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The Relationship between Metacognitive Reflection, PBL, and Postformal Thinking among First-Year Learning Community Students

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Abstract

Wynn, Mosholder, & Larsen (2014, 2016) studied the effect of problem-based learning (PBL) on the development of postformal thinking (PFT) skills among first-year learning community (LC) students and attributed the significant PFT gains, in part, to the metacognitive reflection component of their PBL method, recommending it as a way to facilitate PFT skills. The current study tested this relationship by comparing PFT growth of first-year LC students who practiced metacognitive reflection during six PBL activities in their LC course (n = 20) with PFT growth of students who completed the same PBL activities without metacognitive reflection in a control group section of the same LC course (n = 17). T-Test results showed significant pre vs post PFT gains in both sections, but no significant difference of normalized mean gain scores between groups. End of Study Questionnaire comments from students in both groups included similar descriptions regarding the extent to which their thinking skills expanded as a result of their PBL experiences. Results indicated that PFT gains among first-year LC students may be facilitated through modeling and cognitive scaffolding of PFT systems (relativistic and dialectical) during multiple PBL experiences without explicitly identifying and reflecting on the cognitive systems utilized.

Keywords

Problem-based learning, Postformal Thinking, Metacognition, Learning Communities, First-Year Students

Cover Page Footnote

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The Association of American Colleges and Universities (2015) established guidelines and principles for developing general education curricula that guide students to develop sustainable problem-solving skills that support their ability to effectively address issues relevant to their lives. However, this significant AACU goal for 21st century general education courses is difficult to achieve when the common experience in gateway survey courses often consists of lectures and discussions that provide little or no opportunity for relevant and applicable problem-solving experience. Survey results from *Gen Z in the Classroom: Creating the Future* (Adobe Systems Inc., 2016) help frame this dynamic:

- Students and teachers agree the current curriculum is more focused around lectures, writing, and reading;
- 42% surveyed in the U.S. believe what they learn outside of school is more important in preparing them for life, and believe the information they are "learning" in school is not adequate for the "real world";
- Gen Z (born from the mid-1990s to the early 2000s) believe they will be confronted with problems and issues we can't even predict at this point.

These responses indicate that Gen Z students enter college with low expectations regarding the extent to which the general education will guide them to practice and acquire skills to effectively address the pressing problems and issues they will face in a changing and challenging world. If Gen Z students surveyed know this, and we know this, why not adapt the curriculum to explicitly facilitate advanced problem-solving skills and related cognitive systems during the first-year of college?

Failing to adapt to such a curriculum may result in the perpetuation of what many argue is a lack of collective and individual reasoning capacity among adults in the United States to address the numerous pressing problem and controversial issues that challenge us today (Griffin, 2011; Inglis & Steel, 2005; Rosenberg, 2004; Talisse, 2005; Wynn, 2018a, 2018b). Commons and Ross (2008) estimated that fewer than 20% of adults in developed countries have adequate thinking skills to effectively deal with complex problem and issues. In this time of increasing political polarization, guiding students to develop deliberative skills, problem-solving/decision-making skills, and the related advance thinking systems is critical if we hope to actually resolve these issues rather than simply continuing to argue (Wynn, 2018a, 2018b). Confronting students with complex, real-world problems as they begin their college experience can be an effective first step in guiding them to practice and acquire more advanced problem-solving and cognitive skills (Basseches, 2005; Sinnott, 1998, 1999; Sinnott, Hilton, Wood, Spanos, & Topel, 2016; Sinnott & Johnson, 1996; Wynn, 2015, 2018a, 2018b; Wynn, Mosholder, & Larsen, 2014, 2016).

Lardner and Malnarich (2008) supported a similar curricular focus for learning communities. They outlined a transitional agenda to guide the development of learning community programs to facilitate "integrative, high-quality learning; collaborative knowledge-construction; and skills and knowledge relevant to living in a complex, messy, diverse world" (p. 31), and suggested making problems and issues the center-piece of learning community integrative assignments: "The intent is to engage students in substantive work, which includes learning how to integrate knowledge from different disciplines and fields of study, multiple perspectives, and conflicting interests" (p. 34). They also emphasized the importance of learning community programs utilizing research to guide intervention strategies to support the learning of all students. Recent research by Wynn, Mosholder, and Larsen (2014, 2016) indicated that problem-based learning can be an effective and integrative instructional strategy that learning community programs can utilize to increase student engagement and promote the practice and acquisition of advanced cognitive skillsets necessary for students to achieve the goals outlined above.

