Motivating Online Learning through Project-Based Learning During the 2020 COVID-19 Pandemic

Avneet Hira
Boston College,
Massachusetts, USA

Emma Anderson
Massachusetts Institute of Technology,
Massachusetts, USA

Abstract

The transition of traditional schooling to online learning during the COVID-19 pandemic disrupted formal school education. Though at home, teachers and students continued teaching and learning in socially distant ways using online technologies. From various teacher surveys, only about 60% of students in the United States regularly engaged with learning activities. Teachers and parents also expressed a significant need for help to keep students motivated and engaged in learning activities. During the pandemic, online learning left teachers and parents needing support for learning activities that motivate and engage students. Project-based learning is an increasingly popular pedagogical practice centered around students working collaboratively on projects while the teacher facilitates learning activities and progression. Project-based learning embodies several factors considered central to motivation in online learning. In this paper, we inquire how this approach presents itself as a candidate for learning during the pandemic when considering students' motivation to learn through online learning experiences. We construct a conceptual framework informed by motivational theories that share core tenets with this form of learning and use the framework to analyze interviews of 11 teachers from 4 schools that taught with a project-based learning approach before the pandemic and transitioned to teaching, using it online, in the Spring of 2020. From our analyses of the teachers' narratives, we discuss teaching aspects of the approach that lend themselves well to online teaching, elements that the teachers believe are missing, and how educators might cater to these missing aspects with a focus on student motivation to learn.

Keywords: COVID-19, motivation, online learning, project-based learning

Introduction

The COVID-19 pandemic disrupted traditional school education. Physical school facilities were shut down, but school education was expected to continue. This disruption created a wide range of schooling, from photocopied packets being mailed home to video conference classrooms. Unlike other disasters like hurricanes and tornadoes where schooling is temporarily paused, the COVID-19 pandemic forced physical school facilities to close, but teachers were expected to continue socially distant teaching using technology. This is attributable to a confluence of factors unique to the current time, comprising broader access to computers and internet than ever before (Child Trends, 2018), availability of technologies for online teaching and learning (Emmanuel, 2018; Meticulous Research, 2020; Wan, 2019), and the unique constraints of the pandemic wherein students, as long as socially distant, can stay home and continue learning.

However, learning from home did not result in the same teaching and learning experience for teachers and students as before the pandemic. From various teacher surveys, only about 60% of students in the United States regularly engaged with learning activities (Educators for Excellence, 2020; Kraft & Simon, 2020). These numbers are difficult to report by districts and states, as no standard metric or definition for student engagement during the pandemic has been agreed upon yet (Barnum & Bryan, 2020). Student engagement was divided across race and socioeconomic status lines, where teachers of students of color and those belonging to low-income groups reported lower student engagement in learning compared to other groups (Gewertz, 2020). Irrespective of student background, teachers and parents expressed a significant need for help to keep students motivated and engaged in learning activities. 44.6% of teachers from a recent RAND study (Hamilton et al., 2020) reported needing help with strategies for keeping students engaged and motivated, and 53% of parents in a National Parents Union survey (Echelon Insights, 2020) indicated needing help with engaging their children in good activities.

This transition to online teaching, a phenomenon that we refer to as social distance teaching and learning (Anderson & Hira, 2020), disrupted formal education, leaving teachers and parents needing support for learning activities that motivate and engage students. In this paper, we explore how teachers who use project-based learning (PBL) were able or unable to motivate their students to learn during social distance learning. We first construct a conceptual framework informed by motivational theories that share core tenets with PBL, and then analyze interviews of 11 teachers from 4 schools that transitioned to teaching using PBL online in the spring of 2020. From our analyses of the teachers' narratives, we discuss PBL teaching aspects that lend themselves well to online social distance teaching, aspects that the teachers believe are missing, and how educators might cater to these missing aspects with a particular focus on student motivation to learn.

Literature Review

Project-based learning, true to its name, uses projects for teaching and learning. Projects provide students with opportunities to be central in their learning, work autonomously over a given period of time with facilitation from the teacher, collaborate and cooperate to research and create projects, and reflect on their learning individually and as teams (Bell, 2010; Blumenfeld et al., 1991; Thomas, 2000). Through PBL, students work on relatively complex and advanced problems that are authentic in context. Learning is grounded in explicit educational goals (Moursund, 1999), often including lifelong learning (Diehl et al., 1999).

