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Exploring How Learners Integrate Personally Meaningful Issues in a Project-Based MOOC

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Abstract: We explore the impact of increasing learner agency through a project-based learning approach in a massive open online course, *Problem Solving Using Computational Thinking*. We discuss ways in which the course's pedagogical approach allowed learners to bring their present views and concerns together with the course's subject matter. Many learners chose to base their final projects on applications of computational thinking that address challenges they face in their personal lives, including the COVID-19 pandemic, carrying an individualized sense of importance and urgency. We assert that this approach enabled learners to more deeply internalize the role that computational thinking can play in their own lives, thereby enhancing knowledge construction and motivation.

Introduction

In this paper, we explore the educational benefits of a pedagogical approach that is rarely used in massive open online courses (MOOCs): project-based learning (PBL). We evaluate how learners in one MOOC, *Problem Solving Using Computational Thinking*, use the increased learner agency that PBL can provide to tackle problems that have a clear connection to their own lives or interests. We identify particular benefits of this less didactic approach to MOOCs, demonstrating its successful implementation in an online learning environment at scale, and we explain implications for addressing some of the issues often associated with online learning.

Objectives

Very little work has previously been undertaken to incorporate PBL into MOOCs. This may simply be due to the overwhelming tendency to conceive of courses of this size as lecture-based by necessity. It may be difficult for instructors and designers to imagine a successful PBL MOOC, or really anything that does not conform to the "traditional MOOC template" (Rhoads, 2015). We therefore attempt to fill this gap by evaluating the effectiveness of one PBL MOOC, specifically focusing on the problems that learners chose to tackle in their final projects.

Our overarching goal was to evaluate the impact of increasing learner agency through a PBL approach, which gives learners room to work on personally meaningful, motivating projects. The timing of our study coincided with the global COVID-19 pandemic, allowing us to further study how learners chose to use the agency afforded by PBL during times of heightened emotional stress. Because the pandemic has so radically altered people's lives, we would expect learners to naturally draw on this experience. We identified the two following research questions to guide our work:

1. How can a PBL pedagogical approach allow online learners to establish personal ties to the subject matter and thereby personalize their learning journey?
2. How has the COVID-19 pandemic—and its effects on the daily lives of people around the world—shaped the kinds of project topics learners choose in a PBL MOOC?

Perspectives

The *Computational Thinking* MOOC was designed around a PBL approach, which integrates instructional activities within projects motivated by students' own interests and contexts (Krajcik & Blumenfeld, 2005). The two essential components of PBL are (1) a driving question or project that drives the instructional activity and (2) an artifact or final product that answers the driving question (Blumenfeld et al., 1991).

PBL approaches for computational thinking instruction have been well documented and have been shown to invoke students' creativity and sense of responsibility (Hsu et al., 2018). PBL is rarely used in MOOCs, which typically adopt a didactic, lecture-based format with instructional videos, quizzes and activities, discussion forums, and graded assignments (Rhoads, 2015; Haber, 2014). It has been explicitly suggested that MOOCs could benefit from other pedagogical approaches (Eisenberg & Fischer, 2014). While PBL approaches are traditionally used in face-to-face contexts, especially in engineering education contexts (Shekar, 2014; Mills & Treagust, 2003), some early work has found positive attitudes among learners in a project-based MOOC and has emphasized the importance of learner autonomy in these contexts (Barak & Watted, 2017).

The *Computational Thinking* MOOC centers much of its pedagogy around a final project where learners identify a problem to solve computationally (in this case, one related to a real or hypothetical “natural disaster”), and then use the knowledge and techniques they learned throughout the course to iteratively develop an algorithmic approach towards a solution. For their final artifact (Blumenfeld et al., 1991), they are asked to submit a graphic organizer that displays the multiple iterations of their work (see *Figure 1*) and a diagrammed algorithm of their final solution for peer evaluation, after which they must also evaluate other learners' projects. This approach affords learners a level of flexibility rarely found at the scale of MOOCs since students are able to select the project topic on which they will center their efforts.