This article reports results from our current study that tested results, conclusions and recommendations from our earlier study, *Measuring the Effects of Problem-Based Learning on the Development of Postformal Thinking Skills and Engagement of First-Year Learning Community Students* (Wynn, Mosholder, & Larsen, 2014). Results from that study indicated that the problem-based learning (PBL) method utilized, which included an explicit metacognitive reflection component, promoted significant postformal thinking gains among first-year learning community (LC) students. As the primary investigator and PBL instructor in that 2014 study and in a second study confirming the pilot study's results (Wynn, Mosholder, & Larsen, 2016), I wanted to test the assumption that the metacognitive reflection component of the PBL model was a major factor in explaining postformal thinking gains. Therefore, our current study, in which I was the primary investigator and PBL instructor, tested postformal thinking growth of first-year LC students who participated in the same six activities and PBL procedures implemented in the 2014 and 2016 studies. The only change was to add a systematic metacognitive reflection component for one group of students in the LC but to omit it in a control group section of the same LC.

The Cognitive Dynamics of Problem-Solving in a PBL Context

Hmelo-Silver (2004) argued that one of the primary goals of PBL is the development of effective problem-solving skills, which includes the ability to apply appropriate metacognitive and reasoning strategies. These "appropriate" reasoning strategies may be found in the postformal stage of reasoning (Arlin, 1984; Basseches, 1984; Chiou, 2008; Commons, Ross, & Miller, 2010; Commons &

Ross, 2008; Labouvie-Vief, 1985; Labouvie-Vief, Adams, Hakim-Larson, & Hayden, 1983; Marchand, 2002; Perry, 1970; Reigel, 1975; Sinnott, 1989, 1998).

Guiding first-year students to recognize and practice postformal thinking in a PBL context involves confronting them with complex problems and issues in order to prompt a reflection on the fit or adequacy of thinking systems they commonly use during late adolescence to address problems and issues, a dual system of cognition involving intuitive and/or formal thinking (Berger, 2008; Keating, 2004; Witteman, van den Bercken, Claes, & Godoy, 2009). Intuitive thinking prompts decisions to be made based on a dynamic best described as "if it feels right, it's right" (Basseches, 2005; Berger, 2008, Epstein, Pacini, Denes-Raj, & Heier, 1996; Evans, 2008, Wynn, 2010, 2015, 2018a, 2018b). Formal thinking, Piaget's final developmental stage of individual cognition (Inhelder & Piaget, 1958), allows students to reach logical conclusions based on abstract analyses based on logic rather than intuition. However, this formal system is often characterized by a closed approach to problem-solving during late adolescence that is absolutist in nature and is based on conclusions derived from experiences with what is assumed to be similar problems and issues from their past. This closed systems approach limits consideration of complexities and contradictions that are inherent in real-world complex problems and issues (Sebby & Papini, 1994; Sinnott, 1998; Wu & Chiou, 2008; Wynn, 2015, 2018a, 2018b; Wynn, Mosholder, & Larsen, 2014, 2016). PBL, which prompts students to learn and apply content and more advanced thinking strategies through the experience of solving problems (Hmelo-Silver, 2004; Lenkauskaite & Mazeikiene, 2012), becomes a catalyst for first-year LC students to recognize the inadequacy of closed systems and intuitive problem-solving and to practice and gain more advanced, postformal, thinking skills (Wynn, 2010, 2015, 2018a, 2018b, Wynn, Mosholder, & Larsen, 2014, 2016).

Postformal thinking involves a metasystematic approach to problem-solving and includes two subsystems: relativistic thinking and dialectical thinking (Scott-Janda & Karakok, 2016). Relativistic thinkers approach problem-solving by systematically looking for multiple truths, multiple perspectives, ambiguities, and contradictions that are inherent in complex problems and issues as they work to contextualize the problem through multiple frames of reference. They realize that context, complexities, and contradictions are critical in developing resolution alternatives and recognize that some problems do not have viable solutions (Chang & Chiou, 2014; Chiou, 2008; Kahlbaugh & Kramer, 1995; Kallio, 2011; Kramer, 1983; Sinnott, 1998; Wynn, 2015, 2018a, 2018b).