Theoretically, PBL is grounded in constructivist and constructionist educational theory, wherein learners construct knowledge based on their experiences and prior knowledge (Piaget, 1970) and mediated by their interaction with artifacts (Papert, 1980; Papert & Harel, 1991). Savery and Duffy (2001) claim PBL to be one of the best exemplars of constructivist learning. PBL has been shown to produce a better attitude towards learning and higher academic achievement (Baş, 2011; C. Chen & Yang, 2019) compared to traditional instruction and textbook-based teaching. Students are motivated to pursue nontrivial problems by genuinely engaging with them (Blumenfeld et al., 1991). Ideally, PBL in practice is scaffolded to meet appropriate learner goals, supports teachers and students to enact effective teaching and learning, includes formative reflective and peer evaluations, promotes both collaborative work and individual student ownership and agency (B. J. S. Barron et al., 1998; Kokotsaki et al., 2016; Svihla & Reeve, 2016). In synthesis, PBL places student autonomy and agency at the center of the learning process, takes place in socially connected settings, develops individual students' abilities and skills, and the projects are relevant and interesting to the students.

Many studies exploring PBL and online learning have focused on how online tools like cloud computing and online forums can help facilitate PBL pedagogy. Studies have found that cloud computing or collaborative online tools such as the Google suite or Office365 are valuable tools for facilitating PBL (Çakiroğlu & Erdemir, 2019; Sutia et al., 2019). Ching and Hsu (2013) concluded that peer feedback encouraged student participation and learning in online PBL assignments. Others have explored student group dynamics in the online environment. Yilmaz et al. (2020) investigated how different online group dynamics comprising vertical and shared responsibility are both effective in completing PBL assignments. While prior work on online PBL provides relevant grounding for this paper, it is essential to note that our study is situated in a time when teachers abruptly moved to remote teaching or what we have termed social distance learning. Most prior work in the area has focused on intentionally designed online PBL experiences, whereas during the shift to online teaching during the pandemic, schools and administrators did not have the time to deeply think through and implement any major redesigns mid-semester. Thus, we report on this unique maneuver that many teachers across the world were expected to perform.

Conceptual Framework

To understand relevant motivational factors that play a role in effective online PBL, we form a conceptual framework by synthesizing tenets of relevant motivation theories, namely, self-determination theory (SDT) (Deci & Ryan, 1985), achievement goal theory (AGT) (Nicholls, 1984; Pintrich, 2000b; Senko et al., 2011), and the role of interest in learning and development (Renninger et al., 1992). Below we explain how these theories aid understanding motivation to learn in PBL settings.

According to Deci and Ryan (1985, 2000), individuals' self-determination towards various tasks is promoted by their experience of achieving the psychological needs of autonomy, competence, and relatedness. Autonomy refers to an individual's sense of agency in a given situation, competence refers to an individual's capability to carry out a task, and relatedness is the quality of connecting with others. SDT has also been used as a theory to understand motivation in online learning environments (Hartnett, 2016). Unsurprisingly when students are supported in their autonomy, competence, and relatedness to learning, students improve in these three psychological areas, in turn favorably affecting their self-determination to learn in online settings (K. Chen & Jang, 2010). Kim and Frick (2011) reported that perceived relevance and competence to use technology, in addition to age, were the best predictors of learners'

motivation to begin self-directed e-learning. This motivation to start self-directed e-learning, along with learners' perceived quality of instruction and their fit for online learning, predicted their motivation to continue self-directed online learning. Hsu (2019) also reports that in an online setting, individuals' experience of agency, capability, and relatedness, resulting in self-determination, is associated with a higher perception of knowledge transfer and increased achievement of course objectives.

Another prominent and relevant motivational theory is the achievement goal theory. Originally, the theory proposed two types of motivational goals for learning, task and ego goals (Nicholls, 1984), as in goals that are met by completing tasks or supporting one's ego, respectively. Over time, these goals have been revised to be called mastery and performance goals, respectively (Dweck, 1986). The first aimed at mastering tasks, and the second at performing better than others (Pintrich, 2000b). Some propose that mastery goals are more socially desirable by students because of their ability to please parents and teachers (Darnon et al., 1997). Contemporary conceptualizations have introduced a multiple goal perspective to the theory which combines both mastery and performance goals (Elliot, 1999; Harackiewicz et al., 2002; Pintrich, 2000a). A relevant approach for this study is the idea that students shift their motivation between the two types of goals as and when it is relevant in their learning: they focus on mastery goals while they are learning new information and working by themselves, and motivate themselves by performance goals when taking tests (K. Barron & Harackiewicz, 2001; Pintrich, 2000b). In the case of PBL, a majority of learning time is spent in the former.

Finally, the third theory that supports motivation to learn in PBL settings is the role of interest in student learning and development (Renninger et al., 1992). According to Renninger et al., students' interests play an essential role in their engagement with learning experiences. This interest can be personal or situational, or both. Personal interest influences a learner's engagement with the social and non-social environment, and situational interest refers to how interesting the environment is by itself to encourage interactions with people and objects. A related theory is that by Voss and Schauble (1992), who propose a model of learning in which learning takes place in both, within the individual, and in the environment that the individual is in. They claim that individuals use two types of "equipment" to learn. The first is value-based that informs individuals' goals and interests, and the second is intellectual that informs individuals' knowledge and beliefs. As per their model, learning takes place within the interplay of these two equipment.