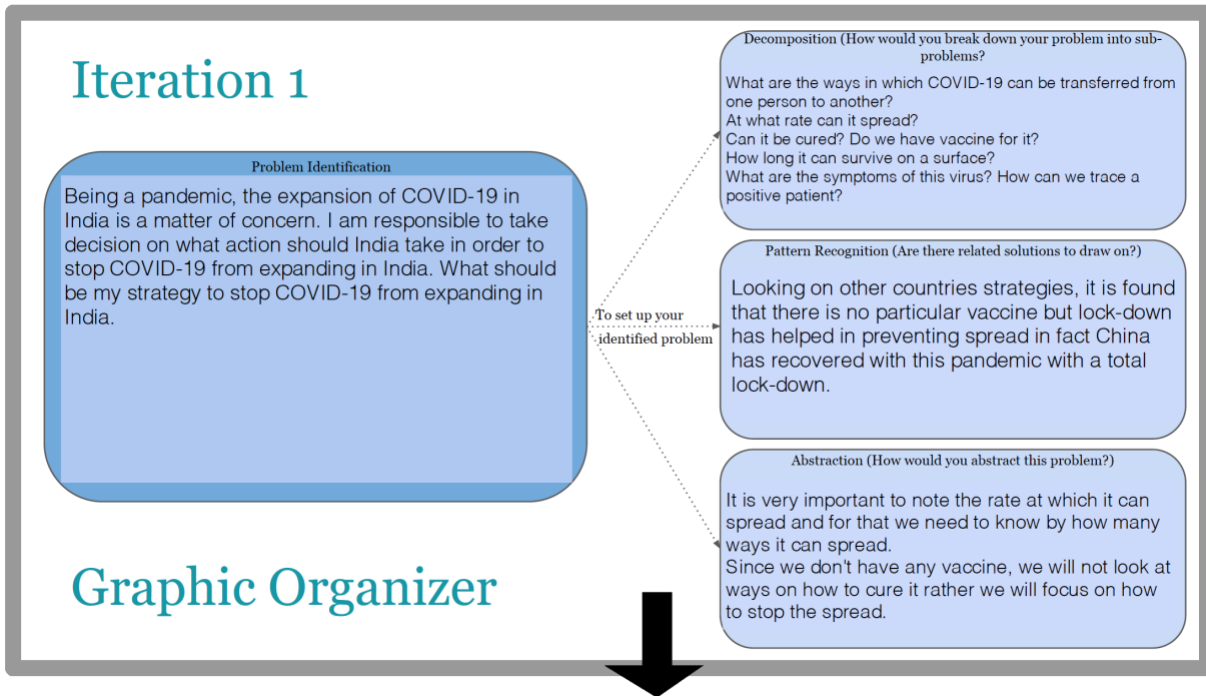


Figure 1. Example of the first iteration from a learner’s graphic organizer.

Materials and Methods

Our study consisted of a qualitative analysis of 164 peer-reviewed final projects, submitted between November 18, 2019 (the course launch date) and August 11, 2020. We identified general categories of problems addressed by these projects to get an initial sense of the “natural disasters” that learners chose to focus on. We also tagged wording that reflected a personal connection to the chosen topic.

To answer our second research question, we extracted a total of 32 final projects related to the COVID-19 pandemic that therefore reflected current world events. For each of these pandemic-related projects, we first used an inductive approach (Thomas, 2006) to data analysis at the project level in order to identify the specific aspects of the pandemic that learners addressed. We organized our results into broader categories and performed a second round of coding using this updated codebook. We then distilled the main problem that each project chose to tackle into a succinct problem statement and matched these to our final codes for analysis.

Results and Discussion

Our qualitative analysis of final projects revealed that many learners chose to focus on problems they are familiar with or have a strong personal incentive to address, providing some insight into our first research question. Common project topics included floods, cyclones, earthquakes, tsunamis, tornadoes, and drought. One learner wrote about cancer and identified themselves as a pathologist. Many learners from India focused on flooding or cyclones, while learners from California wrote about earthquakes. One learner from Vietnam who wrote about drought

explained that “in this first quarter of 2020, Vietnam’s Mekong Delta is bracing for severe drought and salinity in the coming months, and local authorities must take every step to carefully mitigate the damage.” Similarly, a learner who focused on air pollution presented themselves as “a citizen of India” and went on to explain how “our country is facing a problem of air pollution and it is increasing continuously.”

Perhaps one of the most personal accounts, and a clear example of how PBL can allow learners to situate inquiry within personal experience, is demonstrated by the following excerpt from one learner’s final project description:

“I am in Rio de Janeiro I own a restaurant in the favelas and I am analyzing whether I need to move due to landslides in my community, which occur mainly in times of rains.”

These findings support Quintana et al.’s (2018) observations that learners in one MOOC situated the problem sets they wrote for future iterations of that MOOC within the context of their own lived experiences.

