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Design-based Research Method in PBL/PjBL: A Case in Nursing Education

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ABSTRACT

Design-based Research (DBR) focuses on real-world problems, emphasizes studying an educational intervention in its supposed context, uses a cyclical process of design, implementation, evaluation, and improvement, utilizes mixed research methods, stresses reciprocal relationships between theories and practice, and involves a close collaborative relationship between researchers and practitioners. Three iterative DBR research cycles were conducted on a project-based learning (PjBL) implementation in three population health nursing clinical PjBL blocks at a Midwest university. Data were collected at the end of each cycle through surveys, focus group interviews with students, faculty, and clinical agency contacts, as well as student work and performance. The data were analyzed, and revisions and improvements were planned for subsequent blocks and future use in the course.

In the field of problem-based learning (PBL) and project-based learning (PjBL), quantitative, qualitative, and mixed research methods have provided researchers with powerful tools in answering critical research questions and helped advance the field tremendously. Yet, there is always a need to improve ways of conducting educational research for expanding our understanding of the pedagogy. This paper is to discuss the method of design-based research (DBR) and its affordance for PBL/PjBL research.

PBL/PjBL is a pedagogy in the discipline of applied science. It emphasizes creating an authentic learning environment where the learning takes place by solving real-world problems. It is practiced in real-world environments where individual cognitional, psychological, socio-cultural, physical, environmental, or political variables come together to form a unique educational ecosystem (Moallem et al., 2019). An instructional ecosystem continuously evolves, rather than remains static. Student learning outcomes result from the interactions of these variables over time. In the 1990s, a group of researchers in learning sciences, The Design-Based Research Collective (2003), argued that educational research should focus on investigating the effects of a given intervention that is implemented in an authentic environment over a number of iterative (re)design-implementation-evaluation cycles. DBR provides researchers with a research paradigm capable of catching the dynamics between the stakeholders and the contextual environment in these highly complex PBL/PjBL educational ecosystems. Moreover, the built-in feedback loops and iterative-cycles mechanism in DBR provide a timely opportunity for PBL researchers and educators

to adjust the intervention in response to how the learners and other stakeholders react to the intervention. In turn, they are then able to improve and refine the intervention.

Design-based Research

In 1992, Ann Brown (Brown, 1992) and Allen Collins (Collins, 1992) proposed the idea of design experiment to conceptualize an alternative research method in addressing the gaps of traditional research methodologies. Building on Herbert Simon's classification of natural science (analytic science) and design science (artificial science), Collins (1992) argued that the goal of research in design science is to understand how designed artifacts (e.g., a car, a winter coat, an instruction) function in different contexts. Similar to engineering and architecture, education is also considered a design science. Studying how an educational intervention behaves and reacts to the learners and the environment could illuminate its theoretical foundation and improve the practice.

Shavelson et al. (2003) stated that DBR is "based strongly on prior research and theory and carried out in educational settings, seeks to trace the evolution of learning in complex, messy classrooms and schools, test and build theories of teaching and learning, and produce instructional tools that survive the challenges of everyday practice" (p. 25). Today, DBR has been accepted by the learning sciences community as a paradigm of educational research (Sandoval, 2014) and become increasingly popular in the field of education because of its goal of continuous improvement of educational practices in real classrooms (Anderson & Shattuck, 2012). DBR is pragmatic, flexible, and iterative methodology. Its procedure, data collection, and interpretations of the results are integrated and grounded in the real-life context (Wang & Hannafin, 2005). DBR also focuses on "theoretical questions about the nature of learning in context;" studies real-world learning phenomena "beyond narrow measures of learning;" and derives findings primarily from formative evaluations (Collins et al., 2004, p. 16).

Not surprisingly, the DBR approach corresponds with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) process (Dick et al., 2009) that has been practiced for decades within instructional design. The cyclical processes of DBR help researchers construct a deeper understanding of the complex and dynamic nature of teaching and learning. They also facilitate practitioners engaging in effective and adaptive educational practices (Barab & Squire, 2004; Gravemeijer & Cobb, 2006). More importantly, the iterative cycles approach gives the researchers much comprehensive insights as to how the intervention evolves with interacting with different stakeholders, contextual factors, and the time for an intervention to mature.

Characteristics of DBR

Address Real-World Educational Problems

Education and instruction is a field of applied science; therefore, educational research has a dutiful aim to address practical issues and solve educational problems that educators face in real-world settings. As The Design-Based Research Collective (2003) asserted, DBR focuses on addressing and seeking solutions to such problems. Many issues or problems may not emerge until the intervention is implemented in real-world settings. For example, the issues surrounding PBL facilitators' specific skills and training, as well as how the quality and process of facilitation affect students' learning, were not realized until implemented. Two traits of real-world problems are ill-structuredness and dynamicity (Jonassen & Hung, 2008). The former complicates the interrelationships among the variables in the problem (Jonassen, 2000), while the latter injects uncertainty for the problem solving. These two traits make the traditional research approaches less useful for studying real-world problems. DBR, on the other hand, is designed and equipped to tackle these real-world problems with a research mechanism and process that takes these factors into account when seeking and refining solutions.

Emphasis on Context and Situatedness

Barab and Squire (2004) argued that simply manipulating and isolating one or two variables in a controlled environment when studying an educational intervention is unlikely to lead to a complete understanding in its naturalist context. DBR emphasizes situating the educational interventions

within specific contexts in which they will take place. Such contexts include classrooms, schools, or corporate training settings in which the reciprocal relationships between and among the target participants and other stakeholders can be observed, along with physical, socio-cultural, environmental, and/or political factors. All parties and contextual factors interact with and shape each other; therefore, they form a unique educational eco-system in which the intervention is taking place (Collins et al., 2004).

Iterative and Cyclical Process

The purpose of DBR is to improve and innovate educational practices, rather than simply test existing theories or interventions (Reeves et al., 2005). DBR uses an iterative process of design, implementation, evaluation, and improvement in which each cycle builds upon the knowledge or "mistakes" learned from the previous cycle to improve and refine the intervention (Anderson & Shattuck, 2012, p. 17). This necessary approach gives researchers and practitioners sufficient opportunities to observe the evolution of the intervention interacting with its target students and environment. Also, the iterative cycles allow researchers to know whether the adjustment to the intervention is effective in this data-driven fine-tuning process (Reeves et al., 2005). Similar to other fields of applied sciences, such as engineering or medicine, the solution is rarely a one-shot effort. Rather, refining the target product, process, or educational intervention through the iterative process of design, implementation, evaluation, and improvement is a common thread and necessity when seeking better solutions in the fields of applied science.

Use of Mixed Methods

DBR is a data-driven research method that uses a combination of qualitative and quantitative methods to collect and analyze data. Both qualitative and quantitative data collection and analysis techniques are necessary to capture the complexity and multifaceted nature of educational interventions (Anderson & Shattuck, 2012), especially for complex, ill-structured problem-driven instruction such as PBL/PjBL. Quantitative data give the researchers information about how the students perform at different points in the process and at the end of the course. Simultaneously, qualitative data give the researchers a lens to examine what happens during the implementation process and to understand why the students perform in the manner the quantitative data reveal. Quantitative data collection and analysis (such as performance assessments or surveys) are typically used to measure the effectiveness of the intervention. In comparison, qualitative data collection and analysis (e.g., observations, field notes, or interviews) can be used to understand the context and its effects on the intervention and the students and to triangulate with the results from the quantitative data.

Reciprocal Relationship Between Theory and Practice

Disagreeing with the notion that basic and applied research are at polar opposites, Anderson and Shattuck (2012) argued that "good science often leads to very practical outcomes while contributing to theoretical and basic understandings" (p. 17). DBR emphasizes grounding the design and implementation of the intervention, as well as the research of the intervention, on theoretical frameworks. The research results from the design and implementation not only inform the improvement plan of the intervention but also provide feedback to contribute or refine the theoretical framework (or theoretical understanding) upon which the intervention is based (McKenney & Reeves, 2019). Therefore, empirical investigation and intervention development are reciprocal in DBR. The linkage between theory and practice is strengthened through the bi-directional feedback loops. With DBR, interventions can be designed and refined to support student learning more effectively, while helping enrich its theoretical foundation.