For our study, we synthesize the factors from the above theories as relevant to PBL. These include personal meaning and relevance, autonomy and agency, connections with others, and competence development.

Methodology

For this paper, we interviewed eleven high school teachers from four schools across three states of the United States. All four schools had adopted a PBL approach to teaching prior to the pandemic and continued their PBL practices with the limitations of the pandemic and virtual teaching. See table 1 for the teacher pseudonyms along with their school contexts. The teachers belong to a mix of suburban, urban, rural public, and public charter schools.

Table 1: Teachers and school background

Pseudonym	School
Chloe	Urban Public Charter
Leah	
Melissa	
Naomi	
Denise	Urban Public Charter
Jacob	
Eric	Suburban Public
Eli	
Tiffany	
David	Rural Public
Rebecca	

All four of the above schools are part of a network of schools supported by an organization committed to rethinking and changing high school education. As members of this organization, the school leaders and teachers from the four schools are part of common communities of practice.

We interviewed the teachers between May 11th and June 15th, 2020, using a semi-structured interview protocol developed to understand the teachers' perspectives on teaching with a PBL approach, their experiences working with instructional coaches, and their transition to social distance teaching in the wake of the pandemic. For this paper, we limit our analyses to the answers and narratives from the interviews in response to their experiences transitioning to social distance teaching triggered by the pandemic. All the teachers were teaching completely remotely i.e., from home, at the time we interviewed them. We conducted deductive coding (Corbin & Strauss, 2012; Denzin & Lincoln, 2005; Miles & Huberman, 1994; Patton, 2014) of the interviews based on the concepts of the conceptual framework, as explained in the previous section. The line of inquiry or research question for this paper is:

> How does PBL present itself as a candidate for social distance learning when considering students' motivation to learn in online learning experiences?

Ethical Considerations

This research study was determined exempt by the Massachusetts Institute of Technology Committee on the Use of Humans as Experimental Subjects under the exemption criteria as defined by Federal regulation 45 CFR46 under Category 2 – Educational Testing, Surveys, Interviews or Observation. All participants provided informed consent to be interviewed for the purposes of this research study and were compensated for their time spent on the interview. Pseudonyms were used in reporting the data to protect the participants' identities.

Findings

Personal Meaning and Relevance

The first lens in the conceptual framework is that of personal meaning and relevance. In PBL, students work on projects and activities that they find personally interesting and relevant to their lives. This is true of the students' projects in class and still true once classes pivoted to remote in the spring of 2020. The teachers share how, during the pandemic, their students continue to work on projects that the teachers find educationally meaningful, and the students personally interesting. In the following quotes, teachers speak to how PBL as a pedagogy provides opportunities for their students to find personal meaning and relevance in what they are learning, and how this continues to be true in social distance learning.

In watching her students pursue projects that are personally meaningful Leah shares how this is helping to shift her notions of what counts as school learning and growth.

> *I love doing PBL... how can we continue to reinvent what's school ... I have some students who are sewing hats ... teaching themselves random instruments ... It's helped expand my idea of how do we measure learning and growth.*

PBL is allowing students to pursue their interests and expand Leah's notion of learning.

Tiffany, a business teacher, uses PBL pedagogy to help her students connect their class work to their own lives.

> *...I know that kids are kids, at the end of the day, they're going to say, ""It's not important to me."" But if I can show you the parts that are important, and you can walk away with those life lessons, then I've done my job.*

She recognizes that students often do not see how what they learn in school is essential. In her instruction, she ensures that students take what will be relevant and vital to them as life lessons from the project experiences.

When schools moved to remote learning, Chloe needed to reframe her PBL lessons so that students could work on projects that were still of interest to them but were also feasible given the constraints of remote learning, including a loss of supplies in her classroom. By *having students devise their own projects, and what will they need and what do they have available to them already.* Chloe reframed her PBL lessons to be relevant and feasible.

Autonomy and Agency

The second lens in the conceptual framework is that of student autonomy and agency. A PBL approach can enable students to have autonomy over their work, as they can work at their own pace and schedule in self-directed ways as long as they meet the project's broader goals. Since projects are often related to student interest and are created to be relevant to them, there is space in the experience for students to practice agency and perceive control over the learning experience and outcomes. In their experience of teaching socially distanced PBL, teachers share how they have provided differentiated learning experiences for students in the way they deliver content and mentor their students one on one. While some students who struggled in the traditional classroom performed better and even took charge of how they learned, other high performers struggled. The teachers attribute successful performance to fewer distractions

and certain students being able to better self-pace their learning. We will discuss the possible factors for students struggling to learn in the next section on connections with others.

