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Variations in Project-Based Course Design

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ABSTRACT

Project-based learning (PjBL) is seeing increasing scholarly interest and pedagogical use in higher education, but instances of PjBL do not necessarily seek the same educational outcomes. Using the grounded theory method, the authors plot five courses in a PjBL program on a matrix of course design characteristics ranging from Fixed to Flexible and Individualistic to Cooperative. They describe four major variations of PjBL based on this matrix. Recognizing that PjBL courses vary in their use of student choice and student collaboration, the authors make recommendations for assessment researchers and for teachers wishing to develop new strategies that fit their institutional and disciplinary contexts.

Keywords: Project-Based Learning, Collaboration, Student Choice, Teaching Styles

INTRODUCTION

As project-based and other student-centered learning strategies gain increasing use in higher education, there is a need to recognize variations across institutional and disciplinary contexts. At present, the single term "project-based learning" (PjBL) encompasses a wide variety of practices (Helle, Tynjälä, & Olkinuora, 2006), definitions (Thomas, 2000; Kokotsaki et al, 2009; Tamim & Grant, 2013), and design principles (Condliffe, 2017). Some researchers have addressed this variety by trying to sort "high-quality" or "gold-standard" project-based learning from lower quality experiences (Larmer et al, 2015; Buck Institute, n.d.; Mergendoller, n.d.). We wish to introduce a vocabulary that recognizes distinctions between types of PjBL that may be better adapted

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to different teaching styles, institutional contexts, disciplines, and other factors. In this paper, we propose a schema for discussing project-based learning pedagogies as a spectrum of methods, with emphasis on two characteristics in particular: the degree of teacher or learner decision-making about the course, and the degree of individual or collaborative work required by the project. By plotting variations on a *course design matrix*, we hope to add nuance to future discussions; to allow teachers and administrators to talk about PjBL with a common vocabulary that celebrates the unique aspirations of every course; and to allow researchers to assess this pedagogy's diverse, not uniform, outcomes and merits.

LITERATURE REVIEW

Project-based learning has attracted an increasing amount of scholarly attention and enthusiasm in recent years, with applications ranging from elementary to college levels to professional training. According to a review of literature by Kokotsaki et al. (2016), most studies focus on the way PjBL differs from traditional learning, on problems with implementation (see also Lee et al, 2014; Tamim & Grant, 2013), or on impacts (see also Guo et al, 2020). While researchers often draw data from a single setting (such as a program, class, or school), some seek to offer comprehensive principles and best practices to apply across many educational contexts (Larmer et al, 2015; Kokotsaki et al, 2016; High Quality Project Based Learning, n.d.). Condliffe et al. (2017) provide suggestions for future research.

There is not yet clear consensus in the PjBL scholarship about the degree to which two characteristics in particular are necessary, optional, or incidental to methods of project-based instruction. Those characteristics are *student collaboration* and *student initiation* of projects. A literature review conducted in 2017 found "little consensus among developers of P[j]BL design principles . . . about . . . the roles of student choice and collaborative learning" in PjBL, among other variable factors (Condliffe, et al., 2017). To demonstrate this point, in a much-cited early review of literature, Thomas (2000) identified five criteria for PjBL: projects are "central to the curriculum" (p. 3); students struggle with major concepts to solve problems; courses involve the students in constructivist investigation; projects are "*student-driven*"; and outcomes are "realistic," (p. 4) or embedded in real-world problems, audiences, or partnerships (emphasis added). In a more recent literature review, Kokotsaki et al. (2016) found that in both project-based and problem-based learning "participants . . . achieve *a shared goal through collaboration*" (p. 268, emphasis added). As these two sources indicate, researchers tend to agree that a "project" must be central to project-based learning; however, there is no consensus on the degree to which projects must be "student-driven" or "collaborative."

