

A Lesson Structure and an Instructional Design Model for Project-Based Online Learning

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Research-based best practices that employ learning theories such as Project-Based Learning (PBL) have not been thoroughly developed for the constraints of the K-12 online setting, nor have they been tested in this unique context. K-12 online teacher-developers face many constraints during the process of instructional design and require additional supports to translate these learning theories into their lessons. The researchers of this study employed a design and development research method to co-develop two instructional design models for creating project-based online learning (PBOL): the *PBOL Lesson Structure*, which maps an order of content presentation to offer to learners, and the *PBOL Instructional Design Model*, which maps a step-by-step process for teacher-developers to follow in designing project-based online lessons for K-12 learners.

INTRODUCTION

Determining whether K-12 online students receive a better or worse education than learners in the K-12 brick-and-mortar schools is complex and debatable (Means, Toyama, Murphy, Bakia, & Jones, 2010; Woodworth, et al., 2015); however, K-12 online educators must continue to improve the education they offer as it is unlikely that the trend of K-12 online schools will disappear after a decade of avid growth and investment (Watson, Pape, Gemin, & Vashaw, 2015).

Research on the quality of content and pedagogy offered through K-12 online schools has been limited given the proprietary nature of many K-12 online schools (Watson et al., 2015). Additionally, many K-12 for-profit management companies repackage and sell their curriculum content to other smaller or locally-controlled online schools further limiting access to online school curriculum content that might result in critical analysis. Identifying non-profit or public online schools that design, develop, and manage their own curricular content may be the best opportunity to investigate instructional design practices in K-12 online schools.

The Buck Institute has published extensively on best practices in the development and facilitation of project-based learning (PBL), with ample literature validating the model in the face-to-face context (Larmer, Mergendoller, & Boss, 2015). This model has been touted as effective in both the face-to-face and the blended environments (Baines & DeBarger, 2015; Ravitz & Blazeviski, 2014; Thomas, 2000) and has been tested in teacher professional development (Dabner, Davis, & Zaka, 2012). Like PBL, many best practices founded on constructivist philosophies have already been established and evaluated in the K-12 face-to-face classroom, such as inquiry-based learning, authentic assessments, collaborative learning, etc. (Gitomer & Bell, 2016); still, many of these best practices have not been thoroughly tested and reported on in the online context for the K-12 learner.

Currently, PBL in fully online K-12 environments is not represented in the research literature. Researchers have not investigated how applications of such a model would translate to fully-online K-12 courses when learners and teachers are never working on the project in the same physical environment or even at the same exact moment in time. This gap in the literature calls for a study that serves K-12 teacher-developers by investigating what prescriptive design steps lead to the design of effective online PBL lessons and units. To address this gap, this study explains the design and development process of a model of instructional design, which was tested and revised through a process of co-development of three online ninth grade PBL lessons on literature and one tenth grade online chemistry lesson. These preliminary models will contribute to a larger design and development study intended to refine and validate this prescriptive model of

instructional design for PBL in the online classroom, or Project-based Online Learning (PBOL). In the K-12 context, a lesson is typically conceptualized as a subset of a unit of instruction. While both a lesson and a unit serve as a designed and structured learning experience, many non-K-12 online education institutions might refer to them as a learning module. The terminology within the field appears to be institutionally-specific, flexible, and evolving. In this study, the terms lesson and unit will be used interchangeably.

THEORIES INFORMING K-12 ONLINE CURRICULUM

PBL is frequently traced to Dewey's (1916) pragmatic and progressive view of teaching and learning. The approach is also compatible with sociocultural views of knowledge acquisition (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Vygotsky, 1978). In these traditions, theorists reject the notion of learners as passive recipients of fixed absolute truths. Instead, learners are thought to actively construct knowledge through their experiences, especially experiences that involve interactions with others. Novices are compared to apprentices who advance their knowledge and skills through increasingly complex engagement in community life.

These theoretical perspectives align with pedagogical approaches that situate student learning in meaningful, authentic tasks. Because these tasks mirror real life, students often are required to assume adult or professional roles as they answer a driving question, solve a problem, or design a product. As students pursue these active learning tasks, teachers shift their roles to facilitators, guides, and co-learners. There is a substantial body of research suggesting these instructional strategies are promising. Researchers have documented increases in student learning, motivation, and higher-order thinking within a variety of instructional settings, student subgroups, and academic disciplines (Barron & Darling-Hammond, 2008; Condliffe, 2017; Larmer et al., 2015; Thomas, 2000). At least one longitudinal study suggests that students who experience PBL strategies in their K-12 education may develop deeper levels of content knowledge and more successful career trajectories as adults (Boaler, 2017).