When the pandemic started, Denise moved to a more hands-off approach, an approach that PBL enables, to provide students with high-level project goals and not day to day instruction. The students had to self-pace their way through the project, a shift in trust and agency for her students, as Denise stated *really trusting kids to guide themselves.* In giving more autonomy and agency to her students, Denise found

> *...something else that's changed is students...have traditionally struggled...doing a lot of work ...* [now they] *have been the most on top of it and the most creative.*

Remote PBL allowed Denise to place more autonomy and agency in pacing her students' work, which gave space for some students who had traditionally been struggling to thrive.

Tiffany likes that she can provide differentiated instruction for her students by teaching PBL online, which she calls a low floor, high ceiling approach. Seeing how another educator includes both the essential questions for the lesson and a section of the virtual learning platform called

> *...enrichment. I love that, and that's going to be a new thing for me because you always have more information you want to share with the students, but you don't want to overwhelm them ... It helped me reestablish what differentiation was in a different way ... it's a low floor, no ceiling approach.*

Even while providing added scaffolding Tiffany also noticed that not all her students are experiencing social distance PBL learning the same. Some of her usual high-performing students are struggling, and some that she was concerned about are doing well. Tiffany heard from her students who were thriving that they

> *...love this because I'm succeeding, and I'm getting good grades ... There's nobody in the classroom cracking stupid jokes to distract me.*

Tiffany gives the students space to have more autonomy and agency without the distractions of the classroom.

In the same vein as Tiffany, Melissa is experimenting with individualized one-on-one mentoring during the quarantine:

> *One-on-one actually helps. ... You're the person doing the work, I'm the person just giving feedback ... And I think what I would love is to translate that when we go back next year of the same way...*

Teaching PBL virtually has allowed Melissa to provide more autonomy and agency to her students through shifting her role from the holder of knowledge to guide and supporter of learning – a role she wants to continue back in the classroom.

Similar to Melissa's students', Jacob's students demonstrated agency, advocating for their classwork to be less a to-do list and more project work related to the environment, which is the school's focus.

> *I had a couple kids that wrote me and said, "Well, I can't do this. Every class is just 'Give me a list of things to do,' and it's taking forever. I hate it. ...this one student, she really was...challenging us on the mission of the school and said, "We're this environmental school, and I'm just in front of a computer all day long".*

Students spoke out for the learning they wanted to do and successfully changed the work that was asked of them.

Connections with Others

The third lens from the conceptual framework is that of experiencing connections with others. As we mention in the previous subsection, teachers share that some of their students struggle with social distance learning. One of the factors attributable to this is the lack of connection with their peers, mentors, school community, and the communities that their projects are focused on. Teachers share that in addition to the rift of not being in the physical vicinity of each other, they are also observing an emotional separation as they cannot make themselves available in their students' lives as caring adults in the same way as being in person in the classroom. Teachers believe that this lack of connection has adversely affected teamwork and collaborative aspects of learning.

Denise spoke about how the rift in social distance learning is negatively impacting relationship building:

> *...[our school] struggle with a lot of things, what we don't struggle in is relationship-building. Kids like coming to school...I feel like I've lost that joy.*

Eli similarly noticed a rift that social distance teaching has created between him and his students:

> *There's a legit distance between you and the students, not only, obviously, spatial. It feels like, emotionally, there is a distance there. It's really hard.*

He can see his students struggling to be at home without the supportive community of a classroom.

Leah misses being able to see her students' progress on their project over time, and being available for just in time supports:

> *When I'm building things for in-class, a lot of that is just me being able to be there. So, if a kid does have a question, I can just give them that sentence stem.*

In teaching online, she is unable to provide these scaffolds as easily.

Similar to Leah, Tiffany shares how she was not able to dynamically engage with her students resulting in students working by themselves on their projects: *once in a while they had*

questions, but for the most part, they did things on their own... , often not doing the complete background reading and work.

Rebecca too misses meeting with and interacting with her students one-on-one. She thinks that online communication can come across as cold:

> *... I feel like everything online seems a lot colder and a lot... more harsh when you're just typing an answer to a question.*

Similarly, Melissa craves the energy and passion that in-person engagements with her students generated, *It's really difficult to maintain enthusiasm and passion for projects when you're by yourself.* She also thinks that her students are not getting the social connections they need to do work as they are used to.

Several teachers spoke about the loss of collaborative team projects in the move to remote learning. Eli highlighted how working together in groups is absent from the online experience.

> *That's definitely missing. The small group works, having a dedicated space within those groups to be able to discuss and plan and map things out, and to even build their artifacts or their projects, that's so hard to transition to, especially, in distance learning.*

Naomi echoes Eli in the loss of social interactions and, in particular, the collaborative team projects of PBL, *I think that teaming aspect was kind of lost at this time and that is an invaluable thing that we do at (school name) is a lot of teamwork.* In the spring of 2020, collaborative projects, an integral part of many PBL assignments, were missing.