The lack of consensus about the necessity of student collaboration and student initiation of projects reflects a more significant imprecision about the definition of PjBL itself. Historically, "project methods" in higher education have involved "the solution of a problem; often, though not necessarily, set by the student himself" leading "commonly" to "an end product" such as a thesis, report, design plan, or computer program (Adderley 1975, p. 1; cited in Helle, Tynjälä, & Olkinuora, 2006, p. 288; see also Blumenfeld et al., 1991). Blurring of definitions between problem-based and project-based learning remains common (Helle, Tynjälä, & Olkinuora, 2006; Wurdinger, Haar, Hugg, & Bezon, 2007; English & Kitsantas, 2013), though some scholars find it useful to distinguish between them (Wheeler, 2008; Wurdinger & Rudolph, 2009). Whether or not a "project" begins with a "problem" (or a "problem" results in a "project") is, in our view, not always a consequential point for instructors designing a course. As Helle, Tynjälä, & Olkinuora (2006) observe, "project-based learning in practice can assume a variety of forms depending upon the pedagogical, political or ethical reasons for its adoption" (pp. 288-289). This point applies to student initiation and collaboration, as well as other characteristics of PjBL.

The scholars associated with the Buck Institute for Education (pblworks.org) and The High Quality Project Based Learning Framework (hqpbl.org) seem to provide a resolution to ambiguity by focusing on best practices rather than definitions. The book *Setting the Standard for Project Based Learning* (Larmer et al., 2015) proposes a "gold standard" for PjBL that includes "student voice and choice"--along with a challenging problem or question, sustained inquiry, authenticity, reflection, critique and revision, and a public product (p. 34; see also https://www.pblworks.org/what-is-pbl/gold-standard-project-design). Coauthor Mergendoller adds "collaboration" as an element of high-quality PjBL in an article posted online in 2021 (Mergendoller, n.d.; Hqpbl.org, n.d.). The concept of "high-quality PjBL" implies that teachers are incorporating "projects" into learning activities without a consistent "quality" of outcomes. While more study would be helpful to validate this implication, the course design matrix we propose below recognizes that course attributes such as student voice and collaboration exist in a range of variations, and the matrix encourages teachers to design course projects best suited to their discipline, institutional context, and personal strengths.

METHODOLOGY

Grounded Theory and Study Evolution

As co-teachers in a program of problem- and project-based courses, in 2019-20 we conducted a study that revealed to us the need for a more nuanced schema to recognize variety in project-based learning experiences across disciplines and other factors. Because

we teach a humanities course in a program weighted with STEM courses, we were initially curious about the way students and faculty perceived the "teamwork" and "leadership" opportunities in project-based courses across disciplines. When our study began, we expected STEM and humanities courses to produce different understandings of these "soft skills" associated with project-based learning. Using the grounded theory method of drawing theory out of data, our research question shifted from the beginning of our project to the analytic phase. We began our study with the following question in mind: How do students and faculty understand and practice "teamwork" and "leadership" in a sample of courses representing the diverse disciplines of a broad project-based learning program? Not surprisingly, we found close resemblances between some student and faculty ideas in the same course but very different ideas about what these key words meant between one course and another. However, disciplinary boundaries did not explain the results as we expected. As we reviewed the data, a new question emerged: With disciplinary boundaries fading, how can we account for the variety of project-based course designs that lead students and faculty to such different experiences of PjBL?

Context

We conducted our study at an urban state university in the U.S. Intermountain West. All courses were offered within a program of interdisciplinary electives called Vertically Integrated Projects (VIPs). In a VIP, students of any class year and major work alongside faculty on an authentic research or service project leading to "real-world" outcomes such as creation of devices, materials, programs, or apps; publications; or other accomplishments. Students have the option to enroll for up to six semesters, growing their expertise on a single project. Projects are "vertically integrated" because they channel the work of every academic rank (first-year student to faculty) into addressing a single challenge, community need, or problem. (For more about the VIP course model, which originated at Georgia Tech University, see http://vip-consortium.org/content/vip-consortium).

From a total of 23 VIPs offered on this campus at the time of our study, we examined 5 courses representing a range of disciplines, from engineering to social sciences to literacy education. One of the five courses was our own. All courses had a different history. One was being offered for the first time during our study. Three courses had been offered for one year prior to our study. One course had been offered for more than two years. All but one were team-taught by two or three faculty "coaches" (so called in the program's course descriptions). At the time of our study, there were 4 to 8 students, including undergraduates and graduates, registered in each class.

