneuver obstacles to get there should be initiated by them.

The fact that the students were primarily junior and senior undergraduate students who took the C&I 100 course as a prerequisite to enter the teacher education program presented a number of challenges for the design process. First, the fact that this course was a prerequisite to the teacher education program raised a question whether the students enrolled in the class by choice or because they were required to be there, which in turn posted another question about

their priority, motivation and aspirations to thrive technologically in the course. Next, with a few exceptional cases who were currently full time or substitute teachers, most of these students did not have prior teaching experience in a classroom. Thus, most would have less to contribute to conversations about classroom teaching. Finally, and most critically, these students were products of a system that accustomed them to rigid instructions and procedures to follow. In other words, they were used to being told exactly what to do in their entire school career. When deciding to employ a more fluid, liberal instructional system in the C&I 100 and to hand over to the students the design ownership, self-maneuverability and accountability and expect equivalent performance in return, I was fully aware of the double sword effect and yet determined to invest in to awaken the creativity side of the students.

Arriving at Human-Centered Design

Meanwhile, in the previous year, I experienced a full cycle of creativity when participating in an emergency design challenge with regards to improving the delivery of and access to educational content through technological means. The competition was sponsored by the Australian government and MIKTA (i.e., an innovative partnership among Mexico, Indonesia, South Korea, Turkey and Australia that bridges multilateral system divides and build consensus on global complex and challenging issues) and run by OpenIDEO, an open innovative platform for social good that adopted Human-centered Design Mindsets at both operational level and as expectations on the participant's performance.

My experience with the Human-centered Design (HCD) process as a participant started on the first day when I joined the competition. I was introduced to the challenge and groups of audience that would need a solution to be designed (i.e., children, especially girls who lost schooling due to internal displacement). Before starting to design anything, the HCD prompt guided me as a participant to conduct a great deal of research about these internal displaced people (IDP), their loss of schooling, their geographically, financially and emotionally unstable life, and life opportunities being stripped away from them (Internal Displacement Monitoring Center, 2016). As I was drawn deep into the topic, I developed a strong emotional connection and feeling of agony for what these IDPs were going through. I started to ponder what could be done as a healing remedy for them which motivated me to continue researching. Ideas were playing around in my head as I kept searching for solutions. However, as soon as I started to put them down on the paper and elaborated on one, I got stuck. I went back to more researching, more thinking, and more iteration.

The process repeated for many of the ideas that played around in my head until I landed on one that I was content with after a few days. My idea was to develop an online

course to teach the IDPs from California and Texas refugee centers technological skills to digitally tell stories away from home. The goal was for these IDPs to tell their stories away from home and share them to the public. In my mind, this could be a remedy to their inner pain should they be able to talk about it. Besides, they could also use the story to apply for a college scholarship, enter a digital story contest or contribute a voice to stop the displacement. Figure 1 shows an image of the course I built.

In retrospect, I started out not knowing the answers to the problem that I was looking to solve. However, through research and by being fed with ways of understanding the audience, I managed to arrive at different unexpected hypotheses and possibilities to help them. I was able to tinker each idea until I arrived at one that felt most viable, that was, to offer a digital storytelling course. The process was not particularly visible at first. I had to stumble towards the light many times while being open to different ideas and testing them out one by one. In the meantime, I attempted to understand the people I was designing for and building a connection with.

As the design proceeded, I was also guided to be optimistic and embrace possibilities that the idea I landed was neither final nor perfect and that was okay. In the meantime, I was given the opportunity to explore the options and to follow my gut. I surveyed and interviewed the IDPs, talked on the phone with the staff members at the refugee centers in Texas and California about the IDPs conditions at their place. These insights and feedback helped as I revisited my idea to add new insights or remove false assumptions. As I kept revising the idea, I realized my understanding about the target audience had become more well-rounded, refined, subtle and unique. The drive to a solution has thus become robust, natural and personal for me.

I was selected to prototype the solution with the real audience together with the other 71 ideas on the shortlist, chosen from the pool of 384 ideas worldwide. At the time, the audience for my project was the IDPs and staff members at five refugee centers in Texas and California. Even though my idea was not among the top five that won the awards, going through the design process and developing strong emotional empathy for a specific group of people was an invaluable and unforgettable experience for me personally and professionally.

In designing the C&I 100 course assignments, I found many similarities between the design challenge that I participated in and the TLP I intended to facilitate student creativity (i.e. the making and innovation) and foster passion and emotional changes in my student participants. Being open to ideas allowed me to open up freely. Stumbling towards the light and dealing with ambiguity challenged my preference for comfort zones, and developing the emotional connections

Google Classroom and Digital Storytelling: Stories Away from Home.

Empowering internal displaced children to learn technology and amplifying their voices with digital storytelling tools



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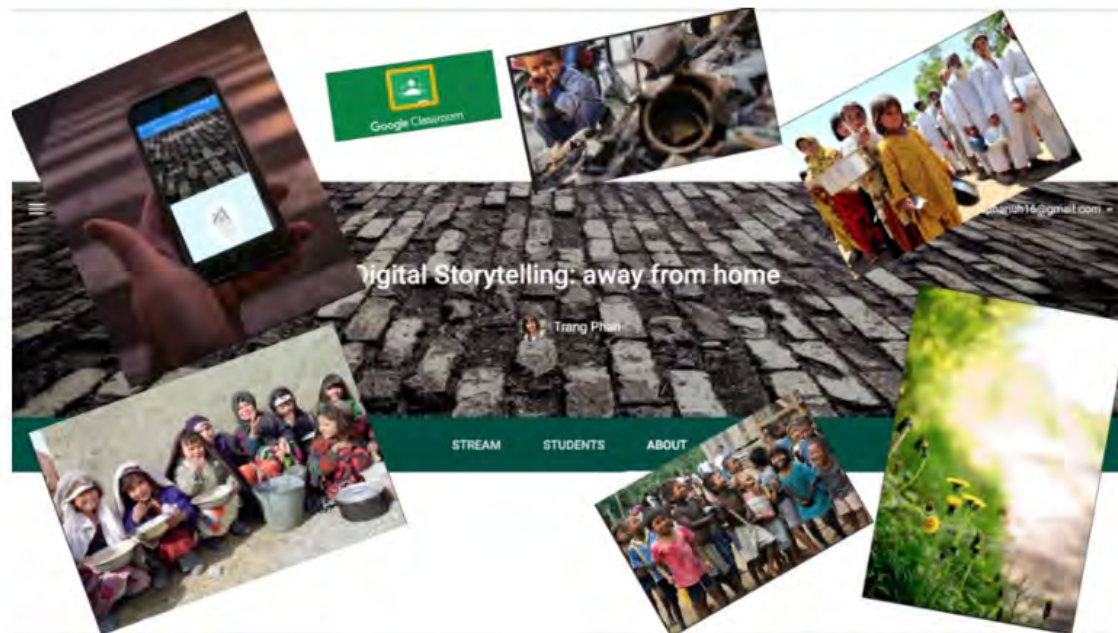


FIGURE 1. Digital Storytelling course on Google Classroom using Human-centered design.

with the audience helped me grow as a person and a designer. By considering the HCD process in the C&I 100 course design, I envisioned to create a similarly organic and authentic design scenario for my students to experience starting from figuring out a real problem to arriving at a meaningful solution by employing IDEO HCD guidelines. Despite all the visible challenges ahead, I forged forward with an inspiration and determination for my students to experience and adopt the HCD values and mindset in this course and hopefully in their future teaching career.