Along with a loss of collaborative learning in the move to virtual learning, students were less able to engage with the school community. Chloe longs for celebrating her students' growth as a classroom and school community. Similarly, Eric believes that an essential aspect of PBL and their school is the community that students build and feel in the school, and social distance learning omits this part of teaching and learning. In particular, Eric states:',

> *... a big part of project-based learning is not just the projects, but also the sense of social growth that happens during the project.*

In virtual learning, teachers and students had a more challenging time connecting with others to create a sense of community.

Competence Development

For the fourth lens of the conceptual framework, we look at what competencies the students are developing, and those that their teachers want them to develop while learning from home via PBL. We asked the teachers about the kind of skills they hoped their students were learning at home by themselves. The teachers shared skills and lessons that can be mastered individually, as many school districts changed their grading system due to the pandemic (Reich et al., 2020). The teachers' answers ranged from learning how to be self-directed learners and managing their time efficiently, knowing what is valuable to them and self-advocating, and relevant skills for life like essential math and professional email communications.

Naomi shared that she hopes for her students to have learned and practiced leading their own learning and planning out their work accordingly.

> *One of the competencies we've been focused on [is] lead ones [own] learning. ... The kids were tracking their work every week and planning their week out.*

Denise aspires for her students to learn time management and knowing when they are most effective.

> *I think time management has been really interesting, and also kids kind of gauging when they're most efficient... The kids that I knew struggled in school that haven't struggled, I think it's because a lot of them were able to work when the time is effective for them.*

Denise believes that students being self-aware of when and how they are most effective is a possible reason for some of her students to thrive with social distance learning. Similarly, Tiffany wishes for her students to learn to take initiative of their learning, which she believes is essential to becoming lifelong learners.

> *I hope that they see that there's always a way to learn so that they can continue to be the lifelong learners that we're trying to convince them that they should be. I do a lot of reminding them that as adults, the way we learn is that we have to take the initiative.*

By encouraging students to take more ownership of their own learning Tiffany believes her students are more likely to become lifelong learners.

Melissa aspires for her students to feel empowered to know when it is okay not to do an assignment and, in turn, where they should be focusing their learning efforts.

> *I want them to learn that you should not do things you don't want to do. Because over and over again, they would come to me and be like ... "I guess I'm supposed to do it* [an essay]. *But also, my grade is really good in his class and I kind of don't care. And I'm stressed, and I'm working on this other thing." And I would just be like, "... Don't do things that don't matter to you."*

Similarly, Jacob hopes that the final projects that his students completed to answer the larger school-wide questions felt real and valuable to his students.

> *I hope that with all the different phases of the year from actually being in seats to doing the distance learning that they were able to see a thread that was consistent throughout in terms of being aligned with the mission, aligned with the big questions we're trying to ask about the community ... and that the fact that we were trying to approach schooling differently. At the end, they were producing things that felt real. When I think about the podcast and the book, I love those projects so much, because at the end of the day, it produced this really tangible...product that exists in the world ... So, I really hope that that is something that they experience and trusted...*

Eric taught his students the relevant math concepts of logarithmic growth.

> *So definitely due to the nature of the pandemic, I wanted to prioritize the exponential and logarithmic growth because I want them to understand how quickly viruses branch out and how you can model and track their growth. How are the people that are making the predictions... how are they doing that?*

Eric wants his students to gain specific skills in order to understand the science behind the pandemic's exponential growth.

Eli wanted to use this as an opportunity for his students to develop a healthy and productive relationship with technology and learn professional communication etiquettes via email.

> *Email etiquette, I hope, how to not be afraid of technology, sometimes. I think that's one. It's not because the program is difficult to use. It's because of their attitudes towards technology, sometimes. Same with Microsoft Word, everything is in size 14 Comic Sans MS.*

Through the move to social distance PBL during the spring of 2020, teachers emphasized professional skills, life skills, and lifelong learning goals for their students.

Discussion

In the previous section, we presented how the teachers in PBL focused schools are social distance teaching in the COVID-19 pandemic from the four lenses of our conceptual framework, namely, personal interest and relevance, autonomy and agency, connection with others, and competence development. In this section, informed by the findings and our conceptual framework, we discuss key takeaways and ideas to consider when teaching PBL in online settings. For successful online project-based teaching and learning, activities and projects should be relevant to students and develop skills that can be mastered by students individually. Students should be encouraged to take control and ownership of their learning, and activities should provide for peer to peer and peer to mentor interactions even in online settings. Finally, technology should serve as a means to support effective teaching and learning. In these key takeaways, we provide examples of the teachers from our study enacting motivational theories that informed the conceptual framework. These takeaways, at a high-level, apply to most approaches of effective teaching and learning from a motivational perspective. However, below we discuss instances of teachers adopting exemplar strategies while teaching PBL online during a pandemic. We share these to provide examples and inspiration for teachers facing similar predicaments, and also to capture and archive how teachers rose to the challenge of keeping their students motivated to learn in disrupted times.