Several conceptualizations of project-based learning exist (Bender, 2012; Boss & Krauss 2014; Katz & Chard, 2000; Moursund, 2003), but the framework and supporting materials published by the Buck Institute on Education (BIE) are perhaps the most widely-used by teachers trying to design PBL for their classrooms. Currently, BIE is connected to more than 30,000 educators through their online learning communities and has published more than 250 sample lessons in its project library (Larmer et al., 2015). BIE's project design framework begins with key knowledge, understanding, and success skills that students need to master. Other key design elements in the

framework include (1) a challenging problem or question, (2) sustained inquiry, (3) authenticity, (4) student voice and choice, (5) reflection, (6) critique and revision, and (7) a public product (see Figure 1).

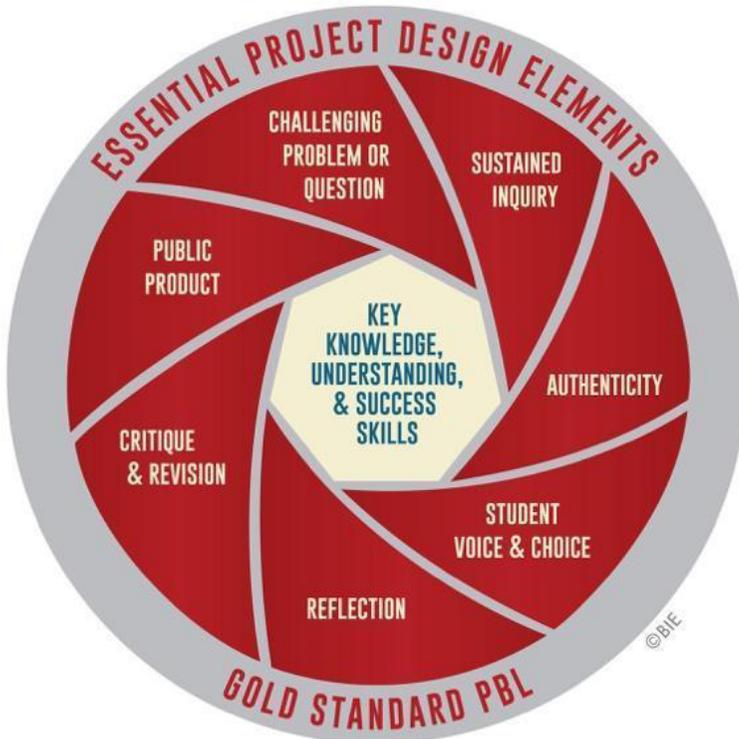


Figure 1. Gold Standard PBL image from *Setting the standard for project based learning* by J. Larmer, J. Mergendoller, & S. Boss, 2015, p.46.

When designing PBL, BIE suggests three major design steps. The first step is to consider the learning context, including the students who will participate. The second step is to generate ideas, whether new or based on previous learning experiences. The third and final step is to establish the details. Key components include setting learning goals, selecting major products, deciding how the products will be made public, and writing a driving question (Larmer et al., 2015).

While researchers have documented success in supporting teachers in creating PBL in face-to-face environments, designing PBL for K-12 online learning, or PBOL, has not been thoroughly investigated. This study aims to address that gap and provide K-12 online teachers with the high-quality design support available to traditional face-to-face teachers.

RESEARCH DESIGN AND METHODS

Design and development research is “the systematic study of design, development, and evaluation processes with the aim of establishing an empirical basis for the creation of instructional and non-instructional products and tools and new models that govern development” (Richey & Klein, 2007, p. 1). This method was chosen as a scholarly way of testing both the concept of PBL and a prescriptive design and development processes for this concept in K-12 online schools. Design and development research is a common research method in the field of information technology, where human problems are solved through an iterative process of digital development and redevelopment. While this approach has been used in education more sparingly, with a focus on the development of instructional products rather than design models (Richey & Klein, 2007), the focus on model development fits the goals of this study.

This type of applied research is best approached from within the problem’s context or natural work environment, where a variety of authentic variables can interact with the design, and test data can inform the outcome processes and features. For this study, Gwinnett Online Campus (GOC) served as the naturalistic setting for design and development. GOC is a fully-online, district controlled K-12 school enrolling nearly 500 full-time learners in grades 4-12. Although the full-time program is relatively small, GOC also serves an average of 5,000 enrollments every year through a supplemental program which serves students across the entire district. A defining characteristic of GOC in comparison to a majority of K-12 online schools is that all of GOC course content is designed by teacher-developers. Teacher-developers are individuals identified by the school’s administration as competent in both content knowledge and pedagogy. GOC provides ample support to teacher-developers including a video production studio, technical expertise, and software collections. Teacher-developers use these resources to design and develop online curriculum content that is delivered by the teacher of record, or facilitator. The general instructional format of GOC courses is paced, asynchronous daily activity, with optional synchronous events.