DESIGN PROCESS

This section explains how I applied HCD in the C&I 100 course and uses students' application of HCD as examples of their engagement in the course.

Adopting the HCD Mindset

According to the IDEO field guide, embracing HCD means believing that all problems are solvable and that the people who face problems are the ones who hold the key to the answer. HCD offers problem solvers chances to design with communities, to deeply understand the people they are looking to serve, to arrive at different ideas, and to create innovative new solutions rooted in people's actual needs. Being an HCD-er is about believing that staying grounded in what they learn from people and arrive at new solutions that the world needs (IDEO, 2015a).

The HCD process was applied in the C&I 100 course design stage to allow students to integrate their knowledge and technological skills to solve a real-world problem through a collaborative effort. As a mindset, it was geared towards improving the usability and user experience of the products

or services for a specific group of audience. Put differently, HCD sought to focus on a concrete human-oriented implementation when looking to solve a human-related problem. There are no other fields that problems and solutions are more human-centric and require a more holistic understanding of the audience's background, needs and wants than in education. In the context of a K-12 teacher education program, it is imperative for these prospective teachers to learn to observe, identify and analyze problems with teaching and learning, identify the audience (i.e., students, teachers, parents, counselors, etc.) and understand their backgrounds and stories holistically in order to design any teaching and learning solutions.

The HCD process employed in this design case was developed by the design company IDEO and used at Stanford d. school. The process was not linear, and each project had its unique characteristics based on the subject area and the intended audience. The design of course learning activities and assignments had to reflect these characteristics. Nonetheless, despite different design problems, the student designers would go through three main phases: (a) inspiration, (b) ideation, and (c) implementation. Following these three phases would allow them to build deep empathy with the communities and individuals that they were designing for and turn what they learned into an opportunity to design, build and test the ideas before putting them out to use in the world. Figure 2 shows the HCD process from Stanford d. school by the time it was used in this paper.

Application of HCD process in C&I 100

The design process in this study was two-fold: 1) building course learning activities and assignments around the TLP assignment that led to understanding of the HCD process among the students, and 2) having students apply HCD process in their TLP group projects. Specifically, course learning activities involved exercises for the students to observe and identify problems in the K-12 teaching and learning environment. The students then were guided through HCD process exercises to further detect and analyze the problem, brainstorming possible solutions while attempting to understand the audience and refining their needs. The students were also tasked to get feedback from the audience, design, prototype the product to the audience and iterate based on the received feedback. As for the student's application, they followed the HCD process field guide with the understanding gained from the class activities on the TLP. Specifically, the students applied the HCD process and mindset to reach and build connection with the audience, to express their voice of concerns for them, to demonstrate choice making for tools and instrument to implement in the solution design, and to claim ownership of the artifacts they created. The student teachers started with compassion and empathy for the audience as they detected the problem and aspired

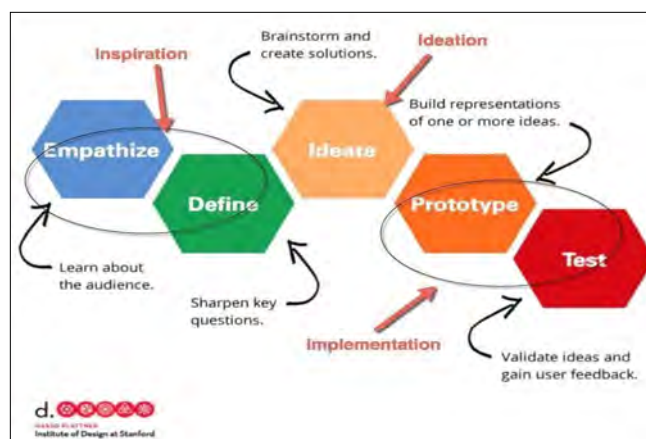


FIGURE 2. Stanford d.school streamlined design process (Legacy, circa 2012; used by permission of the Stanford d.school).

to search for a solution. The empathy could be experienced from one's own experience, or through observation of others' that led to a drive to search for a solution.

The initial design products

Application of HCD process in the C&I 100 course started in the spring semester of 2018 and went through a number of revisions over the semesters until fall 2019 when the final design product was completed. Initially, the instruction on the TLP in spring 2018 involved asking students to work in a group to design a solution for a real-world problem based on their technological capacities and interests in a subject area of their choice. The final product was required to include such elements as knowledge, creativity, statement of purpose, and information about the audience that the design was intended for. The students had the freedom to select their team members and reported to the instructor when the group was formed. Techniques from the Field Guide were converted to class activities to support the student group with their TLPs; however, students were not required to read the materials in advance.

As an instructor and course designer, I realized that such simplistic, general instruction gave students a lot of autonomy and room for creativity in pursuing their ideas. Specifically, they had complete freedom over the technological tools they would like to implement in their project, as well as the topic they would like to pursue provided it pertained to teaching and learning in K-12 settings. Although it was intriguing for some to generate and be accountable for their own topic, it required a great deal of work to formalize an idea from scratch, and could cause anxiety acceleration for students with low ambiguity tolerance.

Another pitfall found later in the design was that a master list of technological tools was not provided at the beginning for the TLP. Instead, the students were introduced to each of the six groups of tools by function (i.e. communication, creativity,

PHASES	GOALS	KEY LEARNING ACTIVITIES
INSPIRATION	<ul style="list-style-type: none"> Enabled students to formulate an idea/problem in the K-12 environment that was rooted in their interests and past experiences Allowed them to experience empathy by having their voices honored and ideas invested Equipped them with technology tools to help solve the problems 	<ul style="list-style-type: none"> <i>30 circles</i> to generate ideas <i>Identifying problems</i> and forming groups based on mutual interests <i>Framing a challenge/problem</i> with guided questions using a concept mapping tool <i>Reviewing technology tools</i> and making decisions on incorporating technology in the project <i>Application/software evaluation checklist</i> allowed students to weigh multiple aspects of technology tools of their choice to mindfully and meaningfully implement technology into their project
IDEATION	<ul style="list-style-type: none"> Allowed students to approach, gather and process inputs from an actual audience for which the project was designed and to form an action plan Encouraged students to practice empathy with the users by eliciting and honoring their inputs Motivated students to exercise mindful and informed decision making by integrating technology to solve a problem 	<ul style="list-style-type: none"> <i>Survey and interview</i> design that focused on empathy practice <i>User experience map</i> (as a method of showing empathy) to visualize the learner's journey in the project from start to finish <i>Peer feedback on Inspiration phase</i> to help groups fine tune their ideas
IMPLEMENTATION	<ul style="list-style-type: none"> Allowed students to design lesson plans that integrated technology as a problem solver Enabled students to highlight the values of the project through digital storytelling Allowed students to demonstrate their product to the whole class Fine-tuned the work based on peer feedback 	<ul style="list-style-type: none"> <i>Lesson plan design</i> highlighted technology integration in the classroom <i>Promotional video</i> to bring the TLP values to life <i>Peer feedback on Ideation phase</i> to give groups input in order to revise their work <i>Peer feedback on Implementation phase</i> that focused on technology integration in the lesson plan <i>Final TLP Presentation</i> <i>Revision of the entire TLP</i>