This same sense of personal investment can be seen in the projects centered around different aspects of the pandemic, helping to address our second research question. The timing of pandemic-related final project submissions clearly corresponds with the rise in coronavirus cases outside of China, with the first related project submitted on March 24th and quickly increasing from there (see *Figure 2*). Since that date, 20% of submitted projects have been related to COVID-19 in some way. Interestingly, as issues and problems surrounding the pandemic unfolded in real time, learners articulated specific dimensions that could be addressed using approaches advanced in the course. For example, early projects were mostly about deciding to enforce stay-at-home orders and social distancing measures, while later projects largely focused on whether and when to begin reopening society. The reopening trend began with a project on May 4th and ramped up since then. Other broad aspects of the pandemic addressed by these projects include considerations on when and how to best distribute resources, decisions about treatment and prevention, and how to manage the running of schools and universities. The complete list of general topics and individual problem statements can be seen in *Table 1*.

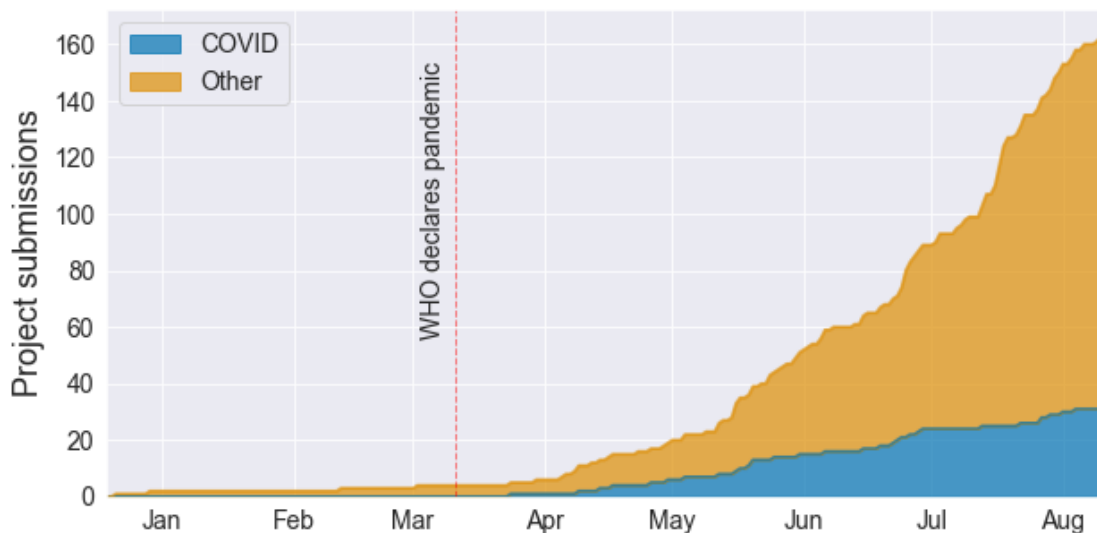


Figure 2. Proportion of pandemic-related final project submissions over time (stacked).

One thing to note is the possibility that some learners were deterred from choosing to focus their project on the pandemic because of the wording on the project’s instructions, which asked learners to choose “a potential natural disaster that could impact the well-being of nearby residents.” Some learners who nevertheless chose to write about the pandemic did not feel that COVID-19 fit within the category of “natural disaster,” as is clear from these excerpts from their project descriptions:

“Rather than focusing on a ‘natural disaster’ like too much snow or flooded streets, I’ve chosen COVID-19 since it has limited people’s access to proper nutrition and healthy diet.”

“COVID-19 is a pandemic the whole world is talking about right now. This may not be a natural disaster but is more effective than a natural disaster.”

These excerpts—along with learners’ decision to choose a different path than instructed—highlight the weight that the pandemic held in their personal lives at the time of their project submissions.

Many of the pandemic-related projects dealt with aspects that hit close to home, such as considerations for keeping schools safe or how to prevent further transmission of the virus while minimizing harm to the economy. One learner from Bangladesh explained that they chose “the most concerning issue right now, COVID-19” and how “many people” in their community in Bangladesh “are suffering from the coronavirus and every day the new cases are just growing and growing.” Another learner expressed concern for their own personal safety while commuting, stating that “I have to decide whether to go shopping or not, as the areas that are not locked down are equally dangerous since the people there might have been infected by the virus.”

We also identified some unique challenges and considerations surrounding the pandemic. One learner focused on the potential benefits of home gardening to counteract the possible loss of nutrition caused by lockdown policies and social distancing measures. Another project addressed the compounded issue of a commonly occurring natural disaster in their region—in this case a cyclone—exacerbated by the pandemic and the need to practice social distancing. A youth team leader considered the benefits of developing a social distance training program for adolescents.

In one final project, a learner expressed optimism, believing that “computational thinking can solve this problem [of the pandemic] for people around the world. Computational thinking can make the problem clearer, helping us understand how to protect ourselves better.” This sentiment clearly demonstrates a strong motivation to understand the course’s subject matter, which was strengthened by a personal commitment to addressing this issue affecting so much in their own life.