Data Collection

Over a two-semester period in 2019-20, we collected syllabi from 5 courses, conducted interviews with 8 faculty coaches, and examined 30 student reflections. The interviews were semi-structured and lasted for approximately 30 minutes. During the first semester of the study, we interviewed faculty twice, around midterm and during the final weeks of class. In the second semester, we interviewed faculty once near the end of the semester. One of us took detailed notes while the other led and audio-recorded interviews. Both of us asked follow-up questions when needed. Faculty interview questions and student reflection questions centered on perceptions of teamwork and leadership in the VIP. (See also Penry & Son, in-progress).

Data Analysis

From a total pool of 30 student reflection papers, we read 10 together to establish the categories of our analysis and to assign them color codes. We then divided the remaining papers and used our categories to color code the rest of the data. Our four initial categories, General VIP, Humanities VIP, Leadership, and Teamwork, reflected our hypothesis that we might see a difference in leadership and teamwork concepts and practices as courses represented more or less of STEM or Humanities influence. We used the same four coding categories for the faculty interview data. We read the detailed notes of the interviews and color coded them. If we needed more information or contexts of certain words or phrases, we went back to the interview audio files and listened to them to understand and capture ideas or exact quotations. We also read the course syllabi and color coded them using the 4 categories. This completed the first round of our data analysis.

Between the first and second round of analysis, we noticed patterns of data that did not fit our original hypothesis or coding but which yielded interesting information. For example, we observed different ideas of teamwork and leadership between courses, as expected, but the distinction of STEM or humanities course seemed insufficient to explain the data. Thus, in the second round of analysis, we used the constant comparative method to identify and refine emerging themes, ultimately changing our research question. Specifically, we now wondered: How can we account for the variety of project-based course designs that lead students and faculty to such different experiences of PjBL? Using the constant comparative method, a hallmark of grounded theory (Schwandt, 1997; Glaser & Strauss, 1967), we continuously compared emerging themes with data to modify, extend, and confirm categories or concepts. As opposed to the traditional scientific method, which begins with a hypothesis, grounded theory is an inductive method that begins with data and derives theories and interpretive themes from its systematic, recursive review. “Grounded theory is a way of . . . theorizing from data, so that the end result is a theory that a scientist produces from data collected” (Morse et al., 2009, p. 18).

In keeping with the demands of this method, we expanded our review of scholarly literature during and after analysis of our study results, as our understanding of our findings changed.

At one point in our constant comparative analysis of data, we saw that we could organize certain data in a 2 x 2 matrix. We debated the naming of the x and y spectrums at multiple points, recursively testing new x and y terms against the data until we were both satisfied that our analytic categories reflected data from syllabi, interviews, and student reflections. We consistently triangulated the data from all three of these data sets and found that similar patterns and themes emerged from them. That matrix became the basis of the present essay.

After coming to agreement on the terms of the 2 x 2 matrix that best represented our data, we named one axis the "course structure spectrum," with endpoints called "Fixed" and "Flexible," and the other the "interpersonal work style spectrum," with endpoints called "Individualistic" and "Cooperative." These terms will be discussed further in the next section. We reviewed and re-sorted our data to elaborate on the meaning of these points and their resulting quadrants, pasting quotations into a new section of our notes.

FINDINGS

The Course Design Matrix

The two key variables that we identified helped us to describe the variations in project-based courses across the multiple disciplines we were examining, without making direct correlations between disciplines and PjBL characteristics. Each variable represents a spectrum of possible course design choices. On the *course structure spectrum*, classes range from Fixed to Flexible, describing the relative roles of faculty and students in making decisions about such matters as goals, assignments, tasks, timetables, and assessment criteria. When faculty make all or most of these choices, we consider the course more "Fixed"; when students make most or many of these choices, we consider the course more "Flexible." On the *interpersonal work style spectrum*, classes range from Individualistic to Cooperative, describing the way that individual members of a course conduct their work in relation to other members of the course. In courses at the "Individualistic" end of this spectrum, students have individual goals to meet, and they work independently to reach those goals. In courses at the "Cooperative" end of the work style spectrum, students work with each other to achieve common goals. Using the interpersonal work style and course structure spectrums as the x- and y-axis of a 2 x 2 matrix (see Figure 1), we plotted the courses in our study in four quadrants, which represent four ways of approaching the organization of PjBL courses or assignments (See Figure 2).