TABLE 1. Application of HCD process in the C&I 100 course in fall 2019.

presentation, delivery, collaboration, and engagement) per week and performed a tool evaluation for each. Although this evaluation was intended to enable the students to explore various tools in depth and pick a tool for their TLP, the pacing out of the tool evaluation appeared to affect the students' timely decision making for their TLP tool.

Learning from this lesson, a master list of tools by function category was introduced in the revised fall 2018 course syllabus should they wish to explore and choose one for their TLP. Another revision made included adding subject-area choices for the TLP groups. This did not only help to ease choices of a subject, it also narrowed the design focus to

classroom settings, which in this case appeared relevant and thus reduced ambiguity significantly for the students. Entailed from this, the Implementation phase was revised to specifically require the design product in a course format with lesson plans. Accordingly, the students would present an overview and timeline of the course and showcase five sample lesson plans that detailed the chosen technology to deliver the instruction, as well as a rubric(s) to measure student learning outcomes in the course.

Thus, when reviewing the TLP final products, I realized there was a lack of consultation of expert insights in the creativity process done by the students and their final design

solutions. Hence, another revision was added in the spring 2019 syllabus to require TLP groups to include three to five research resources related to their design problems. For each resource, the groups were asked to report: 1) how the problem was addressed in the past, 2) whether solutions were presented, 3) whether technology was involved, and 4) their evaluation of the solutions. The equivalent of these was consulting experts in the field (i.e. experienced teachers, college professors, etc.) to gain their perspectives on either technological tools or the significance of the problem or the direction of the solution.

The final design product

The final design product in the fall 2019 syllabus included all the changes made in the prior cumulative semesters plus classroom activities to help students select their TLP group members. Table 1 shows the application of the HCD process in the TLP assignment in which the goals and learning outcomes were manifested by key learning activities in each phase and followed with examples of students' performances. The activities were completed in the class through individual and group work.

Parallel the design plans in Table 1, Figure 3 shows the student application of the three phases (i.e., Inspiration, Ideation, and Implementation) of the HCD process with examples. These examples serve as design artifacts, anchoring the representations to the design activities.

Inspiration

This phase starts when a problem arises that motivates the search for solutions. As for the TLP, this phase enabled the students to formulate problems in the K-12 environment that they could relate personally or professionally. It also allowed them to experience empathy with the audience by observing their lives, hearing about their hopes, needs and wants in order to get smart and knowledgeable about the problem. Besides their own viewpoints and observations, the student teachers were asked to review the literature and consult experts in the field to build a more well-rounded understanding of the problem as they developed connections to the topic. Students were reminded to stay at length in this phase to fully explore the audience and context instead of rushing to the execution stage.

As another example, in the second class, the students were tasked to brainstorm at their table groups problems in the K-12 environment that they either identified or experienced themselves. Each table group would have 15 minutes to list 3-5 problems that they would like to solve. The group would present their list in front of the class while everyone else took physical or mental notes. After all the groups presented, everyone would approach one another in a conference fashion to further explore the problems of their interest and to form their TLP group. Thus, the partnership was built upon mutual intrinsic interest in the topic and the initial drive to solve a problem that they had just identified.

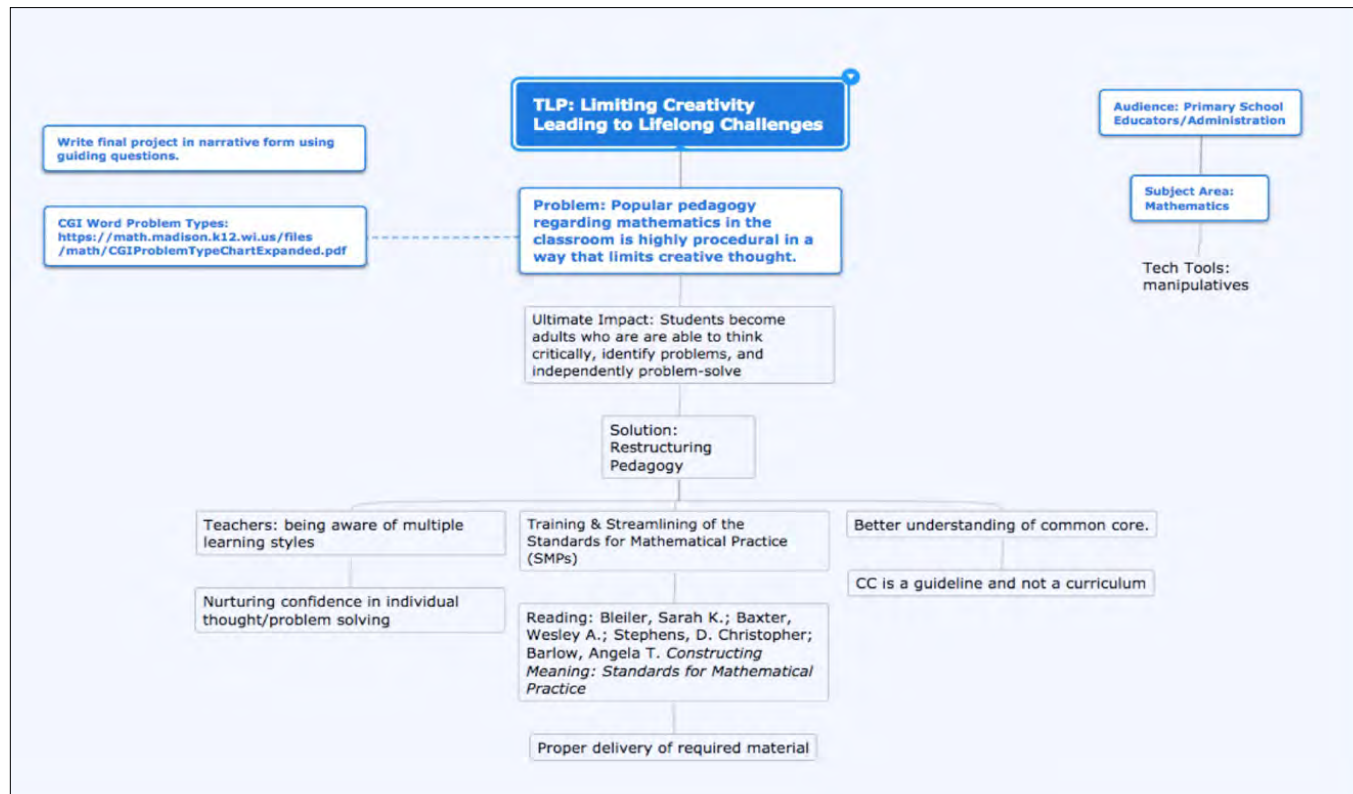


FIGURE 3. A framed challenge using Mindomo concept map: Limiting Creativity Leading to Lifelong Challenges.