Dialectical thinkers understand that complex problems and issues are always changing and include contradictions that are interrelated and connected (Basseches, 1989). Recognizing the inherent contradictions within a problem prompts the dialectical thinker to apply multiple cognitive operations, including relativistic and dialectical considerations, to understand how diverse and even opposing positions

are constructed and defended (Savina, 2000). These insights are then utilized in the process of developing potential solution alternatives. This metasystematic approach leads to higher levels of understanding and cognition (Ho, 2000; Kallio, 2011; Scott-Janda & Karakok, 2016; Wu & Chiou, 2008). Dialectical thinkers also recognize that resolutions or solutions implemented to address a problem/issue will change as the problem/issue at hand inevitably changes (Blouin & McKelvie, 2012).

Guiding first-year LC students to practice and reflect on these postformal cognitive systems was a central focus of the PBL model used in our 2014 and 2016 studies, with the metacognitive reflection component serving to guide first-year students to explicitly recognize the postformal systems they used during PBL and to facilitate a cognitive self-awareness that may continue to support the use of postformal thinking systems when confronted with future problems/issues. Demetriou, Spanoudis, and Mouyi (2011) explained the importance of this explicit metacognitive dynamic in complex problem-solving:

> Students must be given the opportunity to think on and assemble complex hierarchical problems where hierarchies are embedded into each other. Working on problems of this kind may enable students to differentiate between the various cognitive systems and processes activated in problem solving. (p. 654)

Therefore, modeling, cognitive scaffolding, and metacognitive reflection of postformal thinking systems were explicit components of the PBL model used in our previous two studies. In order to recognize multidimensional/multi-truth complexities, opposing perspectives, and contradictions in the problem/issue at hand, students need to learn to systematically apply relativistic and dialectical considerations. Therefore, I modeled postformal operations and provided prompts/scaffolds in each step of the PBL process to help students identify and practice the more advanced cognitive systems. In addition, peer modeling was provided by students who had successfully applied postformal operations and expanded their PBL skills. Vygotsky's (1978) social learning theory helps explain the PBL modeling/scaffolding dynamic through his concept of Zone of Proximal Development (ZPD). In a PBL context, it is the distance between the actual level of cognitive development when the first-year LC student is confronted with a complex problem/issue (possibly applying intuitive and/or closed systems formal thinking) and the level of potential development as determined through problem-solving under the guidance of the PBL instructor and more capable peers (students practicing postformal/multisystematic problem-solving operations, including relativistic and dialectical systems) (Wynn, Mosholder, & Larsen, 2014). The PBL model used in the first two studies and in the current study is described below.

> Step 1—Problem Development: The problem/issue is presented both to pique student interest and "stakeholdership" and to portray the problem/issue as multidimensional.
>
> Step 2—Initiation of PBL Events-Argumentation and Student Inquiry: Students are guided to define the problem at hand and to identify both its multidimensional or multi-truth characteristics the need for advanced thinking systems. A decision-based/argumentation structure is then used to prompt students to generate arguments and to work on resolving conflicts and contradictions among competing positions. This is done primarily through simulations based on periodized historical issues and current issue presentations. After each simulation and issue presentation, students identify what they learned about the problem/issue and the inherent contradictory or opposing positions and then identify additional information needed to develop solution alternatives.
>
> Step 3—Problem Solution and Debriefing: Students generate solution/decision alternatives, examine their "fit," propose the most appropriate one, and evaluate its historical or potential consequences. We assign a concluding opinion essay and guide students through debriefing, which includes a review of the content, concepts, and skills encountered and practiced during the problem-solving cycle. We use a metacognitive reflection questionnaire (MRQ) to guide students to recognize and reflect upon the types of thinking strategies they used and the successes or failures of each in the problem-solving process. This helps students develop a cognitive self-awareness in a problem-solving/decision-making context. (Wynn, 2018a, p. 3)