This research was conducted by a university faculty member and a GOC administrator responsible for curriculum development. These researchers were also participants in the study, along with a GOC teacher-developer. Each participant fulfilled various roles in the research process. All participants served as PBOL instructional designers. The GOC administrator and teacher-developer also served as course facilitators, implementing the PBOL units they designed. The researcher and participant roles for this study are summarized in Table 1.

Table 1
Participant Roles

Roles	University Faculty	GOC Administrator	GOC Teacher-Developer
Researcher	X	X	
Instructional Designer	X	X	X
Course Facilitator		X	X

When developing a new model, rather than an instructional product or lesson, the model should be validated both internally and externally. As a new model of instructional design, this study offers preliminary evidence of internal validation within the GOC context; however, external validation will require ongoing research by these and other researchers evaluating the model in new learning environments and varying contexts. As a body of literature grows supporting or contradicting the external validation of the model, the role of context in the model's generalizability likely will emerge (Richey & Klein, 2007).

Constraints of time and organizational culture for projects occurring within natural work environments pose challenges to data collection and analysis, which can affect reliability. Multiple sources of data can help mitigate these challenges and ensure reliability of a dataset (Richey & Klein, 2007). In design and development research, data or evidence sources often include surveys, interviews, observations, work logs, journals, and think-aloud transcriptions (Ellis & Levy, 2010; Richey & Klein, 2007). Additionally, in an online education setting other useful data sources might include designer reactions during the lesson design process, course facilitator perceptions, learner assessment scores, learner analytics provided by a learning management system, or learner click data. For this study, the researchers used designer journals, think-aloud, informal interviews, learner analytics,

and aggregate learner survey data to inform the design and development process and to ensure internal validity of the model, demonstrating that the contextually specific problem at GOC was effectively addressed.

While Richey and Klein (2007) provide a framework for design and development research, their work does not provide a step-by-step process for researchers enacting design and development research. To find an appropriate process to guide this study, researchers turned to Peffer's (2007) six-stage design and development approach (Figure 2). Peffer's six stages include (1) identify the problem, (2) describe the objectives, (3) design and develop the artifact, (4) test the artifact, (5) evaluate the testing results, and (6) communicate results.

For the purposes of this study, the researchers adapted Peffer's six stages to suit the development of an instructional design model. In steps one and two, the researchers identified the problem and described the objectives of this study to address the lack of a model for PBL in K-12 online settings. In step three, the researchers developed a working draft of an instructional design model. In step four, the researchers tested the instructional design models by using them to design PBOL lessons. In step five, the researchers evaluated the implementation of PBOL lesson to judge quality and effectiveness of the instructional design model. Steps three, four, and five were repeated in a spiraling fashion with new PBOL lessons until the resulting instructional design model used was established. Step six is the sharing of these instructional design models. Each step and the resulting outcomes are described in the following section.

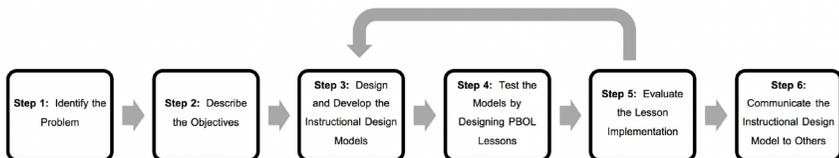


Figure 2. The research process used in this study based on design science research methodology informed by Peffer (2007).

Step 1: Identify the Problem

To identify a problem that lends itself to design and development methods, it is best to look for problems that exist within newly emerging contexts or are surrounded by unresolved conditions (Ellis & Levy, 2010). K-12 online instruction presents itself as a unique context existing within both the information technology field and the field of education. The phenomenon of K-12 online schools is a new context in which project-based learning has not been translated, tested, or reported in the literature.

In an effort to create engaging student-centered curriculum, GOC administrators attempted to infuse PBL into the online K-12 curriculum by providing training on the BIE's model for their teacher-developers (see Figure 1). Even after the training, GOC teacher-designers were unable to adapt the PBL instructional model to the fully-online context. Not only did administrators want PBL to be incorporated into online curriculum, but they also sought a solution that could scale to support all GOC teacher-developers in the instructional design process for all subjects in grades 4 through 12. Such broad-based design capabilities were important to GOC's commitment to having a locally-designed curriculum and maintaining the professional status of online educators. To address these concerns, the school administrators welcomed support that would push student performances towards higher levels of learning leading to this design-and-development study of PBOL in the K-12 online context.