The newly formed groups would frame their challenge with guided questions using a concept mapping tool. The group would review the map they created to decide if they would like the whole picture. The groups were encouraged not to stick with their very first idea. Instead, they were asked to map out a few other ideas or slightly modify one, changing their view if they got stuck. The purpose of this exercise was to get students to be fluid, fast moving, practice generating perspectives and not getting too attached to one specific idea. It also offered them first-hand choices of ideas, the practice of reasoning, critical thinking and filtering ideas. Figure 3 shows a mind map of a TLP group project called *Limiting Creativity Leading to Lifelong Challenges*

Also, in this phase, the groups had to identify one or more possible technological tools to use in their TLP. In order to do so, each group would need to perform three technological tool evaluations using a template provided by the instructor and choose the most appropriate one(s) among all for their TLP. The list of tools was provided by the instructor, as well as the tool evaluation checklist (see appendix A); however, the group was able to choose the tools outside of the list should they so desire. Figure 4 shows a demonstration of the DIY.org tool used by the group in Figure 4.

Ideation

This phase allows students to approach, gather and process inputs from the project's target audience and to form an action plan. As for the TLP, it encouraged the students to practice empathy with the audience by eliciting and honoring their inputs. It also motivated students to exercise mindful and informed decision making by integrating technology to solve a problem. Major activities in this phase included designing and conducting surveys and interview questionnaires focused on developing empathy with the target audience. The students would analyze the feedback they received and develop an action plan based on their synthesis and analysis of the audience feedback in light of research and their own experience.

As an example, in another group project called *Time to Relax (TtR)*, the group started with reviewing the literature on the negative impact of stress on teachers and students and documented the benefits of music, yoga, and meditation such as: (a) reducing aggressive behaviors and mood regulation (EOC, n.d.), (b) improving one's mindfulness, self-esteem, and physical condition (Hagins & Wang, 2015), and (c) creating a more peaceful classroom with more compassionate and caring students towards one another. The group then gathered

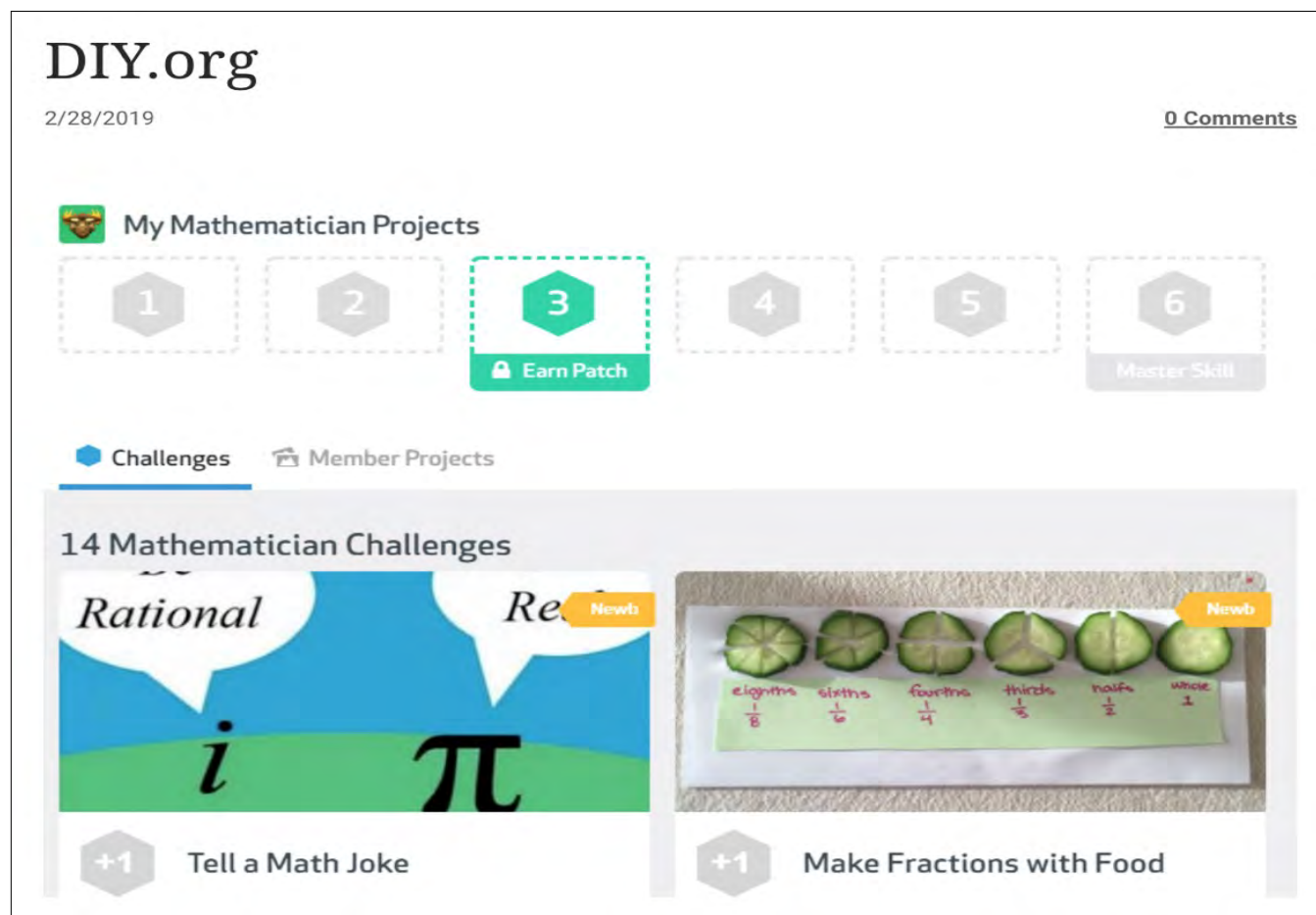


FIGURE 4. DIY.com tool review on a math project.

stress reduction resources, built a website and incorporated activities they developed in the classroom (Figure 5). They also proposed methods of measuring students' progress over time with the treatment.