The Relationship between PBL and Postformal Cognition

PBL has been shown to facilitate more advanced problem-solving processes and thinking skills across a variety of disciplines (Birgili, 2015; Blumberg, 2000; Cognition and Technology Group at Vanderbilt [CTVG], 1997; Kek & Huijser, 2011; Downing, Kwong, Chan, Lam, & Downing, 2009; Jumari, Phang, Helmi, & Mohd-Yusof, 2018; Maxwell, Bellisimo, & Mergendoller, 2001; Mergendoller, Maxwell, & Bellisimo, 2006; Walker & Leary, 2009). As stated above, the first two studies focused on this relationship by specifically examining the postformal cognitive systems involved in advanced adult problem-solving. The 2014 pilot study measured the effects of the PBL model on the development of postformal thinking skills among PBL LC survey history students (n = 40) and PBL regular section survey history students (n = 31) compared to students who experienced primarily traditional lecture/discussion (n = 35) in the same U.S. history survey course (TLD). Results for the three groups showed significant postformal thinking

increases among both PBL groups, with the PBL LC group having significantly greater net postformal gain scores and normalized postformal gain scores on the *Postformal Thought Questionnaire* (Sinnott & Johnson, 1997) than either the PBL regular history group or the TLD group and the PBL History group having a significantly greater postformal thinking increase than the TLD group. Direct content analysis of two short answer questions on an *End of Study Questionnaire* showed significantly greater frequency of self-reported PFT related comments/experiences occurring in the PBL LC and PBL regular section group compared to the TLD group (Wynn, Mosholder, & Larsen, 2014). [1]

The second study confirmed the results of the pilot study with results showing significantly greater net postformal gain scores and normalized postformal gain scores for PBL sections of the LC/history survey course groups (n = 64) compared to lecture/discussion groups (n = 109). Direct content analysis results showed a significantly greater occurrence of self-reported postformal operational experiences in the PBL sections (Wynn, Mosholder, & Larsen, 2016). A sampling of the *End of Study Questionnaire* responses from both studies are below.

> PBL Student 130: "I believe it has expanded my ability to think critically. I have always been a problem solver and understood perspectives as well as knowing the facts. I now realize that you have to know context, contradictions, multiple solutions, and various perspectives in order to effectively solve a problem, and this class confirmed my way of thinking and helped me further develop it."
>
> PBL Student 159: "I think it's now easier for me to see things from more than one perspective. I understand now that it is important to understand both sides of a dilemma or problem before making a decision. Understanding different points of view will be very important when dealing with other things in life."
>
> PBL Student 19: "I personally have never really been a person to pick sides and this class only strengthened that. I was reminded that both sides of an argument may have very valid points. One other way that I feel like I have gotten better is collaborating with others to make a better solution. It is silly to debate about something and not come up with a solution. I learned how to reach a solution with people who have very different viewpoints than me."
>
> PBL Student 20: "Yes. I can look at more than one view point. I can look beyond gut thinking. I can understand why opposing views think the way they do and use their perspective in my thinking toward a solution. I will use this in all aspects of my life. It is a great thing to have and utilize."

[1] The two short answer questions were: Do you believe you have expanded your ability to think critically as a result of this course, if so how? To what extent do you believe you may utilize these thinking skills as you continue your education and life in general?)

> PBL Student 39: "Yes. Before, if I had an opinion I would only look at it from my point of view and I would automatically think I believe the other side is wrong. This class made me look at both sides critically and then come up with a decision."
>
> PBL Student 85: "Yes. [The instructor] made us realize that there are always more points of view other than our own. For example, the activity about the end of WWI and how to punish Germany showed me Germany's side for the first time ever. Our class was able to find compromise in every situation we were given. It makes me wonder how our government fails to do the same." (Wynn, 2018b)

Implications from the results of the pilot study attributed postformal thinking gains among PBL students, in part, to the metacognitive reflection component of the PBL method (Wynn, Mosholder & Larsen, 2014):

> Taking time to implement the metacognitive reflection component (questionnaire) of the PBL instructional method is critical in guiding students to recognize and reflect upon the extent to which they practice multiple thinking systems during PBL activities. We realize that instructors might be hesitant to take on the task of guiding the metacognitive reflection process. It takes instructional time and some working knowledge of thinking systems. The metacognitive reflection questionnaire (MRQ) is offered as a way to introduce the thinking systems involved in problem-solving/decision-making and to facilitate reflective discussions. Instructors do not have to be experts to guide the process. As stated above, the first-year seminar is an ideal setting to reinforce this reflective process. (p. 18)

Hypotheses

The research question we addressed in the current study was the extent to which the explicit metacognitive process of the PBL model, as prompted by the MRQ (Appendix D), impacted the development of postformal thinking skills among first-year LC students. The related null hypothesis was as follows:

1. There will be no significant difference in cognitive growth as measured via pretest-posttest changes in postformal thinking skills between students in the experimental section of a PBL U.S history LC who practice systematic metacognitive reflection via the MRQ and students in the control section of a U.S. history LC who completed the same PBL experiences without the metacognitive reflection component/MRQ.