Fixed *Quadrant 1 (Q1)* **Individualistic**	**Course Structure** *Quadrant 2 (Q2)* **Cooperative**
Work Style *Quadrant 3 (Q3)* **Flexible**	**Work Style** *Quadrant 4 (Q4)* **Course Structure**

Figure 1. Course design matrix for project-based pedagogies.

Our course design matrix bears a notable resemblance to Mascolo's (2009) foursquare matrix of teaching and learning modes. In the extended review of literature that followed our data analysis, we found that the two spectrums that helped us organize PjBL course variations were affirmed in Mascolo's schema for complicating the binary of "student-centered" and "teacher-centered" pedagogies. The variable that we call the course structure spectrum resembles Mascolo's "degree of teacher direction," ranging from Directed to Non-Directed, and what we called the interpersonal work style spectrum, Mascolo refers to as "individualized versus group learning" (p. 22), ranging from Individual to Social. Mascolo classifies many teaching and learning modes, ranging from "group drill" and "chant" (Directed-Social mode) to independent learning (Non-directed-Individual mode). The findings of our PjBL study lead us to differ with Mascolo in the relation between "inquiry learning" and our similar matrices. Whereas Mascolo plots "[p]roblem-based or inquiry learning" (his closest pedagogical mode to PjBL) on the Social end of his matrix (in it, "groups of students collaborate in an attempt to solve particular problems"), we find that PjBL can happen in all four quadrants of the course design matrix (Mascolo, 2009, p. 16). Nonetheless, we share with Mascolo the finding that teaching strategies are implemented on a spectrum, and we find the concept of a teaching spectrum essential to our understanding of variations in PjBL courses.

Quadrants

Thus far, much of PjBL scholarship creates the impression that all PjBL, by definition, belongs to quadrant 4, the Flexible-Cooperative course type. However, the five PjBL courses in our study represent three different quadrants (#2, #3, #4). These courses varied not only by exhibiting attributes of different quadrants but also by expressing differences

within quadrants. In no two courses was the combination of course structure (the Fixed/Flexible attribute) and interpersonal work style (the Individualistic/Cooperative attribute) exactly alike. (See Figure 2.)

Q1 **Fixed** * Course D * Course C **Individualistic**	***Q2*** **Cooperative**
* Course E ***Q3*** **Flexible**	* Course A * Course B ***Q4***

Figure 2. Courses in our study plotted on the course design matrix.

Consistent with the PjBL literature that associates Cooperative and Flexible course designs with PjBL, the courses in our study tended toward these two characteristics, with four courses (80%) in quadrants 2 and 4, the Cooperatives; 3 courses (60%) in quadrants 3 and 4, the Flexibles; and no courses in quadrant 1, Fixed-Individualistic. More specifically, two courses from our study exhibited attributes of quadrant 2 (Fixed-Cooperative), with one closer than the other to quadrant 1; one course exhibited strong attributes of quadrant 3 (Flexible-Individualistic); and two courses exhibited strong attributes of quadrant 4 (Flexible-Cooperative). Even though Cooperative and Flexible characteristics were prevalent, they were not *definitive* of project-based learning shown in the variations of PjBL courses in our study. In this section, we share qualitative data from course syllabi, faculty interviews, and student reflections to elaborate on the characteristics of quadrants 2, 3, and 4.

Despite the importance of Cooperative and Flexible characteristics in our sample, only 2 courses in our study represented quadrant 4, or a combination of both traits. One syllabus (Course A) called for students to write a "course plan," in which the student would lay out a plan for leadership or support of one or more "missions." If a mission on the syllabus did not win the support of any students, it was dropped from the semester. In one instance, faculty admitted to having a favorite mission for the class one semester, which no students chose on their course plans. Despite faculty attachment to it, the mission was dropped from that term because student interests lay elsewhere. This illustration suggests a

strongly Flexible course in our schema. This course also exhibited multiple Cooperative attributes. For example, students who expressed interest in the same mission became a team for the semester. Student teams drafted plans of action, timetables, and final goals for their chosen missions under faculty guidance. Students worked together to accomplish tasks and communicated with teammates outside of class time by texting each other and calling additional meetings. Class time was spent with teams briefing each other on their actions since the last meeting and calling for support. A key role for faculty in this class was "helping students see that it was ok to change plans" and facilitating student revision of timetables, outcomes, or both.