Collaborations Between Researchers and Practitioners

Because of its reciprocal theory-practice relationship, DBR involves a close collaborative relationship between researchers and practitioners. This methodology is unlike the traditional research model in which researchers design the intervention and research without input from practitioners (e.g., teachers or instructional designers), or the practitioners implement it without knowing its theoretical underpinning. Rather, DBR requires both groups to co-design a theoretically sound, effective, and practical intervention and implement it jointly (Barab & Squire, 2004). Furthermore,

the collection, analysis, and interpretations of the data are also a collaborative effort of both researchers and practitioners. This collaboration enables researchers to ensure that the intervention design is contextually appropriate and practical and addresses the students' and practitioners' needs. Conversely, the involvement of researchers in intervention design also ensures the intervention is grounded in theory and evidence, rather than on anecdotal observations. Through this joint partnership, an effective improvement plan can be devised toward maturing the intervention, and the newly gained knowledge can be incorporated into the theory.

DBR Design & Process

Some researchers suggested various research models or process, for example, Wang and Hannafin (2005), Gravemeijer and Cobb (2006), and Jonassen et al. (2007) This paper will draw on the McKenny and Reeves' (2019) generic model and incorporate Sandoval's (2014) conjuncture mapping to discuss the process of conducting a DBR study.

Flexible, Iterative, and Reciprocal Process

According to McKenny and Reeves (2019), unlike traditional research paradigms that emphasize pre-determination of certain parameters of the intervention and rigid implementation of the procedure, flexible and iterative processes are key research design and implementation principles of DBR. The goal of DBR is not to identify exactly which individual variables cause effects on predetermined outcomes to be measured but to refine and improve the intervention. With the overwhelming amount of uncontrollable or hidden variables in real-world educational settings, a flexible process allows the researchers to be agile, adaptive, and quick to adjust the intervention based on feedback from the implementation in a timely manner. Furthermore, the iterative process goes hand in hand with the flexibility principle, which enables the researchers to test the adjusted intervention, thereby refining the product. Lastly, as discussed above, DBR involves the dual theoretical and practical process. The theoretical and practical aspects of an instructional problem to be solved and the instructional solution (intervention) reciprocally inform and refine each other.

Yet, DBR has been criticized for its lack of explicit structure for research design and data collection. Thus, it is important to establish a DBR study on a sound theoretical framework to guide the design and the evaluation of the study (Wozniak, 2015). Sandoval (2014) suggested using a conjecture map (for this copyrighted figure, please refer to Figure 1 Generalized conjecture map for educational design research, Sandoval, 2014, p. 21) to facilitate data collection in DBR, which consists of six elements. First, Higher level conjectures refer to articulating the conceptual idea for support of a specific learning that the study is targeting in a particular context. The second element, Embodiment, means to translate the conceptual idea into a specific design, which may include specific features in a learning environment, pedagogical approach, and instructional strategies or techniques. According to Sandoval (2014), these designs do not directly produce Outcomes, which rather is a result from Mediating processes that are triggered by the features, instructional strategies, or pedagogical approaches from the Embodiment. The conjecture map depicts the learning trajectory of the student and therefore the data collection path of a DBR study (Sandoval, 2014). It also explains the complex relationships among the different elements at different phases (Wozniak, 2015). Moreover, the design conjectures describe and justify the conceptual causal relationships between the specific design (features, instructional strategies, tools, etc.) and the learning processes that occurred during the mediating process, while the theoretical conjectures define the relationships between the mediating process and the outcomes (Sandoval, 2014).

Three Research Phases

McKenny and Reeves' (2019) generic model of a DBR study consists of three main phases: Analysis and Exploration, Design and Construction, and Evaluation and Reflection (for this copyrighted figure, please refer to Figure 3.3 Generic model for conducting design research in education, McKenney & Reeves, 2019, p. 83).

Analysis and Exploration. Consisting with the scientific problem-solving process, the first step of DBR is to understand the problem to be studied. Using the term from problem-solving research, this step involves problem space

construction (Newell & Simon, 1972). During this phase, DBR researchers start a series of information gathering and data collection from various sources and subject domains. This analysis of the problem will include gap discrepancies, stakeholders, and context. To construct the problem space, an analysis is needed of both the current and desired states of the situation pertaining to the problem regarding the knowledge and practice. This analysis can further lead the researchers to identify the potential causes of the problem and devise the solution. Also, a stakeholder analysis is critical to understand their roles and perspectives on the problem, as they play key roles in the educational ecosystem. In addition, identifying the specific contextual factors that are unique to the problem and may present potential constraints to the design or the implementation of the intervention is critical to the design of the intervention. These rigorous analyses give a thorough theoretical and practical understanding of the problem and therefore a well-informed intervention as a practical solution. Furthermore, exploring solutions to similar problems in different comparable contexts can also inspire the design of the intervention. During this phase, the tasks or techniques that can be used may include needs assessment and literature review (Bannan-Ritland & Baek, 2008), or seeking information from various sources, including personal interviews (Reinking & Bradley, 2008, p. 74).

Design and Construction. Based on the analyses produced from Analysis and Exploration phase, DBR researchers and practitioners will design potential solutions to the problem. As discussed earlier in this paper, the problems for which DBR is designed are real-world problems that are ill-structured and involve multiple aspects in an educational ecosystem. The intervention solution is likely to include a mindfully orchestrated set of instructional strategies, techniques, approaches, pedagogies, and implementation logistics suited to a real educational environment. Such an implementation plan requires articulation of the relationships between the learning issues to be addressed, their causes, and the constraints to be accommodated in the problem space from the Analysis and Exploration phase. Then, an instructional plan will be devised in which appropriate instructional strategies and techniques must be identified and justified for addressing the issues and facilitating the student learning. This instructional plan along with the implementation logistic plan that takes the contextual considerations will then be configured into the intervention plan. Documenting the design process and decisions is extremely important in DBR as they will be the references for the evaluation and reflection (McKenney & Reeves, 2019). Once the intervention plan is complete, an initial prototype of the intervention construction can begin. An important consideration is that though DBR makes use of a reciprocal theory-practice process, the weight of each aspect varies during different phases. A rule of thumb is that, according to McKenny and Reeves (2019), the design of an intervention is more theoretically founded, while construction is more practically oriented. The process of construction is to turn the design ideas into reality, while also testing them for practicality. The actual implementation is the true test of the theory and practicality of the intervention.

Evaluation and Reflection. This phase is critical as it makes the iterative nature of DBR possible. Unlike other research methods whose final report of findings and discussions mark the end of the study, the Evaluation and Reflection phase of DBR is the refinement of the intervention. They prepare for the next cycle of redesign, implementation, and evaluation of the intervention. During this phase, the researchers will analyze the quantitative data collected during the implementation process and critically evaluate the students' performance. They will also review implementation issues defined in the conjuncture map and report what has been achieved and what has not. Also, the qualitative data collected will be used to assist further the inspection of the quantitative data and possibly provide explanations. Depending on the goal of the study defined in the conjuncture map, the evaluation in a DBR may focus on "soundness, feasibility, local viability, broader institutionalization, immediate effectiveness, and/or long impact" (McKenney & Reeves, 2019, p. 86). Reflection, on the other hand, should emphasize what can be learned to further our understanding in terms of theoretical assumptions or empirical findings from the implementation. A final product from this phase is a summary of the recommendations for revising the intervention for the next cycle of

implementation. Therefore, the main tasks in this phase are to evaluate critically the results against the goal of the intervention and thereby revise or fine-tune the intervention.

Research Outputs and Practice

Through multiple iterative research-implementation cycles, two main outputs from the research will be produced: maturing intervention and theoretical understanding. According to McKenney and Reeves (2019), both these outcomes can be directed toward answering research questions specifically to the local context of the study or more broadly to other fields.

Maturing Intervention. The iterative cycles of design-implement-revise processes provide chances for the intervention to be refined and mature. By analyzing the data collected from the implementation process and results, the researchers would be able to identify what and how particular components in the intervention need to be revised or fine-tuned, and then test the conjectured revisions in the next cycle of the research for verification of its effectiveness. This approach, in fact, simulates the natural process of a product maturation occurred in real world. DBR situates the intervention in an environment to gradually mature and be optimized through systematic iterative test-adjust-verify processes.

Theoretical Understanding. The other outputs produced from DBR research contribute to expansion of theoretical understanding of the subject under study. The maturing intervention produces a well-tested and optimized intervention for practice in real world. On the other hand, valuable knowledge can be gained through the process of systematic iterative research cycles to expand, modify, refine, or create new insights to be incorporated into the existing theoretical understanding of the subject. By adjusting the range or depth of the data collected and analyzed, the knowledge generated from the cycles can be specific to the topic under study or general enough to apply to larger contexts beyond the study. The theoretical knowledge informed from DBR provides a more well-tested understanding than the knowledge produced from traditional single-shot studies.