Make Space for Individualized Learning Experiences
Similar to in-person PBL approaches (Diehl et al., 1999; Hira & Hynes, 2017; Moursund, 1999; Thomas, 2000), learning activities in online PBL settings should cater to students' interests and be relevant to their current and future lives. For example, Chloe encourages her students to work on project areas that are of interest to them; Leah's students have been working on activities like hat weaving and playing musical instruments which, they bring to share with classmates and her; and Tiffany encourages her students to see how the start-ups they work on in their business class are relevant to their lives. It is also essential for the skills and learning

outcomes to be adjusted to ones that can be developed by students working the majority of the time by themselves. For example, managing their own time and learning like Naomi, Denise, and Tiffany's students, learning what is valuable to them and advocating for what they need in their school learning experiences like Melissa and Jacob's students, and relevant skills like essential math and professional communication like Eric and Eli's students.

Encourage Students Taking Ownership of Learning
Inherently, PBL allows for greater student autonomy and agency than traditional lecture and homework models of education (Bell, 2010; Blumenfeld et al., 1991). Online PBL instruction should be accompanied by encouraging students to practice autonomy over how they spend their time completing the project's goals. Students should also be encouraged to advocate for the kinds of projects they would like to work on and their involvement. Perceiving control over their work and schedule can prove useful in making students take ownership of their learning. For example, Denise's students are self-pacing themselves; Tiffany's students are doing a minimum amount of common work and then being able to pick how much deeper they would like to go into the content area; Melissa's students are leading their learning and checking in with her as a mentor; and Jacob's students are advocating for doing more work related to the environment.

Enable Connections Between Peers and Mentors
An essential aspect to consider when teaching via PBL online is if systems are in place to encourage and support students to form connections with their peers and teachers. Feeling connected with others is an important motivational factor for student learning (Ryan & Deci, 2000). Many of the study participants reported missing human connections, this virtual aspect of learning and motivation, in their current online PBL teaching experiences. Students need to connect to be on teams together, collaborate on projects, and feel part of the school community. They also need to communicate with their teachers as mentors and be connected with caring adults as they make their way through school. This need for connection and teachers' role as part of the landscape of caring adults in students' lives has been harder to achieve online (Anderson & Hira, 2020). We see this with these teachers as well, Eli and Denise share how they miss the emotional and dynamic parts of their relationships with their students. Leah, Tiffany, and Rebecca are unable to connect with their students one-on-one throughout their projects, and Eric and Chloe miss facilitating a supportive community for their students to learn and develop in. Teachers believe this is a loss not just of connection but a fundamental loss to how learning should take place through relationships.

Use technology to Support Learning
Technology cannot wholly replace the school learning experience. However, it certainly makes teaching and learning a possibility when there are constraints on in-person learning like during the COVID-19 pandemic (Code et al., 2020; Peterson et al., 2020). Since technology mediates the environments in which students learn, it is imperative to consider how teachers and students engage with the environment to experience learning. Technology can also help support the three prior takeaways in this section. It is perhaps useful to think of technology as a means to support teaching and learning, and not entirely replace it (Dowding, 2004). In addition to introducing relevant educational technologies, schools need to provide training on using technology and set up systems to communicate and ensure a common understanding of how and when to use different technological tools.

Limitations

In this paper, we inquired how PBL presents itself as a candidate for online social distance learning in the COVID-19 pandemic. One of the limitations of this work is that it captures teachers' experiences in a moment of time, which is the spring 2020 semester in the United States, soon after the transition to online learning. There is still more to learn and inquire about the teachers' and students' experiences of PBL and online learning during the pandemic over the course of the school year. This study, though in part communicates teacher and student interactions, it does not cover the students' perspective of learning during the pandemic.

Conclusion

This study initiates a conversation about teaching PBL in online settings and exploring motivation with PBL teaching. Future work would include following teachers and students during the academic year 2020-2021 as school districts adopt online, hybrid, and in person learning, to learn how PBL may continue to motivate students to learn. With a particular focus on technology's role in mediating such learning experiences and understanding teachers' motivation to teach PBL in these unusual times.

References

Anderson, E., & Hira, A. (2020). Loss of brick-and-mortar schooling: how elementary educators respond. *Information and Learning Science*, *121*(5–6), 401–408. https://doi.org/10.1108/ILS-04-2020-0085

Barnum, M., & Bryan, C. (2020). *America's great remote-learning experiment: What surveys of teachers and parents tell us about how it went*. Chalkbeat.

Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., & Bransford, J. D. (1998). Doing with understanding: Lessons From research on problem-and project-based learning. *Journal of the Learning Sciences*, *7*(3–4), 271–311. https://doi.org/10.1080/10508406.1998.9672056

Barron, K., & Harackiewicz, J. (2001). Achievement goals and optimal motivation: Testing multiple goal models. *Journal of Personality and Social Psychology*, *80*(5), 706–722. https://doi.org/10.1037/0022-3514.80.5.706

Baş, G. (2011). Investigating the effects of project-based learning on students' academic achievement and attitudes towards English lesson. *The Online Journal of New Horizons in Education*, *1*(4).

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, *26*(3–4), 369–398. https://doi.org/10.1080/00461520.1991.9653139

Brophy, J. (2005). Goal theorists should move on from performance goals. *Educational Psychologist, 40*(3), 167–176. https://doi.org/10.1207/s15326985ep4003_3

Çakiroğlu, Ü., & Erdemir, T. (2019). Online project based learning via cloud computing: exploring roles of instructor and students. *Interactive Learning Environments, 27*(4), 547–566. https://doi.org/10.1080/10494820.2018.1489855

Chen, C., & Yang, Y. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review*, *26*, 71–81. https://doi.org/10.1016/j.edurev.2018.11.001

Chen, K., & Jang, S. (2010). Motivation in online learning: Testing a model of self-determination theory. *Computers in Human Behavior*, *26*(4), 741–752. https://doi.org/10.1016/j.chb.2010.01.011

Child Trends. (2018). *Home computer access and internet use*. https://www.childtrends.org/indicators/home-computer-access.

Ching, Y. H., & Hsu, Y. C. (2013). Peer feedback to facilitate project-based learning in an online environment. *International Review of Research in Open and Distance Learning*, *14*(5), 259–276. https://doi.org/10.19173/irrodl.v14i5.1524

Code, J., Ralph, R., & Forde, K. (2020). Pandemic designs for the future: perspectives of technology education teachers during COVID-19. *Information and Learning Science, 121*(5/6), 419–431. https://doi.org/10.1108/ILS-04-2020-0112

Corbin, J., & Strauss, A. (2012). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). https://doi.org/10.4135/9781452230153

Darnon, C., Dompnier, B., Delmas, F., Pulfrey, C., & Butera, F. (1997). Achievement goal promotion at university: Social desirability and social utility of mastery and performance goals. *Journal of Personality and Social Psychology*, *96*(1), 119–134. https://doi.org/10.1037/a0012824

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer. https://doi.org/10.1007/978-1-4899-2271-7

Denzin, N. K., & Lincoln, Y. S. (2005). *The Sage handbook of qualitative research* (4th ed.). Sage Publications.

Diehl, W., Grobe, T., Lopez, H., & Cabral, C. (1999). *Project-based learning: A strategy for teaching and learning*. Center for Youth Development and Education, Corporation for Business, Work, and Learning.

Dowding, M. R. (2004). Technology and social inclusion: Rethinking the digital divide. *Canadian Journal of Communication*, *29*(1). https://doi.org/10.22230/cjc.2004v29n1a1415

Dweck, C. (1986). Motivational processes affecting learning. *American Psychologist*, *41*(10), 1040–1048. https:// https://doi.org/10.1037/0003-066X.41.10.

Echelon Insights. (2020). *National Parents Union - Coronavirus impact survey*. https://nationalparentsunion.org

Educators for Excellence. (2020). *Voices from the virtual classroom: A survey of America's teachers on COVID-19-related education issues*. https://e4e.org/voices-virtual-classroom

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist*, *34*(3), 169–189. https://doi.org/10.1207/s15326985ep3403_3

Emmanuel, N. (2018). *Education technology is a global opportunity | TechCrunch*. Tech Crunch. https://techcrunch.com/2018/01/19/education-technology-is-a-global-opportunity/

Gewertz, C. (2020). *Data: Students are getting less instruction time during coronavirus*. EdWeek Research Canter.

Hamilton, L. S., Kaufman, J. H., & Diliberti, M. (2020). *Teaching and leading through a pandemic: Key findings from the American educator panels Spring 2020 COVID-19 surveys*. RAND Corporation. https://doi.org/10.7249/RRA168-2

Harackiewicz, J. M., Barron, K. E., Pintrich, P. R., Elliott, A. J., & Thrash, T. M. (2002). Revision of achievement goal theory: Necessary and illuminating. *Journal of Educational Psychology*, *94*, 638–645. https://doi.org/10.1037/0022-0663.94.3.638

Hartnett, M. (2016). *Motivation in Online Education*. Springer. https://doi.org/10.1007/978-981-10-0700-2_2