Faculty in the other quadrant 4 class (Course B) described their method as "find[ing] a project the students are interested in working on" and "facilitat[ing] community contacts" and "the resources they needed." The role for faculty was to provide a "safety net" for student ventures. In this class, faculty helped students connect with real-world community partners on issues meaningful to them, but when partner needs shifted or projects ran into snags that could not be addressed in the scope of a one-semester class, students and faculty together went back to the drawing board to find a new project. When we first interviewed faculty for this course around the midterm of their inaugural semester, teams were reorganizing and revising plans after some initial setbacks. The most important quality of the class at that point, as described by one co-teacher, was "that everyone seems quite relaxed" with extended uncertainty. Or rather, almost everyone. This person corrected: "It's most difficult for ----, who's a do-er." By the end of the semester, faculty reported that students were able to start and accomplish a project; however, at the time of our first interview, this group was experiencing the uncertainty commonly attributed to *all* PjBL but especially likely to appear in quadrant 4. (See Lee et al., 2014, n.p., on challenges of PjBL for faculty, such as the "leap of faith" necessary when an instructor gives up some classroom control.) As the most Flexible-Cooperative course in our sample, Course B also took the most time for students to find their projects and produce results. Everyone in class--teachers as well as students--had to be able to tolerate uncertainty and ambiguity in this course type.

As important to our study as quadrant 4 was quadrant 2, where another two participating courses expressed Fixed-Cooperative characteristics. In both courses, students performed tasks and delivered outcomes substantially envisioned in advance by their instructors--a Fixed attribute. Compared to the three more Flexible courses in our study--in which faculty members did not know in advance exactly what sort of work the students would perform or what tools they would need to perform it--in these courses, faculty provided more guidance to students about what to accomplish and how to get there.

The Q2 course with a combination of Fixed, Flexible, and Cooperative traits (Course C) had a well-articulated goal using a technology funded by faculty in advance of the course.

To meet project objectives, all students needed a certain degree of preparation in common research techniques and technical skills. The need for cooperation was spelled out in three different course learning outcomes on the syllabus: Academically, students were expected to "work as a community of researchers." Personally, they were asked to "practice and reflect on effective teamwork." Civically, they reflected on "the tension between unity and difference" and learned to "honor difference, find commonality." Thus far, this course was Fixed and Cooperative. However, when challenges arose within this course, faculty asked students to brainstorm and execute solutions. According to student reflections, this Flexible approach to problem-solving helped at least one student learn more about another trait, Cooperation. As the student explained, "I've learned that when things aren't going the way you planned, having a team with similar goals made finding the next step way easier. Constantly, in the project and real-life, plans change and things must be redirected, and the best way for that to happen is when there's a pool of minds with similar goals but different perspectives." In this course, even though faculty had a clear plan for outcomes, technologies, and methods, the Flexible approach to problem-solving suggested a possible relationship between the two spectrums, with a Flexible course strategy supporting student learning at the Cooperative end of the work-style spectrum.

The Q2 course closest to quadrant 1 (Course D) was centered similarly on a faculty vision for a particular technology--in this case its development rather than its use to collect data--designed to assist a third-party community partner. All students worked to meet the same outcome, predetermined by faculty as the *raison d'etre* of the course. The syllabus provided a specific list of "deliverables" and a detailed plan for course assessment, which included a final report from each student with a predefined length, structure, and annotation style. As the faculty explained in their interview, they "found the students worked better when given more structure." This was the only course in our study with an assigned text. These characteristics made Course D the most Fixed of course designs in our sample, according to our model. However, this course also had some Flexible attributes. Students carried the responsibility for figuring out how to engineer and market their product, and their regular reflections on *themselves* and their personal growth constituted one of the course's objects of study. On the x-axis in our matrix, this class combined Cooperative and Individualistic traits almost evenly, with a slight nod toward the Cooperative side of the interpersonal work style spectrum. All students belonged to either an "engineering" or a "marketing" team; the teams communicated with each other outside of class; and class time was devoted to mutual briefings, as in other Cooperative courses. However, when asked to comment on what they learned about teamwork at the end of the semester, multiple students affirmed the value of "individual" and "self" concepts. As one student put it, "[I]t's been interesting to watch the interplay between the two different sides of the VIP . . . as far as how they interact and build off of each other's

needs while also remaining self contained." Another student reflected, "In big teams (such as a nation or company) still there is much power in the individual."