Implementation and Spread

The advantage of this approach is that the intervention will be tested in how it is actually practiced in the classrooms or training environments in which unforeseen variables, constraints, or opportunities could be entered and therefore identified. This real-world test provides the researchers and practitioners with a reality check of how the intervention design works in a real-world context, as well as how it needs to be adjusted and refined. Furthermore, if scale-up is part of the research, the intervention can be designed to be implemented at a smaller scale initially (e.g., a single class, a school, or a training facility). During the iterative research cycles, the implementation can be scaled up incrementally, and the data from the implementation scaling can be collected and included in the evaluation data analyses for the next research cycle. The implementation scale-up can also be used as a means for spread and dissemination of the intervention.

An Illustrative Example Study: A PjBL Case in Nursing Education

Program planning, implementation, and evaluation (PPIE) are key components of population-based health nursing courses. They represent three of the six standards of practice for public health nursing outlined by the American Nurses Association (ANA, 2022), which are identified as "the actions and behaviors that all public health nurses, regardless of role, population, and setting, are expected to preform competently" (p. 69). While students can learn the concepts, principles, and skills related to these standards in a didactic population-based health course, real-life application skills are best developed through a clinical course (American Association of Colleges of Nursing [AACN], 2021; Zeydani et al., 2021). Collectively, PPIE is a complex process that public health nurses almost always complete in collaboration with others. The learning expectations related to this content are multifaceted; in addition to program planning, implementation, and evaluation, students develop skills in effective communication, collaboration, cultural competence, and clinical judgment (ANA, 2022; Quad Council Coalition Competency Review Task Force, 2018). In a collaborative

PPIE project, in which students emulate the role of the public health nurse and work in coordination with a clinical agency, students practice and develop all of these skills, rather than the few they would learn in a didactic course. Group projects that are structured and facilitated in an evidence-based manner are also important to the promotion of optimal learning.

Phase I: Analysis and Exploration

Context

Population health nursing, also referred to as public/community health nursing, is "the practice of promoting and protecting the health of populations using knowledge from nursing, social, and public health sciences" (American Public Health Association, Public Health Nursing Section, 2013). This field is recognized as one of the ten domains that represent the essence of professional nursing practice by the American Association of Colleges of Nursing (2021). In addition, population health nursing expertise is a key distinction of a bachelor's degree in nursing from an associate degree in nursing, as a didactic and clinical course in population/public/community health is required for the bachelor's degree.

This study focuses on the population health nursing clinical course that takes place during the final semester of the Bachelor of Science in Nursing program at a Midwestern university. Each semester the students are divided into two groups with one group taking this course during the first of two 6-week blocks and the other group in the second 6-week block. The typical class size is 22-36 students in each block with clinical sections of about 10-12 students. Instruction is face to face, with a faculty facilitator (i.e., clinical instructor) working directly with each clinical section of students, and the course is delivered on campus and in the community. Nursing classrooms are used for some clinical work, as meeting space and technology resources are not consistently available at all clinical agencies. In addition to the PPIE project, students engage in other group clinical activities and have independent experiences with various clinical agencies.

With the focus of this study on the students' PPIE project, educators must recognize clinical judgment as a key cognitive skill in conducting PPIE. Clinical judgment is "an interpretation or conclusion about a patient's needs, concerns, or health problems, and/or the decision to take action (or not), use or modify standard approaches, or improvise new ones as deemed appropriate by the patient's response" (Tanner, 2006, p. 204). Tanner's Clinical Judgment Model (TCJM) outlines four aspects of clinical judgment: noticing, interpreting, responding, and reflecting (for the TCJM copyrighted figure of the model, see Tanner, 2006, p. 208). This model is more important than ever in nursing education. The recent revision of the national licensure exam (NCLEX) to have a stronger emphasis on clinical judgment has led to a shift to place greater weight on the development of clinical judgment in nursing students (National Center of State Boards of Nursing, 2023).

To guide students in this real-life application of their learning, as well as developing PPIE and clinical judgment skills, PjBL was used as the pedagogical structure of this course. PjBL is more than just completing a project. Rather, it is an active learning, student-centered approach in which students design, develop, and construct hands-on solutions to address a complex real-world issue or challenge. Typically acting in small groups, students develop key skills such as critical thinking, creativity, collaboration, communication, goal setting, and reflection (Moallem et al., 2019). PjBL also involves formative assessment through peer review, feedback, and revision of the plan (Buck Institute for Education [BIE], n.d.; Kokotsaki et al., 2016). Figure 1 depicts the Gold Standard PjBL model, which highlights both the design elements and teaching practices that are key in PjBL (BIE, n.d.). In nursing education, PjBL has been linked to improved learning outcomes as well as critical thinking and problem-solving skills (Arif & Putri, 2022; Bassi, 2011; Daley & Sciegaj, 2021; Hanklang & Sivasan, 2019; Koo et al., 2022; Pascon et al., 2022; Sung & Wu, 2018; Wahyuningsih et al., 2020).

Given PjBL's effectiveness in developing critical thinking and problem-solving skills, it lends itself well to developing clinical judgment. In fact, The Buck Institute for Education's (BIE) Gold Standard PjBL model has seven project design elements that have many similarities to the components of Tanner's Clinical Judgment Model. The seven elements of this model include a challenging problem or question, sustained inquiry, authenticity, student voice and choice, reflection,