To obtain various types of feedback on the project, the group interviewed two teachers (i.e., regular and after school) and conducted a simple survey for students to take before and after using the *TtR* site. The group then categorized the

feedback using the provided quadrant prompt *The Good, The Bad, The Unexpected*, and *Action Plan* as follows:

Finally, in this phase, the group created a *user experience map* (as a method of showing empathy) to capture key moments in the learner's journey in the project from start to finish, as shown in Figure 6. The user experience map was a highly visually attractive way of showing the learning journey and breaking the idea into bite-sized pieces to make it easy to digest.

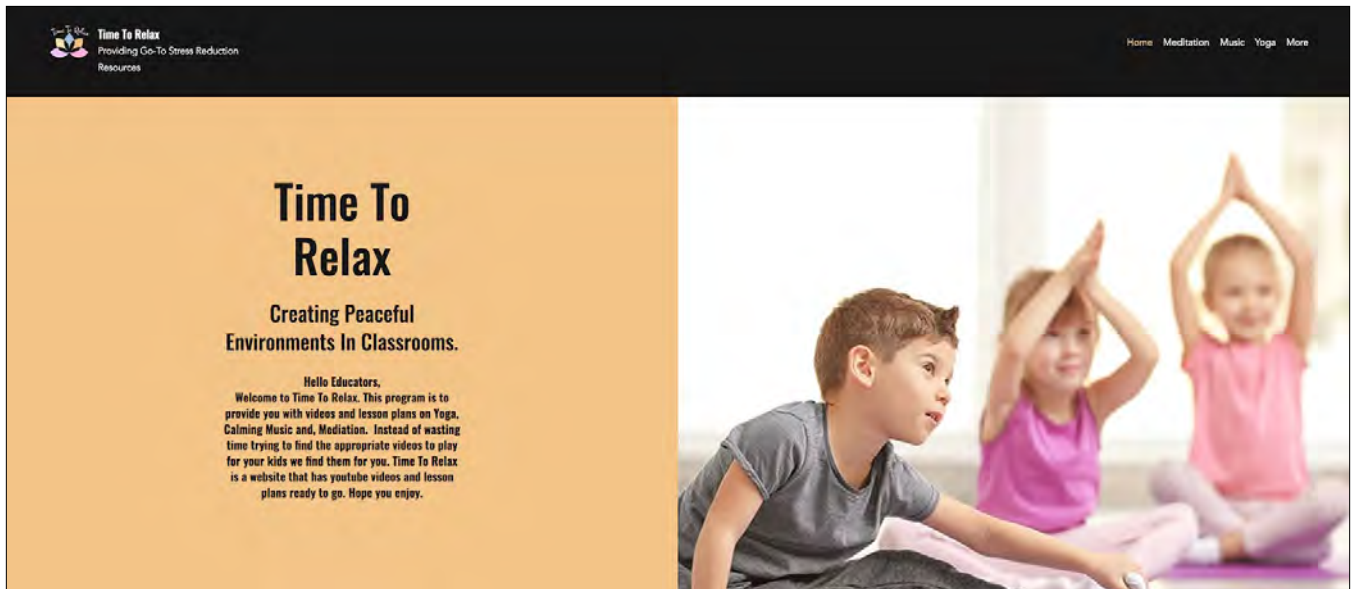


FIGURE 5. Website and curriculum resources for Time to Relax.

THE GOOD	THE BAD
<p><i>What did you (interviewee) value the most?</i> The interviewee valued that our website looked “so clean, detailed and relaxing” The interviewee also mentioned that our website is easy to use and that there are different resources available on it.</p> <p><i>What got the interviewee excited?</i> The interviewee is “excited over the idea that we created a website to do this”.</p> <p><i>What convinced the interviewee about the idea?</i> The interviewee knows how important it is to provide stress relief resources.</p>	<p><i>What failed?</i> Nothing failed.</p> <p><i>Were there suggestions for improvement?</i> Add more videos.</p> <p><i>What needs further investigation?</i> I did not conclude from this interview that we need to further our investigation on our source.</p>
THE UNEXPECTED	ACTION PLAN
<p><i>Was there anything unexpected/surprised you?</i> I was surprised how knowledgeable the interviewee was about the relevance of providing educators and students with stress relief resources.</p>	<p><i>Based on what you learned, how would you change your idea?</i> I would incorporate that the students’ home environments can also create tension and stress in their lives. By this we could research the effects that can come from experiencing or seeing violence and abuse.</p>

TABLE 2. Synthesizing feedback from the target audience.

Implementation

The best ideas generated during ideation are turned into a concrete action plan. At the core of this implementation process is prototyping, turning ideas into actual products and services that are tested, iterated, and refined (Brown & Wyatt, 2010). As for the TLP, this meant the groups would design lesson plans that integrated technology and developed measurement of the learning outcomes. They would also showcase the values of their projects through multimedia in the form of a digital story and present the projects in a conference format in the class.

The *TtR* group prototyped the idea by incorporating the *TtR* website into five sample lesson plans, and developed a measurement of student learning outcomes, which was formed in the ideation phase. The five lesson plans would serve as a guide for the Tk-2nd grade teachers to follow in conjunction with the resources on the *TtR* website. The teachers could choose to incorporate any portion of the videos and/or sample lesson plans on music, yoga, and meditation within and among lessons in their classroom (see Appendix B for the first lesson plan.)

Measurement of student learning outcomes included submission of “How I feel” daily journals and Friday reflections. The teachers could review the students’ journals using a provided rubric and adjust the class activities based on the student feedback. Measurement of teaching effectiveness included the teacher’s self-assessment of incorporating *TtR* in the classroom and their reflection on possible improvement plans. Finally, the group reported some possible issues and barriers for using *TtR*, such as space availability for monitoring student participation in the activity, access to the website at the school site, etc. The groups provided suggested solutions for each potential problem identified (see Figure 7 for the student’s learning outcome “How I feel” journal, and Figure 8 for a weekly grading rubric.)

TLP was essentially a product of collaboration among the group members. The group performed the tasks together with the facilitation of the course instructor at every stage of the HCD process. The employment of the HCD process also put a rigid time frame on the operation of the TLP. As an example, complete work at each phase was submitted to the class for peer and instructor feedback with two-week turn-around time. The group would revise the draft after receiving



FIGURE 6. User experience map for Time to Relax.

the feedback at each phase and submit a final complete project after giving a presentation of the project at the end of the course. Table 3 shows a summary of students' projects that applied the HCD process with the design challenges and project descriptions.

MERITS AND CHALLENGES WITH HUMAN-CENTERED DESIGN

Design Merits

There were several lessons learned when applying the HCD process and mindset into the TLP of which three will be discussed in depth. HCD offered a gateway to innovative teaching and inspired different ways of carrying out meaningful learning activities. An indication of this accounts for the amount and depth of insights generated and shared by the students as they identified and formulated problems, going from *how it felt for a 4th grader to be a Spanish interpreter in class to a call to break the do-what-you've-been-told-to-do mindset and cycle, or a demand for high school graduates to be taught real-life skills*. These were a few example ideas generated by 10 groups of students in the first 30 minutes of the second class as they were forming their groups. Such a large pool of ideas, created by them, was evidence of ownership and the first step to expose students to choices, and options,

critical thinking skills in filtering ideas, and iteration practice with a specific idea.