Step 2: Describe the Objectives

In an effort to address the stated problem, the researchers developed the following objective for this design and development research: Develop a practical and sustainable instructional design model that GOC teacher-developers can use to develop high-quality project-based learning experiences for fully online K-12 students, or PBOL.

This objective honored (a) GOC's commitment to preserving local control over the curriculum and (b) the researchers' intent to address internal validity in this study. Hopefully, such a model will contribute to practical, scalable PBOL development and design resources for other GOC teacher-developers.

Steps 3, 4, and 5: Design, Test, Evaluate

In design and development research, spiraling design cycles work to build upon and improve various iterations of a design until the design sufficiently addresses the problem and objectives (Pressman, 1997). To develop a PBOL instructional design model, participants completed the *design*, *test*, and *evaluate* steps a total of four times during a period of three semesters (Fall 2015, Spring 2016, and Fall 2016). This process adapted the spiraling design cycles of software development for step-wise refinement for the purposes of creating an instructional design model (Peffer et al., 2007; Pressman, 1997). The spiraling design cycles conducted in this study are summarized in Table 2.

Table 2
Summary of Design and Development Cycles

Design Cycle One Fall 2015	Design Cycle Two Fall 2015	Design Cycle Three Spring 2016	Design Cycle Four Spring 2016
The Hero's Journey, Homer's <i>The Odyssey</i>	<i>Night</i> by Wiesel	<i>Romeo and Juliet</i> by Shakespeare	Measurement and Matter
ELA PBOL unit resulting in video or infographic showing student analysis of film or book of choice	ELA PBOL unit resulting in student-created film or paper that identified, analyzed, and included a persuasive argument to bring attention to a current genocide.	ELA PBOL unit resulting in an essay, mock trial, or talk radio show addressing perspective and misconceptions of right and wrong.	Chemistry PBOL unit that resulted in student presentation to administration regarding policy of contents for school vending machines.

During the first three cycles (Fall 2015-Spring 2016), the university researcher and GOC administrator transformed three existing ninth-grade literature units into PBOL (Step 3: Design). The experience in the first design cycle (Fall 2015) was titled “The Hero’s Journey” and related to *The Odyssey: The Story of Odysseus* (Homer & Rouse, 1999). In this unit, students were asked to compare Odysseus’s journey to another hero in a book or film of their choice. In the second design cycle students read *Night* by Wiesel (1960) and created a persuasive film or paper that brought attention to current genocide situations (Fall 2015). The third unit introduced students to Shakespeare’s *Romeo and Juliet* (1913) and asked them to create an essay, mock trial, or talk radio show addressing perspectives of right and wrong (Spring 2016). During the design process, the two researchers kept design journals and collaboratively reflected on their design choices via informal conversations.

Next, the GOC administrator facilitated the newly designed PBOL experience with 50 college prep, honors, and gifted high school students in a fully-online format (Step 4: Test). Each learning experience lasted approximately 3-4 weeks. During this testing phase, the facilitators kept journals of their experiences and reviewed a variety of data sources available to them, including student instructional survey results and learner analytics from the GOC learning management system (LMS). To gather their perceptions, the university researcher interviewed the facilitators at the culmination of the testing phase.

Finally, the GOC administrator and university researcher evaluated the emerging PBOL model based on their reflections, experiences, and collected data related to the design and testing of each unit. Each time a new lesson

design was cycled through the steps, knowledge gleaned from the prior iteration informed the next. In Spring 2016, results from a state-level, end-of-course literature and composition test for ninth-graders were also used to evaluate the first three design cycles.

During the fourth design cycle (Fall 2016), in efforts to test the usability of the PBOL instructional design model, the university researcher and the GOC administrator did not participate as designers or facilitators. In this iteration, a GOC teacher-developer used the instructional design model developed in the first three cycles to design a tenth-grade PBOL chemistry unit on measurement and matter. She also facilitated the unit with students. During the design and test phases, the teacher-developer kept design and reflection journals and reviewed LMS analytics. The researchers interviewed the teacher-developer throughout the process. This cycle addressed confidence and repeatability within the context of GOC, suggesting internal validity. The instructional design model resulting from this research is described in the next section. The following narratives highlight how the model evolved throughout the four cycles.

Design cycle one: A two-part design model and student anxiety

As the GOC administrator and university researcher were creating The Hero's Journey in early Fall 2015, they realized that they were engaged in two different types of design tasks. First, they were engaging in a design process to conceptualize the learning experience, and second, they were grappling with how to present online content for students. In order to adequately describe these different design tasks, they began to see that the PBOL instructional design model needed a companion model, the PBOL lesson structure. While the PBOL design model described what teacher-developers do to create the learning experience, the PBOL lesson structure was necessary to determine what content students would need to engage with the project and how that content should be presented to them. From the beginning, the elements of the lesson structure and the instructional design model were similar. However, given their unique purposes, each contained similar components offered in a different sequence.