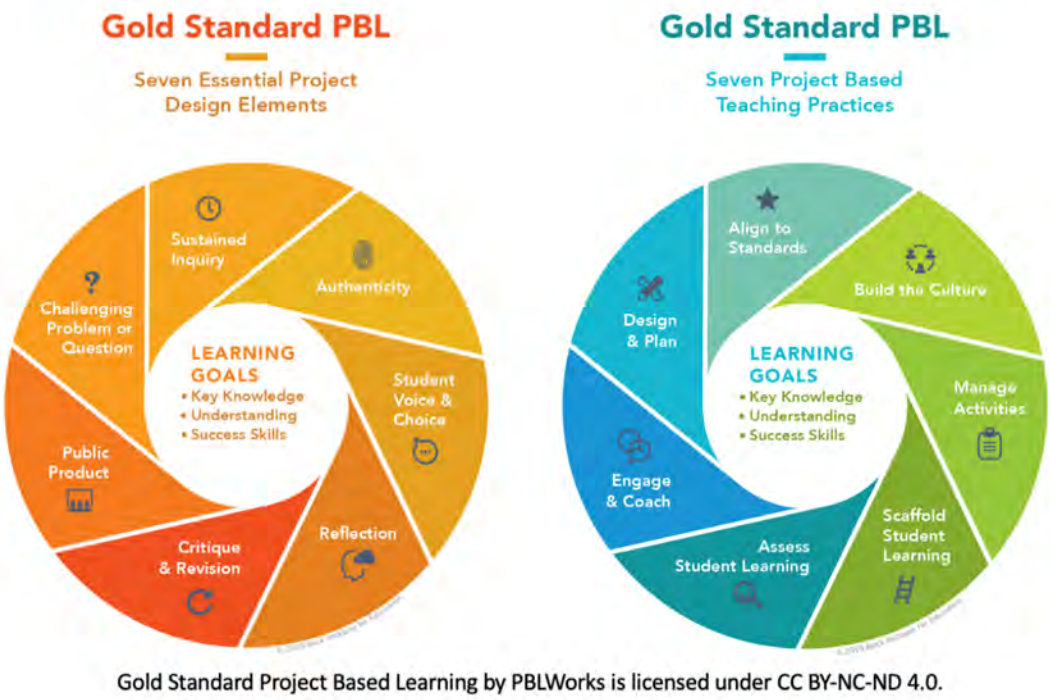

Figure 1. BIE PjBL Model

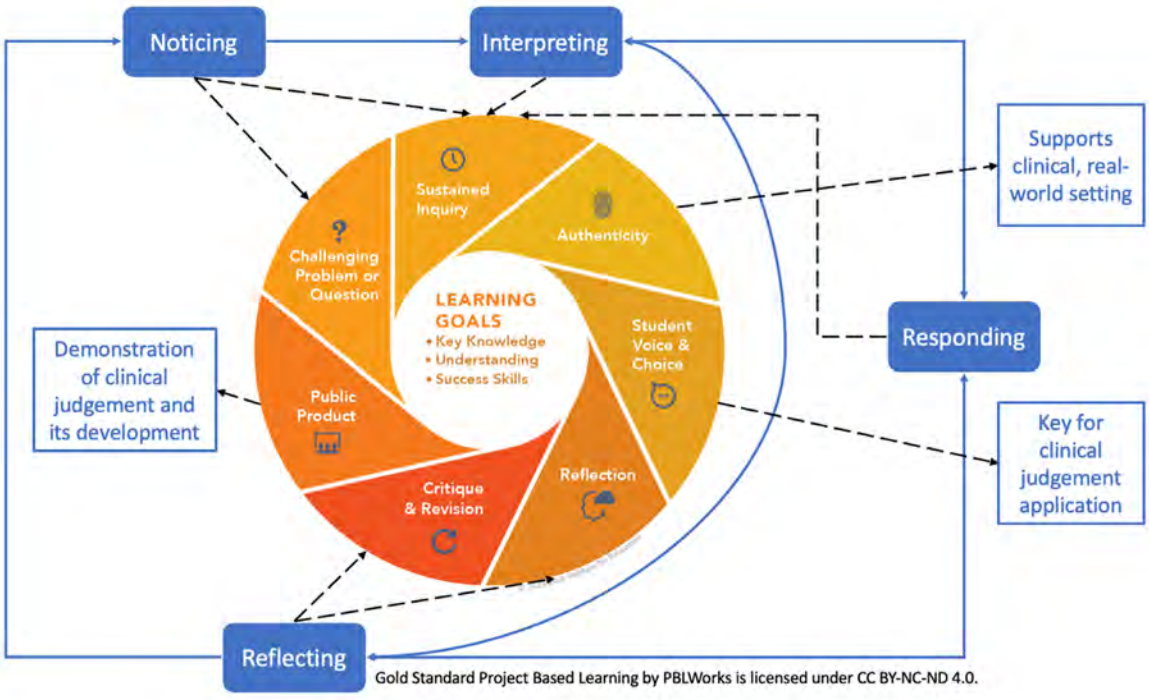

Figure 2. Connection Between BIE's Gold Standard PjBL Model (n.d.) and Tanner's Clinical Judgement Model (2006).

critique and revision, and public project (BIE, n.d.). Tanner (2006, p. 208) and BIE (n.d.) provide more details on these models in their respective works. See Figure 2 for a visual of the connections between these models.

Research Questions

This study focused on the instructional affordability of PjBL for nursing students' clinical judgment development and the feasibility and optimization of PjBL implementation in the context of nursing education. Four specific research questions were used in this study:

1. How does PjBL contribute to student development of clinical judgment?
2. How can a faculty facilitator best promote effective student learning in a PjBL project?
3. How can a faculty facilitator best promote effective collaboration between students, clinical agency contact(s), and faculty facilitator in a PjBL project?
4. How can a PjBL approach be best implemented in a population-based health nursing education setting?

Phase II: Design and Construction

Course Design

The purpose of N443 Clinical Practicum IV is to apply population-based health concepts and the role of the public health nurse, analyzing epidemiological data and collaboratively working to plan, implement, and evaluate a population-based project in coordination with a community agency, all to prepare students to positively impact health, with a specific focus on vulnerable populations. The N443 faculty employed PjBL as the underlying pedagogy to design the course, specifically a PPIE project, to provide students with a structured learning environment in which they must apply their knowledge from this course and the corresponding didactic course to meet course objectives. The PPIE/PjBL project is focused on a need or issue identified by the clinical agency, providing students with a greater purpose for their work by addressing a real-world problem and developing end products that will benefit the clinical agency (i.e., Challenging Problem or Question and Authenticity elements of BIE's PjBL Model), adding greater motivation and meaning for students. For this project, the students work through the planning, implementation, and evaluation process with guidance and support from the faculty facilitator and clinical agency contact.

The project begins during Week 2 of the course with an introduction to their topic and initial meeting with the clinical agency contact. In this planning phase, the students map out their project plan and negotiate roles, responsibilities, and a project timeline (i.e., Challenging Problem or Question, Authenticity, and Student Voice & Choice elements of BIE's PjBL Model). Once the initial plan is developed, the students research evidence-based practices and use their own creativity to develop products and strategies that align with the clinical agency's identified needs and expectations (i.e., Sustained Inquiry and Student Voice & Choice elements of BIE's PjBL Model). Students check in regularly on their progress and receive feedback and direction for ongoing work, as all student-created project products require approval by the faculty facilitator and the clinical agency contact before they can be used with the public (i.e., Critique & Revision element of BIE's PjBL Model).

Typically, the project is implemented during Week 5 of the course (i.e., Public Product element of BIE's PjBL Model). In Week 6, the students meet with the faculty facilitator and clinical agency contact to review their gathered evaluation data and engage in an evaluation discussion based on a set list of questions (i.e., Reflection and Critique & Revision elements of BIE's PjBL Model). As a final product, the students give a presentation to the other clinical sections and the clinical agency contacts about their PPIE/PjBL project (i.e., Public Product element of BIE's PjBL Model). The students' work on the PPIE/PjBL project is evaluated using a rubric that encompasses planning, implementation, evaluation, and professionalism (i.e., Critique & Revision element of BIE's PjBL Model). Key components of teamwork and collaboration are interwoven throughout the rubric as they are critical for the entire process and overall student learning. Many aspects of this project also contribute to the overall clinical performance evaluation that is used to evaluate each student individually at the end of the course.

Research Design Cycles

This research project was designed with three cycles using the iterative process of DBR and guided by the conjecture map (Figure 3). As this course occurs in 6-week blocks with two of these blocks in each fall and spring semester, it was planned to complete three cycles in one academic year. The first cycle occurred in late Fall 2022 with Cycles 2 and 3 falling respectively in the first and second halves of the Spring 2023 semester (Figure 4). Near the end of each cycle, data was gathered using a variety of course assessment documents, along with a student survey, student focus group interview, clinical agency contact interviews, faculty facilitator interviews, and researcher observation notes. This data was then analyzed and used to guide the iterative refinement plan for the subsequent cycle. At the conclusion of Cycle 3 the data from all three cycles would be analyzed collectively

to guide the maturation of the PjBL implementation protocol in the course and the facilitation role and group process management.

Instruments

For this research project, data was gathered through a variety of instruments. This information provided a comprehensive perspective on both the interactions between students, faculty facilitators, and clinical agency contacts, as well as overall student learning through the PPIE/PjBL project.

Course Assessment Documents.

PPIE Project Rubric. This rubric is used to evaluate the collaborative group performance on the planning, implementation, evaluation, and professionalism aspects of the project. Faculty facilitators use this rubric to grade the group's work and provide written feedback.

Mid-Course Eval Form. These forms are used to evaluate each student's performance at the mid-point of the course, focusing on critical behaviors and overall student performance. Each student meets with their faculty facilitator to discuss progress on course goals and group collaboration. Faculty add notes to the form based on this discussion.

Clinical Practicum Performance Evaluation. At the end of the course, each student completes a self-evaluation using this tool. Subsequently, their faculty facilitator evaluates the student's overall performance in the course based on this form. The facilitator then meets with each student to review the form and discuss their performance in the course.

Student Survey and Focus Group Interviews. A student survey was developed using Qualtrics and consisted of 19 Likert scale questions and one open-ended question, allowing students to provide comments on how the PjBL aspect of the course could be improved. The Likert scale questions focused on group process/dynamics, student engagement, and learning experience and satisfaction. Most questions focused on observable interactions between students and their faculty facilitators and clinical agency contacts. The focus group interview questions were designed to allow students to elaborate, focusing on reflection on learning, clinical judgment, and suggestions for improvement for faculty facilitators, clinical agency contacts, and the overall course.

Clinical Agency Interviews. A series of interview questions for clinical agency contacts was developed, focusing on the preparation of the students; effectiveness of student work, communication and collaboration; suggestions for improvement; and overall feedback on the larger purpose and other issues.