As the students moved through the HCD process, it did not really matter what they made, the resources they used, or how polished the result became; what mattered was how the idea was defined, conveyed, shared and improved upon. Accordingly, failure was an inevitable part of the process. The students were told it was neither expected nor the point for them to get the idea right in the first attempt, or even the second. The point was to put something out there and use it to keep learning, testing, and exploring. The mindset that allowed exploration, trial, experience failure before or as part of achieving success and victory was powerful on many levels, especially for this particular group of the population who would be the future teachers. It was a fresh breeze into the student's learning atmosphere that encouraged them to think differently, to focus on their voice and choice and really emphasize what they wanted to do. After all, if not now, when would students be given choices to work on an issue that is personally and profoundly meaningful to them? And where else would they be given opportunities to package the whole learning experience as an emotional and intellectual journey, and education to be treated as a greater personal learning experiment?

Finally, one of the most significant design merits of HCD was the new vibe and spirit given to the student teamwork throughout the entire semester. Instead of being assigned by the instructor, the groups were formed by choice based on students' mutual interest in problems that they would like to solve. The partnership started with mutual interest and accountability on each member as each of them contributed to the group idea(s). The sense of belonging, bonding and level of trust increased among the group members as they built the project at each step together.

Challenges and Resolutions

On the other hand, the process of applying the HCD process encountered numerous challenges, especially at the beginning. In the spring semester of 2018 when HCD

Friday		Friday Reflection!	
Date:	Notes, Drawings		
Morning Check-in	Did you sleep well? I feel... 	<i>How did you do this week with controlling your emotions and staying calm?</i> <i>What do you like the best about Time to Relax? Does it help you feel better or no?</i> <i>How can you get better at staying calm and focused?</i> <i>Draw your favorite activity of the week and/or how you feel:</i>	
Before Time to Relax	I feel... 		
After Time to Relax	Circle today's activity: Music Yoga Meditation I feel... 		
At the end of the day	I feel... How was today?		

FIGURE 8. Post treatment: "how I feel" journal.

5-4 POINTS	3-2 POINTS	1-0 POINTS
For students to receive these points they need to:	For students to receive these points they need to:	For students to receive these points they need to:
<ul style="list-style-type: none"> Fill in all sections 4-5 days in journal Complete all sections of the Friday Reflection 	<ul style="list-style-type: none"> Fill in all sections 3-2 days in journal Complete some sections of the Friday Reflection 	<ul style="list-style-type: none"> Fill in all sections 1-0 days in journal Complete no sections of the Friday Reflection

FIGURE 7. Post treatment: weekly grading rubric for students.

PROJECT	DESIGN CHALLENGE	PROJECT DESCRIPTION
Replacing traditional tests and quizzes with <i>Kahoot!</i>	Test anxiety	<ul style="list-style-type: none"> • <i>Target audience:</i> 4th graders • <i>Tech tool:</i> Kahoot! • <i>Goal:</i> Reduce students' test anxiety in Math and science class using Kahoot application • <i>Behaviors:</i> Students will take and design quiz items on Kahoot!
<i>Habitz</i> creates Healthy Students	Children facing the risk of not having a healthy lifestyle	<ul style="list-style-type: none"> • <i>Target audience:</i> 3rd graders • <i>Tech tool:</i> Habitz • <i>Goal:</i> Promote exercise and healthy eating and an active lifestyle using Habitz application • <i>Behaviors:</i> Teachers and parents can access, guide and co-manage the students' progress on healthy eating and exercise on Habitz
Facilitating Music Learning with <i>Music Tech Teacher</i>	Music being given less attention than other subjects	<ul style="list-style-type: none"> • <i>Target audience:</i> 4th graders and teachers • <i>Tech tool:</i> Music Tech Teacher.com • <i>Goal:</i> Motivate students' learning and exploring their musical potentials with resources and practice • <i>Behaviors:</i> Teachers can access different programs, activities, lesson plans, videos, and collaborate with other music teachers using the resources on the website
QR Classroom	Parents unable to assist their children with math homework	<ul style="list-style-type: none"> • <i>Target audience:</i> 4th graders • <i>Tech tool:</i> QR code generator • <i>Goal:</i> Reinforce classroom learning at home and support parents who want to support their children's learning • <i>Behaviors:</i> A scannable QR code is embedded to the homework sheet which links to a video tutorial that allows students to complete their homework and parents to access and assist their kids if needed
Imagine Learning	Children with pronunciation and reading problems	<ul style="list-style-type: none"> • <i>Target audience:</i> 6th graders • <i>Tech tool:</i> Imagine Learning software • <i>Goal:</i> assist students with pronunciation and reading skills with Imagine Language and Literacy (an area of focus of Imagine Learning) tool • <i>Behaviors:</i> Teachers guide students through learning activities on Imagine Language and Literacy site
Time to Relax	TK-2nd grade teachers and students with stress and anxiety	<ul style="list-style-type: none"> • <i>Target audience:</i> TK-2nd graders and teachers • <i>Tech Tool:</i> student-built website • <i>Goal:</i> Help reduce stress levels in the classroom • <i>Behaviors:</i> Teachers can access and have students do music, yoga, and meditation exercises using the resources from the website
Limiting Creativity Leads to Life-Long Challenges	Students' lack of critical thinking and flexible problem-solving skills	<ul style="list-style-type: none"> • <i>Target audience:</i> 1st—3rd graders • <i>Tech Tool:</i> Cognitive Guided Instruction (CGI) Mathematics, DIY.org • <i>Goal:</i> Help students develop critical thinking and flexible problem-solving skills using resources from CGI and DIY.org • <i>Behaviors:</i> Teachers use CGI Inventory Database to plan the lessons and track students. Students showcase their Math problem-solving skills on DIY.org.

TABLE 3. Summary of students' projects that applied the HCD Process. (Continued on next page).

PROJECT	DESIGN CHALLENGE	PROJECT DESCRIPTION
Get Outside	Kids not getting enough exposure to the outdoors	<ul style="list-style-type: none"> • <i>Target audience:</i> 4-6th graders and teachers • <i>Tech Tool:</i> student-built website • <i>Goal:</i> Educate children on local wildlife and national parks and spark interests to obtain first-hand experience • <i>Behaviors:</i> Teachers organize field trips using resources and guidance from the website. Students will write a report of what they learn from the field trip
Skills for Life	High school students lacking survival skills	<ul style="list-style-type: none"> • <i>Target audience:</i> High school seniors • <i>Tech tool:</i> Skills for Life app • <i>Goal:</i> Equip students with life skills (i.e., cooking, laws, directions, paying bills, filing tax, etc.) to prepare them for the real world after high school • <i>Behaviors:</i> Students will take a quiz about their performance on the skills they learn on the app
Motivating with Monster	Students lack the motivation for academic success	<ul style="list-style-type: none"> • <i>Target audience:</i> K-5 teachers • <i>Tech Tool:</i> Class Dojo • <i>Goals:</i> Improve teacher-parent communication and kids' behaviors in the classroom. Parents can connect to their child and help them academically. • <i>Behaviors:</i> Teachers collaborate with parents in co-managing kids' behaviors. Kids enjoy extrinsic rewards with Class Dojo.