In the implementation phase of this cycle, the GOC administrator reported that students generally enjoyed the project, but many also expressed some anxiety associated with a lack of understanding of project parameters at the beginning of the course. Initially, the researchers assumed that the project criteria could unfold as the students worked through the online lessons, but this level of uncertainty was uncomfortable and stressful to most students. The researchers speculate that lack of proximity to the teacher for frequent questions and interpretations may add to this anxiety for online learners.

Design cycle two: A product introduction, formative assessment, and high levels of engagement

Before designing and implementing *Night* by Wiesel later in Fall 2015, the researchers made several changes to the PBOL instructional design model and the lesson structure for cycle two. To reduce student anxiety, a comprehensive project introduction and formative assessments related to project and content understanding were added to the lesson structure. The project introduction was added to aid student understanding and reduce anxiety. The formative assessment elements were designed to help teachers identify students who might need additional support. The development of a project introduction and formative assessment elements were also added to the instructional design model but in a different sequential position than the lesson structure. In the lesson structure, the project introduction and formative assessments to measure project understanding were among the first design elements. However, these components were among the last tasks addressed by designers in the instructional design model. Although these additions required more work, the researchers found these new components to be implementable, positive additions to the design process.

During the implementation of *Night*, the formative assessments did allow the facilitator to identify students who needed additional support. Learner analytics indicated students were engaging with the content in the intended order. The facilitator reported positive student feedback on the project introduction and less student anxiety. Overall, she characterized this PBOL experience as smoother and more satisfying for both her and students.

Design cycle three: A successful test, but limited perspectives

Given the favorable outcomes in design cycle two, no major changes were made to the PBOL instructional design model or lesson structure. The researchers used the same version to design the *Romeo and Juliet* lesson. During this cycle, they found the design process becoming faster, clearer, and more routine. Learner analytics such as video hours viewed, click stream, and pages accessed indicated students were engaging with the content as intended, and learner project scores were high.

Since this unit was the last one influencing the 50 ninth grade literature students, the researchers compared the standardized, state-mandated End-of-Course Tests (EOCT) for 2016 to the EOCT scores of the previous academic year, which served a different group of learners. Forty-seven of the learners completed the test, and these scores revealed that a larger proportion of 2016 ninth graders at GOC exhibited proficiency as compared to the previous year when no PBOL units were offered (Table 3). While these data are insufficient to suggest that PBOL increased or even influenced student achievement, they do show that one group of students maintained high levels of performance during the three PBOL implementation cycles.

Table 3
GOC and State Percent of Students Proficient on End of Course Test (EOCT)
in Ninth Grade Literature and Composition Georgia Milestones Test

Term	EOCT	Number of Students	Percent of Students Proficient	Mean Scale Score
Spring 2016	GOC	47	70%	546
	State-wide	117,109	41%	512
Spring 2015	GOC	36	56%	533
	State-wide	114,655	39%	510

*Note. Full-time GOC students already outperformed students state-wide.

Given that the lesson was successful and the design process had become much easier, the researchers determined that it was time for an outsider's perspective. This was the last design cycle conducted through the collaboration of the university researcher and the GOC administrator. At the end of this cycle, the researchers felt they had adequate experience to test the instructional design model and the lesson plan structure with another GOC teacher-developer.

Design cycle four: Internal validation

In design cycle four, the GOC administrator co-designed a tenth grade chemistry unit with a GOC teacher-developer. This teacher-developer was a novice online curriculum developer and had limited experience with PBL in the face-to-face classroom. While she was new to online curriculum development, she was the most recent GOC Teacher of the Year for her expert facilitation of online courses and volunteered to learn how to develop PBOL units. The GOC administrator served in a supportive role addressing project management and technical expertise. She logged 25 hours of collaboration with the GOC teacher-developer who designed the PBOL curriculum content using the proposed model.

Initially, the GOC teacher-developer was excited to learn PBOL; however, she struggled with confidence and time management. By the end of the semester, she had completed a PBOL chemistry lesson related to measurement and mass. After a successful facilitation, this teacher-developer choose to reflect on the experience and revise the unit at the end of the design process. After the first design and development cycle, her confidence in course development improved, and she has since independently continued to improve the PBOL measurement and mass unit, no longer requiring the PBOL

design support from the GOC administrator. In the teacher-developer's journal, she wrote,

Overall, I think the PBL experience was great for not only the students, but for the teacher developing the course as well. The documents that were provided were easy to use for my course, but could be very easily manipulated to address many different courses and/or topics that we offered here at GOC. (Teacher-Developer-S).