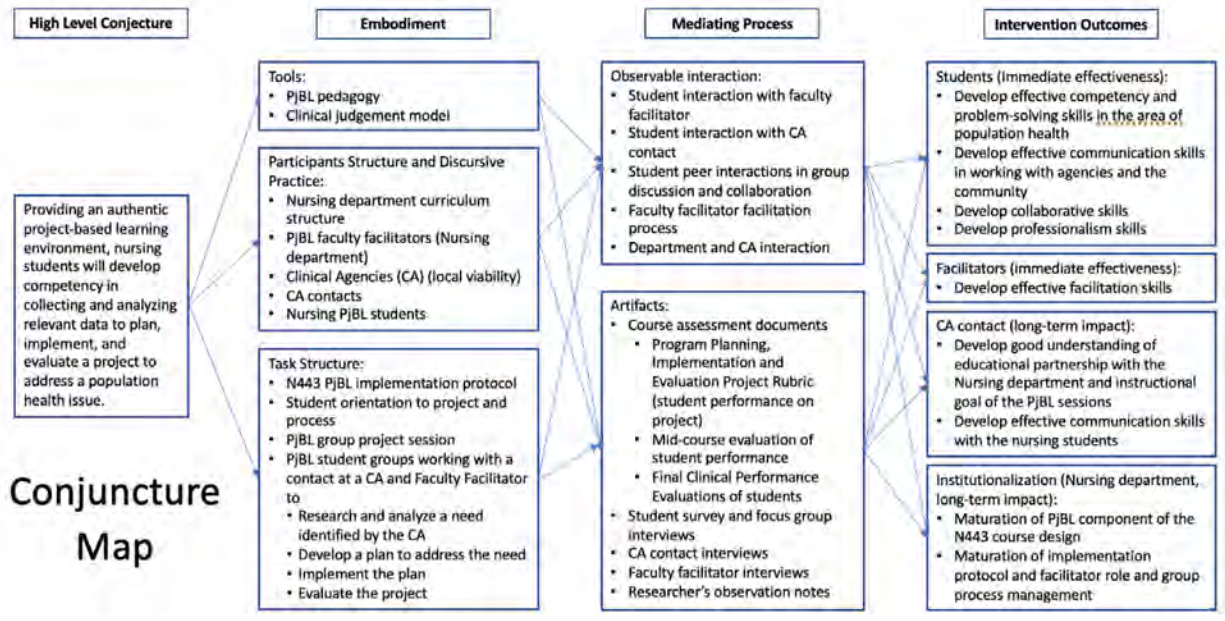

Figure 3. Conjuncture Map for N443 PjBL DBR Study

Faculty Facilitator Interviews/Researcher's Notes. Similarly, a series of interview questions were developed for faculty facilitators. As the researcher was one of the faculty facilitators, these questions were designed to be used for either interview purposes or for researcher note-taking. The questions focused on the facilitation process, specifically what worked well and what did not, as well as the integration of clinical judgment. Other questions asked faculty facilitators to reflect on the evaluation discussion they completed with their students and provide suggestions for improvement.

Phase III: Evaluation and Reflection

Evaluation

Data Collection Process. For this study, data collection began near the end of each cycle. For the first cycle, this step was postponed one week due to a delay in IRB approval, which led to some challenges (as noted below) with the results of Cycle 1. For Cycles 2 and 3, data from the student survey and focus groups were gathered during this final week of the course, which worked much better. Data from course assessment documents was gathered the week after each course concluded. Clinical agency contact and faculty facilitator interviews were typically completed the week after the course concluded, with some sessions delayed due to interviewee availability. Researcher observation notes were also gathered the week after each course concluded.

To effectively answer the research questions, course assessment documents were used, as these resources provided insights into both the immediate effectiveness and long-term impact on student learning and collaboration. The soundness and feasibility of the project process and faculty facilitation were evaluated through questions on the student survey, student focus group, and the interviews with faculty facilitators and clinical agency contacts. For instance, the students were asked a variety of questions about how their group worked together and faculty were asked how the facilitation process went. In addition to these insights, the clinical agency contact interview questions addressed the local viability by asking how well the students' work contributed to their agency's work. Collectively, all the data from the instruments contributed to the maturation process of the project and the development of the facilitation guide, as well as the benefit of using the DBR process.

The instruments remained consistent throughout all three cycles of this study. However, after one interview, faculty facilitators began to take more notes throughout the subsequent cycles and provided copies of these notes to supplement their interview answers.

Evaluation Process. The evaluation process aligned with the previously described research design cycles (Figure 4), with data gathered and analyzed as each cycle concluded. This data was then used to develop the iterative refinement plan for the subsequent cycle. The tight timeframe between two cycles, as well as departmental and institutional complications, made it difficult to implement all aspects of the iterative refinement plan for each cycle. However, any refinement plan elements that were not able to be implemented in the next cycle were pulled forward to guide the maturation of the PjBL implementation protocol and further development of the facilitator guide.

Cycle 1 – Implementation and Evaluation

Description of Student Group. This group of students worked well together, cared about making a difference through their project, and worked hard to make it a success. They were a typical mix of high achievers and a few students who had difficulty and needed more guidance. This group contained an even balance of students who were more outspoken, students who were quieter, and some who were slightly more dominant than the others. The quieter students, with encouragement from faculty and peers, were able to increase their level of engagement and sharing as the course progressed. All students had a high level of interest in the topic of the project, as they knew it had great potential to save lives.

Student Learning Process and Outcomes. The students did very well in developing their problem-solving skills and applying principles of program planning, implementation, and evaluation. As a group grade for this project, the students earned 100%, indicating a satisfactory level of student learning outcome. All 13 students met the course expectations through their clinical performance; however, opportunity for improvement exists, as two students were at the developing, rather than satisfactory, level for one or two sub-objectives. These sub-objectives were related to individual challenges and growth with technology, confidence, and respectful engagement during conflict. In their final evaluations, the students provided many great comments on their learning and growth, as shown in these examples: "Overall, I feel like I have a good grasp on the steps for the [project]. I know where to get resources and how to collect and evaluate," and "I learned more about collaboration, social marketing, and many other nursing interventions."

In general, the students collaborated well to plan, implement, and evaluate their project. They also utilized their resources well, including the clinical agency contact, used technology well to create high quality products, presented the content in an effective and engaging manner, and improved their work and presentations through feedback. In addition,

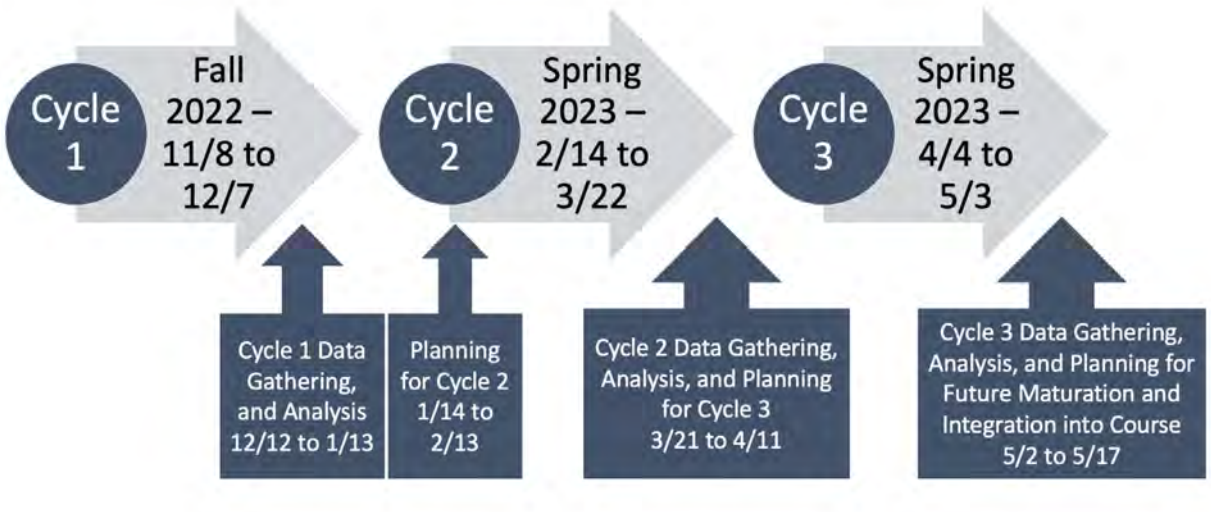

Figure 3. Conjuncture Map for N443 PjBL DBR Study

they demonstrated professionalism in their interactions with each other, the faculty, the clinical agency contact, and the target community. One quote from the students' survey supported this observation: "I have grown a lot . . . [in] my communication skills . . . and how to work [with] my group even if we are having a disagreement."

Issues Identified. The challenges identified from this round of PjBL implementation were more in the areas of collaborative learning and personality issues. During the first few weeks, one facilitator observed in her group that 5 out of the 13 students were quieter than the others and limited their discussion participation. During mid-course evaluations, the facilitator encouraged these students to share their ideas and perspectives more with their peers. In addition, only one student brought up an argument that occurred between one subgroup during the prior week. After facilitator intervention, the students resolved their issue, learning to communicate and collaborate more effectively. This example demonstrates that facilitator's observation and facilitation skills are critical for providing appropriate, just-in-time guidance to direct the students to positive collaboration.

Personality conflict was another issue identified from the student survey data. One student indicated an ineffective collaborative relationship, unfair workload distribution among the group members, and the group's evaluation of the project was ineffective. Based on the facilitator's observation note, the first comment was most likely related to the one sub-group's argument early in the project. The second comment may have reflected personality differences and group dynamics. As for the third comment, the facilitator's observation disagreed with the student's comment. This group truly excelled in their evaluation of their project, as they used their survey results to make progressive improvements to their presentations, and they had a great evaluation discussion at the end. Another personality conflict emerged with students who were more passive than others in their group, which most likely reflects the fact that some students were quieter, more thoughtful, and slower to share.