The final course in our study combined Flexible and Individual attributes (Q3) in a way that made it unique both in our sample and in PjBL scholarship. In Course E, students "obtained expertise in emerging technologies" by developing a business model or designing an object using the "innovative tools and emerging technology" in a campus space designated for production of "videos, podcasts, code, apps, tools, big ideas, prototypes, business ideas, inventions, and more." In this highly Flexible and Individual course, students designed their own individual projects, including goals, timetables, and deliverables. They had a course meeting place but were not required to attend at the same time as long as they continued to make weekly progress on their activity. The syllabus referred to students as a "team," and the instructor noted that students gave feedback and encouragement to each other when they met in the common space, but they did not work together to design the same object or meet the same goal. Each student ended the course with a separate (Individual) final project and presentation. A common template for this presentation provided a rare Fixed attribute for this course, but Flexibility was evident in the wide variety of student projects and outcomes, ranging from creation of a physical object to creation of a curriculum. All final presentations included a summary of the individual project, original semester goals, achievements, and future goals. There was no indication on the syllabus or in faculty interviews that students might collaborate on their final presentations or work toward a common goal.

Our study did not yield any courses in quadrant 1, but we believe it is worth elaborating briefly on what a Q1 course might look like. We both have encountered and taught Q1 projects, and we expect future studies to reveal that this pedagogy is already pervasive at all levels of education. In this quadrant, teachers plan projects that students complete individually. Because every quadrant represents a spectrum of course criteria, students might have a choice of this or that project, and they might complete some portions of the project together and some portions individually. Teachers might assign students to a project, or students could select one from choices created by the teacher. Teachers are likely to create assessment criteria and timetables. Allowing for these variations, what separates quadrant 1 from other quadrants is that students chiefly accomplish outcomes on their own that have been envisioned and planned by a teacher in advance.

DISCUSSION AND IMPLICATIONS

While our findings did somewhat affirm our initial hypothesis – that students and faculty in STEM and humanities courses had different ideas and practices of teamwork and

leadership – the grounded theory method allowed us to draw conclusions that seemed more helpful to teachers and administrators of PjBL. By creating the course design matrix, we answered our revised question, *How can we account for the variety of project-based course designs that lead students and faculty to such different experiences of PjBL?* The flexibility of the matrix, with application to any discipline or institutional context, allows PjBL research and practice to use a common vocabulary while recognizing diversity. The course design matrix introduces the possibility of greater nuance in PjBL assessment and raises questions about how to scaffold both teacher and student learning from familiar methods (usually more Fixed and Individual) to less familiar ones.

We learned from our study of project-based courses that no single set of attributes for PjBL encompasses the variety of activity that we observe across disciplines, instructor styles, and course goals. Nor is it useful to correlate one discipline with one PjBL style. We find it most helpful to think of PjBL not as a single teaching strategy but as a *variety of strategies* that put a "project"--a definable outcome produced at the end of a complex process--and its reflecting learner at the center of a lesson or course.

Most courses in our study exhibited characteristics from the Cooperative and Flexible ends of the course design matrix, which is consistent with the scholarly literature in which the terms "student-driven," "student voice and choice" (Larmer, 2010, p. 34), and "collaborative" appear frequently as defining PjBL traits. However, the diversity of course attributes in our study leads us to conclude that PjBL does not necessarily have to exhibit any *particular* attributes or combination of attributes in the course design matrix.

This finding may be most significant for researchers creating instruments to assess the efficacy and outcomes of PjBL. Success stories for this pedagogy tend to describe Flexible-Cooperative (Q4) pedagogies (see, for example, Thomas, Enloe, & Newell, 2005; Vander Ark & Dobyns, 2018), and researchers have been encouraged by the success of Q4 course types (hqpbl.org). However, Condliffe (2017) and others remind us that the assessment of PjBL is still a work in progress. Before we can be certain that Flexible-Cooperative (Q4) PjBL has the most educational value, it will be necessary to consider also the outcomes for Q1-Q3 varieties of PjBL in teaching environments where they are adopted. For example, studying project-based classes with a high level of student choice and collaboration (Q4) will not necessarily provide insight into the learning value of courses in which a faculty member carefully designs achievable projects for newcomers to a discipline who work individually (Q1) or in teams (Q2). Because we suspect they are widely used but scantily recognized as PjBL, we are particularly concerned that researchers assess Q1 courses as well as courses in the other quadrants. We need research on outcomes to find out the value of project-based curricula, regardless of whether projects are Fixed or Flexible, Individualistic or Collaborative.