TABLE 3 (CONT). Summary of students' projects that applied the HCD Process.

was first applied in the course, I as the instructor, was the walking example of ambiguity who faced a lot of difficulties in approaching, interacting and navigating through the unknowns when operating the method for the first time. As strongly as I believed in its merits, there were times I did not have good answers to questions from my students due to my lack of practical experience with the HCD process. Also, the concept of *ambiguity* was not well taken by many students who were used to being told what to do with granular, literal procedural instructions as explained previously. For examples, the students were confused about what topic to choose for their TLP, what technological tool to use and how many were required, how phase 1 draft would look like, whether word count would be required, what the project impact would sound like, what subject area(s) to focus, how many people they should interview for feedback and what questions to ask.

Most of the answers to these questions could either be found on the syllabus or during the lectures, whereas some questions were irrelevant. However, the fact that they were asked showed the students' level of confusion and anxiety. Although the HCD process embraces ambiguity and risk taking, understanding where my students came from, I realize it was critical to not overdose them with ambiguity and risk taking. Thus, while encouraging them to step out of their comfort zone and be creative, my short-term goal to avoid

overdosed ambiguity or frustration in class was by resolving questions and providing timely support. My long-term goal was revising the syllabus for the following semester as described in the design process.

Fortunately, despite the anxiety and sometimes frustration felt along the way, there was strong evidence of effort and collaboration put in the class activities and group projects. This was shown in the students' final project artifacts, as well as the appreciation and trust in the HCD process in the course reflection.

Major revisions took place by the end of the fall 2018 semester after the students' feedback was gathered. I went through a thorough examination of the process of applying HCD in the course conceptually and procedurally, what worked well, what did not work well and how to improve the steps. A few major amendments made upon the second launch of the course included: (a) reducing the level of ambiguity in the TLP both in the instruction given to the students and the assignment requirements (i.e., more specific description and intention of the assignment was communicated), and (b) more choices on the areas of focus and technological applications for the students. The reduction of (and thus reasonable) ambiguity extent seemed to be well-received by the students in the second launch. Evidently, questions from students were less about confusion around the HCD process but more specifically and in depth of one's TLP.

The expansion of choices and embracement of creativity was the backbone of the design revision process. In addition, the homework assignments and in-class activities were re-designed to be supportive and supplementary to building up the TLP assignment (see Table 1 for details). In the meantime, supplementary readings and activities were added to help students better understand the nuts and bolts of and develop trust in the HCD process as well as adopt calculated ambiguous and risk-taking mindset and mentality. In other words, the revision and instruction were a negotiation process between setting higher expectations on the students' works and mentality development and providing scaffolded (i.e., specific steps that students can follow) instruction.

Peer feedback was one of the major activities performed by the students in the process of creating and developing the TLP. Accordingly, students were supposed to provide feedback to their peer's TLPs at every stage using guided questions provided by the instructor via Google Forms. Although the students reported the guided questions being very useful as they navigated through reading a new project, a lot of times they found it challenging to communicate their thoughts with their peers at an absolute truthful level for fear of hurting their feelings or depreciating their work. They ended up choosing to be nice and tip toeing on their feedback. To alleviate this problem, open class discussion and workshops on how to provide constructive feedback with demonstration were provided to help students

acknowledge the importance and hence change their view about peer feedback.

Another dynamic challenge involved students' anxiety towards the course grade. Similar to the course ambiguity, students reported different levels of anxiety when not knowing about their grade right away or how well they were doing in the class. However, as they were deeply engaged in the making part of the project, their energy and attention were reported being shifted to attempting to make an impact on the audience with their work. Students began to care more about whether their work would make a positive change in the community and pour more energy into making that happen instead of worrying about their grades. As an instructor, I appreciated the shift to intrinsic motivation, aspiration and value building in the students' mindset. This has strongly motivated me to continue navigating the students' attention towards value and connection building during their academic growth and shy them away from anxiety towards course grade.

Finally, the whole class was built on group work and collaboration, which required students to work together during the entire design process. Although collaboration work presented strong values as indicated previously, a number of recurring problems with student teamwork related to schedule conflicts, number of contributions among group members and possible clashes in working style and ethic, intellectual capacity and communication styles, etc.

NAME/CATEGORY	CHALLENGE DESCRIPTION	RESOLUTIONS
APPLICATION OF HCD	Lack of expertise support. The instructor was the walking experience/example of ambiguity	Revision! Revision! Revision! <ul style="list-style-type: none"> Made the project/tasks less ambiguous Designed activities that support TLP Collected student feedback and revised course accordingly
MINDSET ADOPTION	Students were used to literal instructions and were not very inceptive of the ambiguity concept at the operational/procedural level.	<ul style="list-style-type: none"> Supplementary readings/resources on HCD Activities on developing HCD mindset
PEER FEEDBACK	Students were fearful of hurting their peers' feelings and decided to be nice and sugar-coated with their feedback on their peers' works.	<ul style="list-style-type: none"> Training/workshop on how to provide constructive feedback
GRADE ANXIETY	Students freak out not to know about their grades and how they were doing in the class	<ul style="list-style-type: none"> As they engaged in the project, their attention and energy were shifted towards creating a meaningful project and making an impact in the community
GROUP WORK	Schedule conflicts, amount of contributions among group members	<ul style="list-style-type: none"> Students drafted and signed the group agreement with terms and conditions

TABLE 4. Highlighted Challenges and Resolutions in Applying HCD process by the design team.

Research by Tarricone and Rica (2002) lists the top qualities for successful collaboration as: commitment to team success and shared goals, interdependence, interpersonal skills, open communication and positive feedback, appropriate team composition, commitment to team processes, leadership and accountability.

An advantage in this case was the group was formed by choices based on students' mutual interests and solutions to a problem that they aspired to find. Nonetheless, as an instructor, I firmly believed high work ethic, efficient communication styles and accountability must be built and practiced among the group members among the other qualities. Thus, after the group was formed, the students were tasked to research qualities of successful teamwork and draft an agreement that specified terms and expectations on the level, amount and quality of contribution, as well as communication for their team. The group contract draft would be reviewed by the instructor and returned to the students to sign and resubmit. Once the agreement was submitted, every group member was held accountable for the agreed terms and conditions. Table 4 describes some highlighted challenges and resolutions in applying HCD in the C&I 100 course.