Other Observations. The lead researcher noted that some students appeared to have a negative perception of the PPIE/PjBL project in the beginning of the instructional block. Further probing, observing, and analyzing of the survey and interview data suggested that their negative perception stemmed from skepticism of how the project would help them gain real-life nursing experience. The local clinical agency contact met with the students on campus once a week, which helped the students realize the project's authenticity and impact on the population served. For example, one student said, "I found some things I am really passionate about and ways to address those issues in my nursing practice." Therefore, an insufficiency of transparency, in terms of how the clinical project would be conducted, may have impeded the motivation of the students to participate in the project in the beginning.

Curriculum and Implementation.

Facilitator Development. Some personality conflicts among the students were observed in this cycle. Though the conflicts were not significant, they did cause stress for the students and facilitator. A helpful strategy the facilitator implemented was to create a shared project plan document that was updated as the project progressed to keep everyone aligned. Through discussions with other facilitators about how to handle group dynamics issues, other strategies were gathered. Ideas included being as strategic as possible in dividing out student sub-group work and making time for full group discussion and updates to help facilitate communication between sub-groups. Faculty facilitators agreed that a project facilitator guidebook would be helpful for preparing the facilitators to handle challenges related to balancing guidance and student freedom and managing personality conflicts.

Clinical Agency (local viability). While the clinical agency contact came to meet with the students each week, and the project was authentic, faculty observed that some students felt somewhat disconnected with the agency and population of focus because the meetings were not held at the agency facility. Therefore, the clinical agency contact agreed it would be beneficial for the students to visit the agency at least once to feel more connected and engaged with the agency. In the clinical agency interview, the contact additionally mentioned the challenge of devising projects that work well for the students' learning and that are beneficial to the agency. One suggested solution was to request future project ideas from the students at the conclusion of a current project.

Institutionalization. At the beginning of Cycle 1, a faculty coverage issue created some challenges. One faculty member needed to take an extended absence, resulting in a larger clinical section of 13 students than the standard 10-12 students. This situation created some confusion and uncertainty, required that plans be rearranged during the first week, and impacted the project in various ways. For instance, a larger group of students meant a greater challenge for faculty to facilitate the group work effectively, support individual student needs, and help the group stay organized and on task. These circumstances also prompted students to function more independently and collaborate more with their peers before bringing issues and questions to faculty. Additionally, quieter students found it more challenging to speak up and engage in group discussions with more voices present. However, more students working on the project allowed for the reach to a wider audience, which led to higher group satisfaction and pride in the project. Furthermore, the shortage of faculty facilitators also led to faculty being unable to incorporate TCJM into the project as originally planned due to increased time demands with more students and lack of time to develop and implement strategies. Though this issue had a ripple effect on several PjBL implementation aspects, the department saw this scenario as an isolated incident. However, this experience has alerted the department of the potential negative effects on many aspects of the project as well as the student learning.

Research Issues (Data Gathering Timeline). The data collection for Block 2 was delayed due to the wait for a backlogged IRB approval. This lag led to a poorer response rate as the survey was not able to be sent out at a time that worked well with student schedules. Only 6 of the 13 students completed the survey and only three provided any comments on the open-ended question. This inconvenient timing for students also meant a focus group was not able to be conducted. A revision of the data collection schedule was deemed necessary for the next cycle.

Iterative Refinement Plan for Cycle 2. Based on the data analyses, several adjustments were incorporated into the next cycle of implementation:

- Increase new students' interest and excitement of the PPIE/PjBL project by highlighting previous student quotes about what they enjoyed and learned from the project in the course introduction.
- Ensure each clinical section has at least one day at the clinical agency.
- Gather survey and focus group data earlier (during the last week of clinical) to better align with student availability and time.
- Develop a project facilitation guidebook that incorporates the following strategies:
  - o Facilitate group discussion on effective group work, including how to engage others in group work, managing personality conflicts, and when to ask for faculty help/support with group conflict.
  - o Discuss balance between faculty guidance and student freedom with students.
  - o Allow students to sign up for their own groups and tasks based on their preferences and talents/skills.
  - o Guide students in assigning an even distribution of workload.
  - o Create a shared project plan document that can be updated as the project progresses to help keep everyone on the same page.
  - o Incorporate full group discussion and updates to help facilitate communication between sub-groups.
  - o Use smaller group work/discussion to help quieter students feel more comfortable sharing.

o Share TCJM with facilitators to use as a guide for discussion questions.

o Add an evaluation discussion question for student suggestions for future project ideas with that clinical agency.

Cycle 2 – Implementation and Evaluation

Description of Student Group. In this cycle, two clinical sections contained 11 students each. These groups were very similar to the group in Cycle 1. The primary difference from the previous group was in the fewer extremes in outspoken and dominant students versus quiet followers. In addition, minimal to no conflict was identified among group members.

Student Learning Process and Outcomes. Both clinical sections met student learning outcomes, performing very well in their PPIE/PjBL project, with both sections earning 100% on the group project. All 22 students met the course expectations through their clinical performance evaluation. For two sub-objectives, four students (two for each sub-objective) were at the developing, rather than satisfactory, level. These sub-objectives related to issues in regard to lacking self-confidence in presenting and speaking in front of peers, being distracted, and having limited initiative in group work. The following two student comments summed up the learning from this project well: "Through [this project] I have been able to better understand public health interventions, apply them appropriately, and utilize community resources," and "I feel as though my communication skills and confidence both improved, along with my ability to effectively collaborate with my peers."

Both clinical sections in this cycle worked very well together, collaborating effectively and supporting each other. Here is an example: "I feel like in general this whole class worked really well together . . . I was able to find my place in the project and . . . help out with others' parts." In addition to collaborating well, the students adjusted appropriately as challenges arose and carried out high-quality projects. As one student summarized, "Overall, this class really helped me . . . out of my comfort zone to work professionally with agencies that I would have never worked with otherwise [and] to develop into a more well-rounded future nurse."

Cycle 1 Recommendation Needing Further Development. The recommendations from Cycle 1 on issues related to group work, managing personality conflicts, workload distribution, and engaging quieter students were helpful. However, based on the data from Cycle 2, further refinement and additional strategies are warranted. For instance, one facilitator found data from a course intro survey on group work to be helpful in understanding, supporting, and guiding students through their collaborative work and engaging students in a quality group process discussion. The other facilitator reported insufficient time to use this strategy. To help all faculty benefit from and consistently incorporate the survey data in the facilitation process, strategies for using the data need to be added to the facilitation guide.

As for managing personality conflicts, the two clinical sections in this cycle seemed to be more cohesive. However, at the end of the course, some students noted that one of their peers did not contribute as much as the rest of the group. Even with fewer personality issues than Cycle 1, additional efforts to help manage personality conflicts are needed. One facilitator found it helpful to guide the students in establishing ground rules and clear expectations that they can all agree upon. This approach would be a beneficial strategy to incorporate in all clinical sections.

In Cycle 2 faculty allowed students to sign up for their preferred tasks, provided additional guidance to ensure the work was distributed evenly, and checked-in with students during mid-course evaluations. Though a somewhat uneven distribution occurred, the students who did more work shared that it was not too much and that some tasks were not easy to divide up. The facilitators agreed that dividing the work is challenging, and some aspects are hard to redistribute or delegate. Even with these issues, one clinical agency contact noted that everyone took a role and no slacking occurred. While the early guidance and mid-course check-ins help, they are not enough to manage this issue effectively. Additional interventions from facilitators are needed to help maintain a good balance of workload among the students.

To address the issue of students who are quieter and slower to share in discussion, some key strategies were implemented, such as including more frequent small-group work and discussion and encouraging quieter students to challenge themselves to share more often. In addition, more outspoken students were encouraged to engage their quieter peers in discussion more frequently. Facilitators noted the ongoing challenge to encourage the quieter students to participate, but they stated that as long as those students are still contributing, they do not need to share as frequently as their peers. One student shared in the project evaluation that she was proud of how she stepped outside of her comfort zone at the booth and genuinely engaged with people. While there does seem to be improvement with the implemented approach, facilitators would benefit from additional strategies.

New Issues Identified in Cycle 2. Minor issues occurred that led to additions to the facilitation guide. These added guidelines instructed facilitators to direct the students to double-check the QR codes on their educational materials early and to write out or practice what they would say at the educational booth.

Curriculum and Implementation.

Facilitator Development. The strategy of highlighting quotes from previous students about what they enjoyed and learned from the project helped increase interest and excitement about starting the project. However, as the course progressed, the excitement and attitudes of one section declined. The facilitator attributed this result to the agency's chosen topic not fitting the group as well as she would have liked. Despite the challenges, she helped the students understand how the topic was applicable, even though it was not a perfect fit. Her explanation helped students develop creative thinking and flexibility skills in facing this challenge. This observation highlighted the need for more faculty involvement in deciding on student project topics.