In future studies, additional K-12 teacher-developer perceptions, uses, and evaluations of the instructional design model could help researchers and other scholars to further refine the model moving forward.

No additional changes have been made to the model up to this point of publication. Also, since design cycle four concluded, the GOC administrator developed a training course to help teacher-developers across campus design PBOL units. Since this time, the model has been used by both experienced and inexperienced teacher-developers to design PBOL units in high school social studies courses and middle school language arts courses with positive feedback from the developers. Table 4 provides a summary of the four design and development cycles including this PBOL unit designed by a teacher-developer through Design Cycle Four.

Table 4
The evolution of the PBOL instructional design models

PBOL Lesson Structure Used			
Design Cycle One	Design Cycle Two	Design Cycle Three	Design Cycle Four
1. Hook & Driving Question	1. Hook & Driving Question	Same as Cycle Two	Same as Cycle Two
2. Introduce the Project	2. Introduce the Project		
3. Build Content Knowledge	3. Formative Assessment (Project Understanding)		
4. Tutorial-by-Example	4. Build Content Knowledge		
a. Rubric and Sample	5. Formative Assessment (Content)		
b. Model Evaluation	6. Tutorial-by-Example		
c. Peer Evaluation	a. Rubric and Sample		
5. Summative Evaluation	b. Model Evaluation		
6. Sharing	c. Peer Evaluation		
	7. Summative Evaluation		
	8. Sharing		

Table 4, Continued
The evolution of the PBOL instructional design models

Instructional Design Process Used			
Design Cycle One	Design Cycle Two	Design Cycle Three	Design Cycle Four
1. Learning Standards, Objective, Hook & Driving Question	1. Learning Standards, Objective, Hook & Driving Question	Same as Cycle Two	Same as Cycle Two
2. Summative Assessment	2. Summative Assessment		
a. Rubric and Sample	a. Rubric and Sample		
3. Tutorial-by-Example	3. Tutorial-by-Example		
a. Model Evaluation	a. Model Evaluation		
b. Peer Evaluation	b. Peer Evaluation		
4. Build Content Knowledge	4. Build Content Knowledge		
	5. Formative Assessments		
	6. Introduce the Project		

Step 6: Communicate Results

The instructional design model used to start the design process was relatively simplistic and evolved to be more detailed as the co-designers reflected on their design processes and decisions. To start the process, the co-designers began with a skeleton backward design model that included 1) goals and objectives, 2) project assessment including description, student samples, and the rubric, and 3) required content knowledge. Additionally, the co-designers discussed the order in which lesson content would be presented to the K-12 online learner. The model of instructional presentation in the figure below that emerged from this study was called the Project-Based Online Lesson Structure Model (Figure 3).

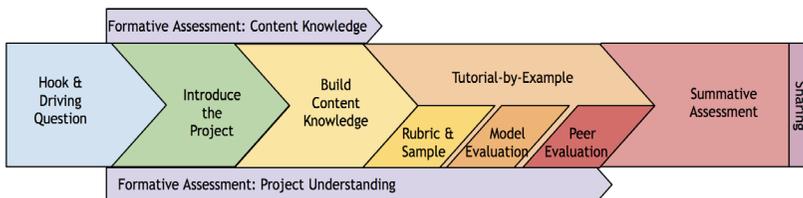


Figure 3. Project-Based Online Learning (PBOL) Lesson Structure.

The major components of this model start at the left with the *Hook & Driving Question*. A driving question is “a statement in student-friendly language of the challenging problem or question at the heart of the project” (Larmer et al., 2015, p. 92). The hook may be a video or news story that places the driving question into a real-world context and stirs learner interest. Paired together, this part of the lesson should pique learner interest and provide authenticity for the project ahead. The second component the learner will encounter is *Introduce the Project*. The project introduction should explain the path the learner is about to embark upon. This may be a video of the teacher, text, or a graphic that explains at a high level the lesson path and project ahead. At this point *Formative Assessments* may begin and continue on into the next several steps. Formative assessments were divided into two categories for this model. Formative assessments that gauge the learner’s knowledge related to the content and curriculum standards like short quizzes, and assessments that gauge learner understanding of the project requirements like graphical planning organizers. Distilling between content knowledge and project understanding was critical to targeting individual interventions or lesson changes. In the third lesson component, learners begin to *Build Content Knowledge*, which includes the readings, videos, and images that introduce the learner to new content for understanding and recall. The fourth step in the process is complex. It is called the *Tutorial-by-Example* and has three sub-components. The tutorial-by-example is intended to scaffold the learner’s understanding of the project expectations and processes. The learner is provided with an in-depth description of the project followed by a rubric and at least one student sample. Next, the learner is provided with at least one video where the teacher grades the student sample using the rubric. This model evaluation is likely a screencast video. The Tutorial-by-Example then ends with a peer evaluation process, likely facilitated by discussion forums, collaborative web software, or a synchronous meeting. Finally, the learner submits his or her project for summative review by the teacher. This *Summative Assessment* step requires feedback provided by the teacher and likely an opportunity for revision before the student publishes the work for *Sharing*. This lesson presentation structure fit with current patterns of GOC curriculum and built off of the online teaching experience of both designers, while applying key principles of PBL.