FINAL THOUGHTS

Being an established goal-oriented learner, I tend to measure my learning with tangible productivity. Given a course of a semester, I aspired the same for my students: to help them accomplish meaningful tasks with measurable learning outcomes and experience a memorable emotional learning journey. As for personalized learning, my desire is for my students to experience empathy, passion and commitment in ways that feel most natural to them. I demonstrated it first by recruiting, honoring their voices and treating them as learning resources. Students will be more engaged and motivated if their ideas and emotions are invested. We the educators can only gain from this investment. I wanted my students to experience choice making as a group and

by taking responsibility for their choice, they developed a sense of ownership and collaboration for their work. Finally, I wanted them to be drawn to creativity and to embrace calculated risk taking by going after what they wanted to do and be mindful of the obstacles on the road.

All in all, adopting a new mindset takes time and effort and should be treated as a form of investment. Given the characteristics of these student teachers who are used to procedural instruction and being told what to do, this process needs to be executed with reasonable and affordable amounts of patience, care, caution, tolerance of ambiguity, risk taking and mindfulness.

Today we are all learners, whether we are on an active career trajectory or retire. As an educator, I strive to retain the passion for what I teach, my understanding of how dynamically students learn, and a genuine caring for them as a person. HCD has helped to obtain these purposes.

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APPENDIX A

Software/Application Evaluation Checklist

Group members:

Name of the software/app:

Official website:

Adapted from *Technology Integration for Meaningful Classroom Use: A Standards-Based Approach* by Katherine Cennamo, John Ross, and Peg Ertmer.

Provide the answers where apply

	YES	NO	HOW (PLEASE SPECIFY)
1. Does the software support the needs and objectives of the curriculum in your project?			
• Are the objectives of the software documented?			
• Do the objectives match the goals in your project?			
2. Does the software/app's target audience match the intended audience in your project?			
• Does the software match the learner audience in age, reading, and other skill level?			
• Is the software accessible to students with disabilities?			
• Is the display of information appropriate to the learner audience in your project?			
3. Is the return on investment justifiable to the school and district?			
• Is the software cost efficient?			
• Is the necessary hardware available?			
• Can additional hardware be obtained easily?			
4. Is the software easy to use?			
• Are directions easily understood?			
• Can the user navigate through the software easily?			
• What kind of technological skills (if any) does it require students to have in order to use it?			
5. Software/app credibility			
• Does the software/app have good review?			
• Is the software well supported			
• Is there a print or online manual?			
• Does the software include all necessary guides or workbooks?			
• Is technical support provided online or by phone?			
6. Is the content accurate?			
• Is the program free of gender and racial stereotypes?			
• Is the language free of errors in spelling, grammar, and pronunciation?			
• Does the program provide immediate feedback?			
• Is the feedback credible and context- based?			
7. Is the software an appropriate medium for learning the targeted skills?			

	YES	NO	HOW (PLEASE SPECIFY)
• Is the text displayed consistently and easy to read?			
• Is the quality of visual and auditory elements acceptable?			
• Are graphics and animations appropriate to the target audience?			
• Do the graphics and animations support the program's intentions?			
• Does the program promote successively higher levels of cognitive activity?			
• Does the program incorporate active participation?			
What is/are your concern(s) about the software/application?			
Other comments			

APPENDIX B

Lesson Plan Example for Time to Relax

Lesson Plan 1

BASIC INFORMATION	
Goal	Students should feel more calm and relaxed after participating in this activity.
Grade Level	2 nd
Class Size	22 students
Time Frame	25-30 minutes
Subject	Music & Physical Education (Stretching)
Technological Source	https://timetorelaxedu.wixsite.com/timetorelax
Materials Needed	Speakers (Can be the laptop's speakers or supplemental speakers connected to laptop) Laptop with access to Internet Small Pillows Carpet Area "How I Feel" Journal (for each student & teacher)
PLANNING CONSIDERATIONS	
Notes:	Some students may have a hard time getting settled into doing the activity. If students are having a hard time focusing, ask them if they would like to move closer to the board or move to a different place in the room.
LEARNING EXPERIENCES	
Sequence of Events: (After Lunch- Optional)	<p>Step by Step Activity:</p> <p>Step 1: Ask students to get out their "How I Feel" Journals, turn to today's date, and mark how they currently feel. The students can write notes in the "Notes" section if they want to. Ask students to leave their journals on their desks.</p> <p>Step 2: Ask students to find a seat and get comfortable. (Students will have options of sitting at their desks, sitting on the carpet, or laying down on the carpet.)</p> <p>Step 3: While the students are finding their spots, turn on the projector, turn on the laptop, open an internet browser, and go</p>
(Integration of Technological Tool:)	<p>to the Time to Relax website: https://timetorelaxedu.wixsite.com/timetorelax</p> <p>Step 4: On the homepage of Time To Relax there will be four categories to choose from: Music, Yoga, Meditation and, Lesson Plans. Please select Music.</p> <p>Yoga: Will have yoga videos. Meditation: Will have meditation videos. Music: Will have calming instrumental video. Lesson Plans: Will include this lesson plan as well as other lesson plans. These lesson plans will incorporate the use of the website (Time to Relax).</p> <p>Step 5: Click on the Music tab and find the "Deep Relax Music for Children" video. Make sure the speakers & sound are on.</p>

Step 6: Slowly start counting down from 10 to 1, which is a cue to the students that they need to quietly find a spot if they have not already. Dim the lights in the classroom and tell the students to close their eyes and rest their heads on their desks, in their hands, or on the pillows on the ground.

Step 7: Start the video by pressing the Play button.

Step 8: Soothingly tell the students to focus on their breathing, the music, and let their minds and bodies relax. Take a seat and observe the students, but also focus on your own breathing, the music, and letting your body relax.

Step 9: At the 18 minute mark of the video, pause the video. Then tell the students to slowly open their eyes and stretch a little bit. You can lead the students on some simple stretching such as stretching arms across chest and stretching arms above head or let the students stretch by themselves. The stretching can last 2-3 minutes. Some sample stretches are:



<https://www.pexels.com/photo/photography-of-woman-in-pink-tank-top-stretching-arm-634030/>



<http://www.freestockphotos.biz/stockphoto/15320>

Self-Assessment

Step 10: Ask students to open their "How I Feel" Journals and turn to today's date. The students will fill out how they feel now and write additional notes if they would like to.

Step 11: While the students are filling this out, assess how you are feeling on your own "How I Feel" journal.

Step 12: After 3-5 minutes, ask students to put away their journals.

On Fridays, ask students to write a small reflection on how they think they did during the week with controlling their emotions and staying calm, what they like best about Time to Relax, and how they can improve at staying calm & focused.

Closure

Step 13: Thank the students for being wonderful and for participating in the activity. Remind students to be kind to one another.