The best assessments of PjBL will consider courses with a variety of attributes before drawing conclusions about PjBL generally. Not only the attributes in our course design matrix--student choice and collaboration--but other attributes commonly associated with PjBL, such as a real-world outcome or leadership, may or may not be important to any particular PjBL assignment. PjBL's overall success can be assessed based on how well the project and reflection helped students meet course learning outcomes rather than how well students acquired specific skills (e.g., collaboration, initiation, ability to apply knowledge to real-world problems). When assessors wish to know how well PjBL *does* support specific skills, it will be important to distinguish between different PjBL course designs (Q1-Q4) and course objectives.

Another implication of our findings is the benefit to teachers wishing to experiment with new teaching methods. We believe that the course design matrix invites teachers to implement project-based strategies in a way that is most complementary with their existing strengths and their institutional culture. The teacher reluctant to experience the "chaos" of a highly Flexible project may prefer a more Fixed approach; the teacher who has most success guiding students to discover their Individual strengths does not need to adopt Cooperative methods. For those who have tried PjBL, found it "messy," and are reluctant to try again, the course design matrix offers alternatives, including entirely different quadrants, so that a teacher can retain what worked about the project, then choose to provide more or less guidance (the Fixed/Flexible spectrum), or more or less of collaboration (the Individual/Cooperative spectrum), until she or he finds the way to deliver a powerful learning activity in the way best suited to the content and to her or his strengths. By considering where they are most comfortable on the course structure and interpersonal work style spectrums, faculty can minimize the risks and discomforts of PjBL while reaping at least some of the benefits of active, outcome-oriented learning combined with reflection.

The course design matrix allows us to introduce new questions to PjBL planning and assessment. Perhaps chief among them is the question (implied by the "high-quality" approach to PjBL) of whether quadrants 1-3 offer developmental value for teachers who want to move their PjBL skills to quadrant 4. As Hmelo-Silver & Barrows (2015) suggest, the "expert facilitator" possesses a "repertoire of strategies" that enable her to manage the chaos of highly Flexible course designs (p. 82). Is it possible that some of these may be developed by teachers growing their PjBL teaching strategies incrementally through quadrants? Designing PjBL in light of the course design matrix allows teachers to scale projects up or down in complexity and duration, according to available time, resources, and other conditions. This variety seems to us important for encouraging teachers not only to try project-based methods but also to keep growing as PjBL practitioners.

A final implication of this study which needs more investigation is the possibility of using the quadrants to support the scaffolding of student learning. Scaffolding in education refers to the teacher's effort to structure learning from the individual student's starting point through a series of stages that increase in difficulty and complexity. Some researchers consider scaffolding as an inherent characteristic in all PjBL (Condliffe et al, 2017). There may be potential to use the course design matrix to scaffold projects so that students move from one area of the matrix more familiar to them to an area less familiar, such as from an individual work style to a collaborative one, or vice versa. By recognizing work in every quadrant as project-based, we gain the ability to imagine various ways not only for teachers to design projects but also for students to engage with them.

References

Adderley, K. et al. (1975). *Project methods in higher education*. SRHE working party on teaching methods: Techniques group. Guildford, Surrey: Society for research into higher education.

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

Buck Institute for Education (n.d.). http://www.pblworks.org, DOA 4/15/2021.

Buck Institute for Education (n.d.). "What is PBL?" https://www.pblworks.org/about/faq, DOA 4/15/2021.

Buck Institute for Education (n.d.). "Gold standard PBL: Essential project design elements." https://www.pblworks.org/what-is-pbl/gold-standard-project-design, DOA 4/10/2021.

Condliffe, B., et al. (2017). Project-based learning: A literature review - Working paper. MDRC. https://www.mdrc.org/sites/default/files/Project-Based_Learning-LitRev_Final.pdf, DOA 03/04/2021.