Additionally, a discussion on the first day of the course about the balance between faculty guidance and student freedom helped clarify expectations and roles for the students. Students commented on how helpful they found instructor feedback and collaborative guidance. They shared that instructors were more like a team member and facilitator than an educator. Faculty reported that students were very independent, focused, had great initiative, only asked for guidance when needed, and effectively utilized the instructor as a resource. Given the positive results of this implementation, the strategy should be continued in Cycle 3. Moreover, a helpful addition to the facilitator guide would include a section directing faculty to add their tips for success in balancing guidance and student freedom.

The recommendation regarding TCJM from Cycle 1 did not play out as intended. While the guidance was shared with facilitators within the course and through a department retreat, facilitators struggled with how to incorporate this model into their instruction. To address this concern, the facilitation guide should include detailed guidance on how to use this model.

Clinical Agency. During Cycle 2, the clinical agency contacts for both clinical sections had the students and facilitator meet with them at their agencies each week, which helped the students feel more connected and engaged with the agency. Despite this arrangement, one section with multiple clinical agency contacts felt they did not receive enough guidance from the clinical agency contacts with whom they worked directly. The students felt they needed to meet with the direct contacts early in the course. The lead clinical agency contact also recommended having the students gather evaluation data from the direct clinical agency contacts to help them better understand the impact of their project and whether they were meeting expectations. This group also struggled with time constraints in the clinical agency schedule that limited their time with the target audience, highlighting the need for improved faculty/agency planning to address such issues.

Research Issues. Because this cycle included two clinical sections with different projects, as well as different strengths and challenges, differentiating responses between clinical sections was important. Unfortunately, the survey did not separate the clinical sections, making it difficult to interpret the meaning behind student responses. To address this limitation, the survey should be modified to allow distinction between clinical sections.

Iterative Refinement Plan for Cycle 3. All successful Cycle 2 strategies noted above were continued for Cycle 3 and incorporated into the standard PjBL implementation protocol for this course. Based on the data analysis from Cycle 2, several adjustments were incorporated for Cycle 3:

Facilitation Guide Improvement.

- Outline how to use the course intro survey data on group work that facilitates group processing.
- Add a guiding question to prompt establishment of ground rules for group work.
- Add a section for providing tips on balancing guidance and student freedom.
- Add guiding questions for weekly project discussion on workload balance.
- Add group texting as a group communication option.
- Add tips for allowing quieter students time to think and frame their thoughts to increase their sharing.
- Add a point to remind students to perform final checks of all materials and practice their presentations/talking points prior to an educational activity/booth.
- Add a point for facilitators to prompt students to work with agency contacts to develop a timeline for each day of engagement with the target audience.
- Have the faculty team discuss agency project ideas more fully to ensure the projects meet the students' learning needs and project expectations.
- Incorporate TCJM discussion questions to guide students to use this model in conceptualizing their projects.

PjBL Implementation Protocol.

- Schedule a project intro meeting with direct agency contacts for each student group to discuss expectations and plan for regular communication on project progress.

- Direct the students to gather evaluation data on their project using a survey of the agency contacts, if not possible with the target audience.
- Add a survey question for students to note their clinical section for elucidating possible issues behind student responses.

Cycle 3 Implementation and Evaluation

Description of Student Group. This cycle consisted of two clinical sections of 10 and 11 students. These groups included students with stronger personalities. One clinical section had several students who were strong leaders wanting to take charge, along with a smaller number of quieter students who were more passive. The other section had a more balanced mix of leaders and quieter students but also included very outspoken students who were strong advocates.

Student Learning Process and Outcomes. In this cycle, all 21 students met the student learning outcomes, with both groups performing well and earning 100% on their project. The students all met course objectives based on their clinical performance evaluations. However, more students remained at the developing level in this cycle for various sub-objectives. All students in one clinical section were at the developing level for devising an evaluation plan. In addition, each of the sub-objectives of functioning effectively as a team member, collaborating with peers and community partners, and maintaining professional boundaries had one student at the developing level. Likewise, the self-confidence sub-objective had three students at the developing level. This increased number of students at the developing level is likely due to weather-related university closures that resulted in 5 rather than 6 weeks of clinical. This shortened timeframe made it more difficult for students to reach the satisfactory level as they needed more assistance from facilitators to accomplish the projects. Despite these challenges, the students were able to demonstrate a high level of growth and learning, as shown in these comments: "I have learned so much from this clinical and feel more confident in myself as I am about to graduate," and "We learned that a lot of work goes into the planning phase; implementation is easy if you plan well."

New Issues Identified in Cycle 3. Cycles 2 and 3 fell back-to-back during the spring semester, with no time in between for faculty to transition and prepare for the next group of students. Tight timelines are always challenging, but this present research project caused additional difficulty: by the time the data from Cycle 2 was gathered and analyzed, Cycle 3 was well underway. As some recommendations from Cycle 2 were focused on the preparation and initiation phases of the project, it was not possible to implement all the recommendations within Cycle 3. Furthermore, the university closed due to weather conditions for 4 days during Week 2 of the course. This setback meant that the normal completion timeline of 12 clinical days was reduced to 10 clinical days. Under this tightened timeframe, faculty had even more difficulty implementing the recommendations while they facilitated these projects.

The students found the tightened timeframe frustrating, but they rose to the challenge and developed high-quality projects. In evaluating their project and reflecting on the role of the public health nurse in program planning, one group shared, "We learned it is unpredictable and it is important to be flexible and patient when things happen, such as snow days. We also know to be resilient and try to plan around what could happen."

Implementing Cycle 2 Recommendation. The implementation of Cycle 2 recommendations related to group work, managing personality conflicts, workload distribution, and engaging quieter students was challenging, given the tight turnaround and weather-related university closure.

One clinical section contained many domineering and quieter students, which made sharing the workload and delegation more challenging. The facilitator worked hard to manage this group dynamic and saw the value in seeking the facilitation guide for assistance. However, with the tightened timeframe, the facilitator struggled to make time to implement the guidelines provided. Even so, the survey and comments were more positive than negative overall. In the final clinical performance evaluation, one student commented, "I think we had a really good group this semester and everyone got along really well; it was a wonderful experience."

The other clinical section was a more even mix of student personalities. The students in this clinical section were very comfortable with each other, sharing openly and encouraging each other to share. During the focus group, one student explained, "We are a very close cohort. We want to work well together and are not focused on competing. We want to see each other succeed." While this group seemed to work more effectively together and the most common response on survey questions was "strongly agree," the experience was not seamless, as shown in the few "disagree" and "neither agree nor disagree" responses on the survey. Overall, this quote sums up this section's experience and growth: "I think I have improved my skills as a team member and gained a lot of experience being part of a group and contributing in a meaningful way to whatever project we are working on."

Curriculum and Implementation.

Facilitator Development. Both facilitators found it to be especially challenging to implement new recommendations from the facilitation guide, given the tight turnaround from Cycle 2 and the weather-related closure of the university.

As these added stressors are inevitable at times, facilitators must be able to implement the strategies easily. One process improvement may include incorporating key parts of the facilitation guide as prompts and reminders within the clinical schedule.

A great example of the challenge of implementing recommendations is found in the TCJM recommendation. One facilitator was not able to incorporate these recommendations into clinical discussion and another facilitator was only able to do so on one occasion. Yet, both facilitators noted that even without intentionally incorporating the recommendations, clinical judgment was still evident in the students' work and discussions. One successfully implemented recommendation was adding a question about clinical judgment to the evaluation of the project that students completed. In answering this question, students shared how they use the clinical judgment in planning and executing the project: "It helps you see it from both ends. You think this will work and then later with the feedback you see how it really worked and think about what would work well next time." In the focus group, a student elaborated on this thought, "With a project like this, it allowed you to think like a [public health nurse] without realizing that you were doing it." Both facilitators agreed that the effects of the PjBL pedagogical process in helping students develop clinical judgment were evident, even without the facilitators explicitly applying intentional strategies to address clinical judgment.

Clinical Agency. The two sections had mixed experiences with their clinical agencies. The students in one section reported experiencing some frustration and confusion early in understanding the project focus and their role. As the course progressed, information became clearer to the students, and they were very happy with their work on the project. The clinical agency contacts commented, "They communicated their concerns and negotiated the project along well." Both the students and the clinical agency contacts reported that improved mutual communication early in the course would be beneficial. The clinical agency contacts suggested Zoom check-ins with the students each day. This Cycle 2 recommendation was one that could not be implemented in Cycle 3 because of the tight turnaround between cycles. This section's experience adds further support for this recommendation. The clinical agency contacts also suggested meeting with the instructor after each cycle to debrief and share ideas for the future.