Hira, A., & Hynes, M. M. (2017). Design-based research to broaden participation in pre-college engineering: research and practice of an interest-based engineering challenges framework. *European Journal of Engineering Education*, *44*(1–2), 103–122. https://doi.org/10.1080/03043797.2017.1405243

Hsu, H. C. K., Wang, C. V., & Levesque-Bristol, C. (2019). Reexamining the impact of self-determination theory on learning outcomes in the online learning environment. *Education and Information Technologies*, *24*(3), 2159–2174. https://doi.org/10.1007/s10639-019-09863-w

Kim, K.-J., & Frick, T. W. (2011). Changes in student motivation during online learning. *Journal of Educational Computing Research*, *44*(1), 1–23. https://doi.org/10.2190/EC.44.1.a

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of literature. *Improving Schools*, *19*(3), 267–277. https://doi.org/10.1177/1365480216659733

Kraft, M., & Simon, N. (2020). *Teachers' experiences working from home during the COVID-19 pandemic*. Upbeat.

Meticulous Research. (2020). *Learning management system market is expected to grow at a CAGR of 20.5% to reach $28.1 billion by 2025*. https://www.globenewswire.com/news-release/2020/02/05/1980255/0/en/Learning-Management-System-Market-is-Expected-to-Grow-at-a-CAGR-of-20-5-to-Reach-28-1-Billion-by-2025-Meticulous-Research.html

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis*. Sage Publications.

Moursund, D. (1999). *Project-based learning using information technology*. International Society for Technology in Education.

Nicholls, J. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review*, *91*(3), 328–346. https://doi.org/10.1037/0033-295X.91.3.328

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books, Inc.

Papert, S., & Harel, I. (1991). *Constructionism*. Ablex Publishing.

Patton, M. Q. (2014). *Qualitative research & evaluation methods*. SAGE Publications.

Peterson, L., Scharber, C., Thuesen, A., & Baskin, K. (2020). A rapid response to COVID-19: one district's pivot from technology integration to distance learning. *Information and Learning Science, 121*(5/6), 461–469. https://doi.org/10.1108/ILS-04-2020-0131

Piaget, J. (1970). *Genetic epistemology*. Norton.

Pintrich, P. R. (2000a). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of Educational Psychology*, *92*(3), 544–555. https://doi.org/10.1037/0022-0663.92.3.544

Pintrich, P. R. (2000b). An achievement goal theory perspective on issues in motivation terminology, theory, and research. *Contemporary Educational Psychology*, *25*, 92–104. https://doi.org/10.1006/ceps.1999.1017

Reich, J., Buttimer, C. J., Fang, A., Hillaire, G., Hirsch, K., Larke, L., Littenberg-Tobias, J., Moussapour, R. M., Napier, A., Thompson, M., & Slama, R. (2020). *Remote learning guidance from state education agencies during the COVID-19 pandemic: A first look*. https://doi.org/10.35542/OSF.IO/437E2

Renninger, A., Hidi, S., & Krapp, A. (Eds.). (1992). *The role of interest in learning and development*. Psychology Press.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Savery, J., & Duffy, T. (2001). *Problem based learning: An instructional model and its constructivist framework.* Technical report: Indiana University.

Senko, C., Hulleman, C. S., & Harackiewicz, J. M. (2011). Achievement goal theory at the crossroads: Old controversies, current challenges, and new directions. *Educational Psychologist*, *46*(1), 26–47. https://doi.org/10.1080/00461520.2011.538646

Sutia, C., Wulan, A. R., & Solihat, R. (2019). Students' response to project learning with online guidance through google classroom on biology projects. *Journal of Physics: Conference Series, 1157*(2). https://doi.org/10.1088/1742-6596/1157/2/022084

Svihla, V., & Reeve, R. (2016). Facilitating problem framing in project-based learning. *Interdisciplinary Journal of Problem-Based Learning*, *10*(2). https://doi.org/10.7771/1541-5015.1603

Thomas, J. (2000). *A review of research on project-based learning.* Autodesk Foundation PBL.

Voss, J., & Schauble, L. (1992). Individual interest and learning in school. In A. Renninger, S. Hidi, & A. Krapp (Eds.), *The role of interest in learning and development.* Psychology Press.

Wan, T. (2019). US Edtech investments peak again with $1.45 billion raised in 2018. *EdSurge News*. https://www.edsurge.com/news/2019-01-15-us-edtech-investments-peak-again-with-1-45-billion-raised-in-2018

Yilmaz, R., Karaoglan Yilmaz, F. G., & Keser, H. (2020). Vertical versus shared e-leadership approach in online project-based learning: a comparison of self-regulated learning skills, motivation and group collaboration processes. *Journal of Computing in Higher Education, 32,* 628–654. https://doi.org/10.1007/s12528-020-09250-2

Corresponding author: Avneet Hira
Email: avneet.hira@bc.edu