English, M. C., & Kitsantas, A. (2013). Supporting student self-regulated learning in problem- and project-based learning. *Interdisciplinary Journal of Problem-Based Learning* 7(2), 128-150. https://doi.org/10.7771/1541-5015.1339

High Quality Project Based Learning. (n. d.). *A framework for high-quality project based learning*. https://hqpbl.org/wp-content/uploads/2018/03/FrameworkforHQPBL.pdf, DOA 03/04/2021.

Glaser, B. G & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Aldine Publishing Company.

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, 102, 101586. https://doi.org/10.1016/j.ijer.2020.101586

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education – theory, practice and rubber sling shots. *Higher Education*, 51, 287–314. https://doi.org/10.1007/s10734-004-6386-5

Hmelo-Silver, C.E., & Barrows, H. S. (2015). Problem-based learning: Goals for learning and strategies for facilitating. *Essential Readings in Problem-Based Learning: Exploring and Extending the Legacy of Howard S. Barrows*, eds. Walker, A., Leary, H., Hmelo-Silver, C. E., Ertmer, P. A. West Lafayette, IN: Purdue University Press, 69-84. https://doi.org/10.2307/j.ctt6wq6fh.10

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

Larmer, J., Mergendoller, J., Boss, S. (2015). *Setting the Standard for Project Based Learning: A Proven Approach to Rigorous Classroom Instruction*. Alexandria, VA: ASCD.

Lee, J. S., Blackwell, S., Drake, J., & Moran, K. A. (2014). Taking a leap of faith: Redefining teaching and learning in higher education through project-based learning. *Interdisciplinary Journal of Problem-based Learning*, 8(2). https://doi.org/10.7771/1541-5015.1426

Mascolo, M. F. (2009). Beyond Student-Centered and Teacher-Centered Pedagogy: Teaching and Learning as Guided Participation. *Pedagogy and the Human Sciences*, 1(1), 3-27.

Mergendoller, J. R. (n.d.). Defining high-quality PBL: A look at the research. *High Quality Project Based Learning*. https://hqpbl.org/wp-content/uploads/2018/04/Defining-High-Quality-PBL-A-Look-at-the-Research-.pdf, DOA 3/4/2021.

Morse, J. M., Stern, P. N., Corbin, J., Bowers, B., Charmaz, K., & Adele, E. (2009). *Developing grounded theory: The second generation*. Walnut Creek, CA: Left Coast Press.

Penry, T., and Son, E.H. (In progress). Leadership Variations in Project-Based Learning.

Schwandt, T. (1997). *Qualitative inquiry: A dictionary of terms*. Thousand Oaks, CA: Sage.

Tamim, S. R., & Grant, M. M. (2013). Definitions and uses: Case study of teachers implementing project-based learning. *Interdisciplinary Journal of Problem-Based Learning*, 7(2), 72-101. https://doi.org/10.7771/1541-5015.1323

The VIP Consortium (n.d.) http://vip-consortium.org/content/vip-consortium, DOA 01/05/2021.

Thomas, J. W. (2000). *A review of research on project-based learning*. San Rafael, CA: The Autodesk Foundation.

Thomas, D., Enloe, W., & Newell, R. (2005) *"The coolest school in America": How small learning communities are changing everything*. Lanham, MD: ScarecrowEducation.

Vander Ark, T., & Dobyns, L. (2018). *Better together: How to leverage school networks for smarter personalized and project based learning*. San Francisco: Jossey-Bass.

Wheeler, R. (2008). Experiential learning: Impact of two instructional methods on student-instructor interaction, student critical thinking, and student course evaluations. *Journal for Advancement of Marketing Education*, *12*, 63-78.

Wurdinger, S., Haar, J., Hugg, R. & Bezon, J. (2007). A qualitative study using project-based learning in a mainstream middle-school. *Improving Schools,* 10(2), 150-161. https://doi.org/10.1177/1365480207078048

Wurdinger, S., & Rudolph, J. (2009). Teaching Practices that Improve Student Learning: Five Experiential Approaches. *Journal of Teaching and Learning*, 6(1), 1-13. https://doi.org/10.22329/jtl.v6i1.505