Realizing that this lesson presentation order was not the same order of the design and development work, the co-designers documented their processes of design during the first design cycle. After the first design cycle, which resulted in a project-based unit addressing the classical text, *The Odyssey*, the co-designers had developed a first draft of the prescriptive instructional design model. During design cycles two and three, this model of instructional design was enacted with slight variations resulting in a

modification. Projects from design cycles two and three related to texts *Romeo and Juliet* and the novel *Night* (Wiesel, 1960). The latest version of the Project-Based Online Learning Instructional Design Model (Figure 4) illustrates the order in which the lesson components from the PBOL Lesson Structure Model were designed. The color and title of each component are the same in both models to indicate the complimentary relationship between the two models.

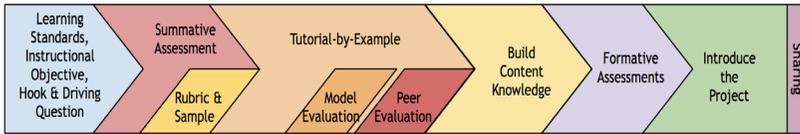


Figure 4. Project-Based Online Learning (PBOL) Instructional Design Model.

DISCUSSION

Scholars have recommended that the field of K-12 online learning look outward to theories that can help explain the unique factors of online learning (Lokey-Vega, Jorrín-Abellán, & Pourreau, 2018). One theory that may help explain the challenge GOC teachers were experiencing with PBL and why the instructional design model that emerged is so structured is Moore's Transactional Distance Theory (1993). This theory assumes that students who are physically separated from their teachers experience a psychological distance that influences learning and is affected by three components including the structure of the course, the dialogue or communication among parties in the course, and the autonomy of the learner. In a face-to-face classroom, because there is more opportunity for dialogue, there is less need for autonomy of the learner. The structure of learning does not need to be high in order to overcome high levels of transactional distance. As the transactional distance increases, as seen with the online learner, misunderstandings and challenges to success become increasingly likely. Moore (1993) argues that the intrinsic nature of online education requires more learner autonomy in order for these learners to be successful, which may be developmentally difficult for K-12 learners. In a face-to-face or blended classroom, learners can still flourish in less structured PBL experiences as the dialogue between learner and teacher is abundant and timely. In the online environment, distance in time and space limit the opportunities for dialogue and demand the learner be highly autonomous, requiring PBOL to be more structured than PBL if it is going to overcome the transactional distance unique to the fully

online environment. Future instructional design models that serve to create higher-order learning experiences for K-12 online learners may prove to be more structured than their face-to-face counterparts as seen in the outcomes of this design and development study.

This study exhibits limitations. As a contextually-embedded design and development study, the resulting model lacks external validity at this point in time. Future research that tests this model in new environments could provide external validation measures and even improve upon the model. Additionally, the quality of the resulting PBOL lessons were only informally evaluated by the researchers during the quick pace of design and development. In reflection, it is clear that each PBOL lesson developed had strengths and weaknesses when held to the BIE PBL Gold Standard criteria; however, this is expected with all PBL as well, and did not deter the researchers.

CONCLUSION

The work of K-12 online teacher-developers is complex, and these professionals seek support in the instructional design process (Gyabak, Otternreit-Leftwich, & Ray, 2015). The co-developers in this study faced several constraints when trying to apply a PBL model to the K-12 online context. However, by documenting the design decision and creation process, they were able to develop a prescriptive instructional design model, the Project-Based Online Learning Instructional Design Model, as well as a related model for presenting the materials to learners, the Project-Based Online Lesson Structure. This research begins to provide scaffolds and guides in designing project-based lessons for K-12 online teacher-developers. Future research should validate this model by evaluating it when used in other subjects, grade-levels, and contexts including higher education. More immediately, this prescriptive instructional design model for project-based learning in the K-12 online environment may help other teacher-developers more easily translate project-based learning principles into the online school context, a much-needed support.