Our exploration of learners’ final projects revealed ways in which learners were able to personalize their online learning journey by establishing personal ties to the course’s subject matter. The emotion and sense of urgency with which many of the final projects were written indicate that learners were able to internalize the value of computational thinking in their own areas of interest for real-life problem solving.

Table 1. Final project topics and problem statements addressed by learners.

Topic	Problem statement
Fighting the virus generally	<ul style="list-style-type: none"> ● How can we ensure that we have enough resources to fight the virus for the foreseeable future? When does further action need to be taken? ● How can we best save people from the coronavirus? ● What actions should an individual take in order to stay safe from COVID-19, and what should they do if they contract the virus? ● What actions can be taken to reduce the number of infections while maintaining a running economy?
Preventing further spread generally	<ul style="list-style-type: none"> ● What precautions should be enforced to prevent the spread of the virus? ● What can I personally do to keep myself safe from COVID-19? ● What can be done to stop the spread of the pandemic? ● What actions or strategies should be considered in order to stop the spread COVID-19? ● What strategies should be considered for preventing the spread of COVID-19 in India? What actions should be enacted if it does spread widely? ● Based on what we currently know about the coronavirus, how can we most effectively prevent its further spread? ● How can we fight the spread of the coronavirus? ● What activities or systems should be considered to stop the spread of COVID-19? ● How can we best fight the spread of COVID-19? ● How should I decide if conditions are safe enough to reopen my business and ramp up production?
Life in quarantine	<ul style="list-style-type: none"> ● How should Indians returning home from abroad be effectively quarantined to prevent further spread of the virus? ● How should I decide if I should commute to buy essential items or wait longer at home? ● How should individuals decide if starting a home garden will provide them with a good alternative to nutrition in order to avoid crowded supermarkets during the pandemic? ● How can we provide the best kind of care for local residents during the government lockdown?

<p style="text-align: center;">Managing school</p>	<ul style="list-style-type: none"> ● After reopening the school, what considerations need to be taken into account daily in order to assess whether school should remain open or if it should close again? ● What options exist for keeping pupils safe without completely canceling school? How should the decision be made? ● Should universities force students to take exams during the pandemic? If not, what alternatives exist? ● What action should universities take to help prevent the spread of the virus? ● How should college exams be conducted in order to avoid the further spread of the virus? What potential alternatives exist, and under what conditions should they be implemented? ● Should educational institutions be reopened, and what precautions should be taken if so? ● What steps need to be taken in order to ensure that each high school student is able to take their exams safely? ● Should schools reopen like normal, go completely online, or take a hybrid approach?
<p style="text-align: center;">Distribution of resources</p>	<ul style="list-style-type: none"> ● Who should I give food/money to that has been most negatively affected by the pandemic? How should I organize the buying and distribution of these resources? ● Which locals have been most negatively affected by the pandemic, and how should my friends and I decide who to give financial assistance to? ● What precautions should the public take, depending on the population they belong to, and how should resources be allocated to treat the infected?
<p style="text-align: center;">Miscellaneous</p>	<ul style="list-style-type: none"> ● What special arrangements should be made for the people who continue to travel for work during lockdown and for those who choose to stay home? ● Considering the need for social distancing, when should residents affected by a local cyclone and currently staying in a shelter be asked to leave? ● Is the development of a distance training program for adolescents a worthwhile effort?

Scholarly Significance

Our findings have demonstrated how PBL can be successfully integrated into a MOOC, while also highlighting specific benefits of this pedagogical approach. In the case of the *Computational Thinking* MOOC, learners were able to choose project topics closely related to their interests,

their experiences, and the large problems currently on their minds. For those who chose to look at the COVID-19 pandemic or other unfolding events, we expect that the ongoing nature of the problem will lead to many additional opportunities to reflect on the skills they have learned. A PBL approach can enable learners to more deeply internalize the role of the MOOC's subject matter in their own lives, thereby enhancing knowledge construction and motivation.

Though providing learners with a high degree of agency in online courses may not always be feasible—especially in courses as large as MOOCs—doing so can empower students and help them establish personal ties to the subject matter. This heightened level of buy-in from students, created through a combination of greater autonomy and personal interest in the subject, has been shown to lead to more robust learning (Patall, 2013). With the increased attention that online learning has received in recent months, it is more imperative than ever to use effective pedagogies that will provide learners with greater autonomy and thereby increase motivation and learning. PBL is one such pedagogical approach that instructors and course designers should consider in order to achieve these ends.

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