Institutionalization. The 2 days of clinical that had to be cancelled due to weather conditions made it more difficult for faculty to guide students in these projects and meet course objectives, leading to added feelings of frustration and overwhelm among the students. The university does not allow classes to be moved to an online format in these types of circumstances. In a part-term course, this impact is much more significant, in that one-sixth of the class time was cancelled.

Research Issues. To address the Cycle 2 survey issue, a question was added to allow students to select their clinical section. As the dynamics of each clinical section were very different, separating the data by clinical section helped ensure a more accurate interpretation of the results.

As mentioned earlier, the timeline between Cycles 2 and 3 was very tight, which made it difficult to utilize the recommendations from Cycle 2 to improve Cycle 3. This limitation was most noteworthy for the recommendations focused on the preparation and initiation of the project.

Iterative Refinement Plan for Future Course Integration. All Cycle 2 strategies found to be beneficial will be incorporated into the standard PjBL implementation protocol for this course. In addition, the Cycle 2 recommended strategies that were unable to be implemented, due to the Cycle 3 challenges, will be implemented during the next semester. If found to be beneficial, these recommendations will be incorporated into the standard PjBL implementation protocol for this course.

Cycle 3 led to some additional recommendations for future integration into the course:

- Add aspects of facilitation guide to the clinical schedule to remind faculty when and where key strategies should be incorporated.
- Direct facilitators to meet with their clinical agency contacts after the conclusion of the course to debrief and share ideas for the future.
- Devise a backup plan addressing the complications caused by unexpected class cancellations.

Reflection

Maturing Intervention

Through the three cycles of this study and the systematic iterative design-implement-revise process, the intervention has slowly matured, developing into an optimized PPIE/PjBL project.

Revision of PjBL Blocks Schedule. One key departmental change that began in Spring 2024 is block scheduling. This change allows a 2-week break between the two 6-week blocks of this course each semester, rather than a back-to-back schedule for these two blocks. This revision of the block schedule made the break between blocks more consistent throughout the academic year and allowed the facilitators sufficient time to complete the preparation for the next PjBL block. The departmental and institutional challenges in

Cycles 1 and 3 informed us of the susceptible areas in our PjBL curriculum implementation plan and led to the revisions. They also highlighted the importance of having an alternative plan for flexibility to minimize the impact of these issues on the PjBL implementation and the student learning experience. The lack of these issues in the semesters following the study further highlighted this impact and allowed for greater optimization of the matured intervention. While this change was not a direct result of this study, the data of this study provided evidence for supporting the change. Furthermore, this change helps faculty be better prepared for departmental, institutional, and course-specific challenges that will undoubtedly arise in the future.

Facilitation Guides as a Living Document. A key aspect of this maturation is the evolution of the facilitation guide and the incorporation of it into the PjBL implementation protocol. By enhancing the facilitation guide and adding it to the clinical schedule in Fall 2023, faculty facilitators have been able to incorporate the facilitation strategies more consistently and effectively. In this study, the importance of a facilitation guide for improved efficacy of PjBL was consistently noted. The efficacy of the facilitation guide is tied to its nature as a living document that can be updated as faculty continue to facilitate the student projects, similar to the approach within the DBR process in this study. Our experience from this research has reshaped our perspective on the frequency of updating facilitation guides. Traditionally, these guides are constructed before initial implementation of PjBL and then reviewed for revisions or updates after several years. However, the findings of this research—along with our experience from the COVID-19 pandemic, the effects of climate change, and the availability of artificial intelligence (AI)—suggest that unforeseen events that disrupt PjBL implementation are likely possibilities. Flexibility is the key to cultivating resilience and adaptability in the nursing PjBL curriculum and implementation protocol amid an ever-changing world. A living facilitation guide serves as a tool to assist facilitators across the department in promptly adapting to changes and consistently implementing the PjBL protocol.

Integration of TCJM. Another key aspect of the maturation of the intervention is the integration of TCJM. Initially, a TCJM didactic component was planned for inclusion in this PjBL curriculum to support the students' learning and application of the model. As noted in Cycle 3, the students were able to recognize their use of this model and the growth in their clinical judgment even without intentional strategies by faculty facilitators. This observation confirmed the students' ability to apply the TCJM in their problem-solving process without explicit instructional guidance. Therefore, the department decided to integrate TCJM into the curriculum by using it to structure the PjBL implementation protocol.

Protocol for Clinical Agency Involvement. Initially, the involvement of clinical agencies was more informal, lacking systematic guidelines for the department, students, and agencies to follow. The loosely structured partnerships with clinical agencies led to inconsistent student clinical project experiences. The data from this research has helped the department create clear guidelines for students engaging in clinical experiences, including the frequency and duration of agency representatives' presence on campus and students' presence at the agency, procedures for student collaboration with the agency, and project selection. Since student learning in this PjBL curriculum primarily occurs with participating clinical agencies, streamlining the clinical project protocol with these agencies is crucial. The refined protocol has significantly contributed to the maturation of the nursing PjBL curriculum.

Theoretical Understanding

This study examined the effects of PjBL as a pedagogy for affording the students' development of clinical judgment. Through the DBR process, the originally designed interventions have been refined to improve support of student learning related to the key components of PPIE within population-based health nursing courses. In this instruction, clinical judgement is a critical cognitive skill that enables population health nursing students to conduct an effective PPIE project. This research has provided greater insights into the theoretical and instructional affordance of PjBL in a population health nursing clinical course.

Authentic Projects in Real-life Clinical Setting. One of the theoretical underpinnings for PBL and PjBL is situated learning (Hung, 2006). According to Herrington and Oliver (2000), providing authentic contexts and activities in which students will apply knowledge and skills in real life is crucial to help them develop deeper understanding and construct situational knowledge. However, instruction in formal educational settings is often limited by the plausibility of situating students in a high level of authenticity in the projected future context. Therefore, some alternatives have been used, such as high-fidelity simulations (e.g., simulation labs in medical education or flight simulators) or low-fidelity simulations (e.g., text-based scenarios). The PjBL course in this study was able to situate students in clinical agencies to work on real-life projects, providing a very high level of authentic learning experience for them. As the qualitative data showed, students were highly engaged and gained an authentic experience about the practices, operations, and nuances in the profession and in the community—a factor that is missing in simulations. Therefore, this study confirmed that when

implementing PBL or PjBL, the higher the level of authenticity, the better the student learning experience and outcomes would be.

PjBL Process Cultivates Clinical Judgement Reasoning Skills. Clinical judgment is one form of problem solving and shares the same core cognitive processing elements and processes as general problem solving. While PjBL is already noted as effective in developing critical thinking and problem-solving skills, clinical judgment is more complex and requires higher-level, discipline-specific cognitive learning. In this study, the students' recognition of and growth in clinical judgment that occurred naturally through the use of the PjBL model for this project lends support to PjBL's efficacy in developing clinical judgment. Therefore, one conjecture is that other profession-specific reasoning skills that share similar cognitive attributes could also be developed through PjBL as a pedagogical framework to address the learning needs in other professional studies disciplines. Additionally, the result of this study changed the initial perception of faculty facilitators needing to explicitly instruct students on how to conduct the clinical judgment process (TCJM). Theoretically, many researchers have argued that formal expository instruction is not effective for helping students develop cognitive reasoning abilities during problem solving or clinical judgment (Neville, 2009; Sweller et al., 2011). PBL/PjBL processes naturally structure students' learning of not only content knowledge but also their development of problem-solving skills and disposition. This study confirmed this conjecture. However, when implementing PjBL with external partner clinical agencies, uncontrollable variables may emerge, and the structure and fidelity of the PjBL process may become challenging. Balancing the benefits of a high level of authentic learning experiences and maintaining the structure of PjBL to cultivate students' problem solving and clinical judgment development is an area for further investigation.

Conclusion

This paper discussed DBR as a research methodology and how it is useful for conducting research in the field of PBL/PjBL. With its iterative research process, DBR provides researchers and practitioners with a methodology whose aim is to not only advance and refine the theoretical understanding of a research area or topic but also improve the intervention for practical applications in real-world learning settings. This researcher-practitioner collaborative methodology closes the gap between theories and practice, which has been a long-discussed issue in educational research. This paper discussed the rationale, theoretical components, and research process of DBR, as well as provided an illustrative example study to demonstrate the DBR process. DBR itself shares the same needs as any of the studies that use it as a methodology, namely, iterative implementation, feedback, and refinement of its own methodology. More studies utilizing DBR would achieve this goal.

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