References

- Baines, A., & DeBarger, A. H. (2015). What is rigorous project-based learning? Lucas Education Research Working Paper. Retrieved on July 10, 2018 at <https://www.lucaseducation.org/files/WhatIsRigorousProjectBasedLearning.pdf>
- Barron, B. & Darling-Hammond, L. (2008). Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. San Rafael, CA: George Lucas Foundation. Retrieved from: <https://eric.ed.gov/?id=ED539399>
- Bender, W. N. (2012). *Project-based learning: Differentiating instruction for the 21st century*. Thousand Oaks, CA: Corwin.
- Boaler, J., & Selling, S. K. (2017). Psychological imprisonment or intellectual freedom? A longitudinal study of contrasting school mathematics approaches and their impact on adults' lives. *Journal for Research in Mathematics Education*, 48(1), 78-105.
- Boss, S. & Kraus, J. (2014). *Reinventing project-based learning: Your field guide to real-world projects in the digital age* (2nd ed.). Eugene, Oregon: International Society for Technology in Education.
- Brown, J., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.
- Condliffe, B., Quint, J., Visher, M.G., Bangser, M.R., Drohojowska, S., Saco, L., & Nelson, E. (2017). Project-based learning: A literature review (working paper). New York: MDRC Retrieved from: <https://www.mdrc.org/publication/project-based-learning>
- Dabner, N., Davis, N., & Zaka, P. (2012). Authentic project-based design of professional development for teachers studying online and blended teaching. *Contemporary Issues in Technology and Teacher Education*, 12(1), 71-114.
- Dewey, J. (1916). *Democracy in education*. New York: Macmillan
- Ellis, T. J., & Levy, Y. (2010). A guide for novice researchers: Design and development research methods. In *Proceedings of Informing Science & IT Education Conference (InSITE)*, 107-118.
- Gitomer, D. H., & Bell, C. A. (Eds.). (2016). *Handbook of research on teaching*. American Educational Research Association.
- Gyabak, K., Ottenbreit-Leftwich, A. & Ray, J. (2015). Teachers using design thinking in K-12 online course design. *Journal of Online Learning Research*, 1(3), 253-274.
- Homer, & Rouse, W.H.D. (1999) *The Odyssey: The Story of Odysseus*. New York: Signet Classic.
- Katz, L. G. & Chard, S. C. (2000). *Engaging children's minds: The project approach* (2nd ed.). Stamford, CN: Ablex.
- Larmer, J., Mergendoller, J., & Boss, S. (2015). *Setting the standard for project based learning*. ASCD.
- Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University.
- Lokey-Vega, A., Jorrín-Abellán, I., & Pourreau, L. (2018). Theoretical perspectives in K-12 online learning, in Kennedy, K., & Ferdig, R.E. (Eds.). *Handbook of research on K-12 online and blended learning* (2nd ed.). Pittsburgh, PA: ETC Press. Retrieved from <http://repository.cmu.edu/etcpres/82/>.
- Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2009). Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies. US Department of Education. Retrieved from <http://repository.alt.ac.uk/629/>

- Moore, M. (1993). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp.22-38). New York: Routledge.
- Moursund, D. G. (2003). *Project-based learning using information technology* (2nd ed.). Eugene, OR: International Society for Technology in Education.
- Peppers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, 24(3), 45-77.
- Pressman, R. S. (1997). *Software engineering: A practitioner's approach* (4th ed.). New York: McGraw Hill.
- Ravitz, J., & Blazeviski, J. (2014). Assessing the role of online technologies in project-based learning. *Interdisciplinary Journal of Problem-Based Learning*, 8(1), 65-79.
- Richey, R. C., & Klein, J. D. (2007). *Design and development research methods, strategies, and issues*. New Jersey: Lawrence Erlbaum Associates.
- Shakespeare, W. (1913). *Romeo and Juliet*. Philadelphia: Lippincott.
- Thomas, J. W. (2000). A review of research on project-based learning. The Autodesk Foundation. Retrieved on Jan. 15 2018 from http://www.bie.org/object/document/a_review_of_research_on_project_based_learning
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University.
- Watson, J., Pape, L., Gemin, B., & Vashaw, L. (2015). Keeping pace with K-12 digital learning: An annual review of policy and practice. Evergreen Education Group. Retrieved from <https://www.inacol.org/resource/keeping-pace-with-k-12-digital-learning-12th-edition/>
- Weisel, E. (1960). *Night*. New York: Bantam.
- Woodworth, J. L., Raymond, M. E., Chirbas, K., Gonzalez, M., Negassi, Y., Snow, W., & Van Donge, C. (2015). Online Charter School Study 2015. Credo Center for Research on Education Outcomes. Retrieved from <https://credo.stanford.edu/pdfs/OnlineCharterStudyFinal2015.pdf>