Based on results of the previous two studies regarding postformal thinking gains and increased levels of perceptions of course engagement and content relevance among first-year LC students, we also tested the following null hypotheses:

2. There will be no significant difference in cognitive growth, as measured via pretest-posttest postformal thinking changes among the PBL LC experimental group.
3. There will be no significant difference in cognitive growth as measured via pre-test-posttest postformal thinking changes among the PBL LC control group.
4. There will be no significant difference in self-reported levels of course engagement, as measured via the *End of Study Questionnaire*, between the experimental and control group PBL LC sections.
5. There will be no significant difference in self-reported levels of course content relevance, as measured via the *End of Study Questionnaire*, between the experimental and control group PBL LC sections.

Research Methods

The primary difference between experimental and control group sections was the administration of the MRQ with the experimental group at the end of each PBL activity. As the primary investigator of the current study, I taught an experimental and control group section of a U.S. history survey course, *America since 1877* (HIST 2112), a required general education course at our university. Both sections were paired with a first-year seminar (FYS 1101) taught by a colleague to form two PBL sections of the LC, *Stepping into America's Past: What Would You Do?* First-year students self-selected their LC during fall registration 2018. The topical outline, activities, assessments, and dates of implementation were identical in each of the PBL sections and followed the scope, sequence, and structure of the PBL LC sections in the two previous studies, which included nine primary instructional topics or units, with six of the nine instructional units culminating in PBL activities. Each PBL activity took one or two 75-minute class periods to complete. A list of the nine units and the six PBL activities may be found as Appendix A.

The experimental and control group sections included 23 and 19 students respectively, with 20 and 17 respectively participating in the study. We randomly assigned experimental and control group status to the sections, with the experimental group attending HIST 2112 at 9:30 am on Mondays and Wednesdays and then immediately attending their FYS at 11:00. The control group followed the opposite schedule, attending their FYS at 9:30 am and HIST 2112 at 11:00 in the same classroom as the experimental group. Experimental group treatment began after the debriefing of the first PBL activity (*The Question of U.S. Expansion)* and included an interactive Power Point that addressed common characteristics of late-adolescent cognition and problem-solving and operational explanations of thinking systems students may have practiced during the activity (intuitive, formal/closed systems, relativistic, and dialectical). The MRQ was then administered to guide students to reflect on which thinking systems they utilized and the success or failure

of each during each PBL step. The MRQ process was then repeated by the experimental group in each of the subsequent PBL activities.

Both groups participated in a general debriefing of each of the first five PBL activities (periodized historical issues), which concluded with a comparison of each class's solution to the problem/issue with what actually transpired and the related consequences. This debriefing was extended with the control group while the experimental group completed the MRQ. The sixth PBL activity required small groups (three to five students) in both sections to research and develop solution proposals to five current controversial issues in the United States: Health Care Reform; Immigration Reform; Fiscal Policy, Regulatory Reform, Entitlement Reform; Energy/Carbon Emission Policy; and Federal Minimum Wage. Students applied postformal operational skills practiced in the previous five PBL activities to research and present the contextual complexities of their assigned issue, opposing perspectives and related rationales, contradictions between opposing perspectives, solution alternatives, challenges to implementation of their solution, and potential changes that could affect the success of their proposal. The procedures for this culminating PBL activity followed a dialectical framework to guide group research, deliberation, and problem-solving. The MRQ was then administered to the experimental group. The control group used this time to address questions, concerns, or comments related to their assigned issues and related solutions.

First-Year Seminar – The primary purpose of the FYS at our university is to facilitate life skills and strategies for academic success among first-year students. The instructor of both LC FYS 1101 sections and I collaborated to align our syllabi to support each PBL activity. Outcomes that guide the first-year LC program and all LCs at our university helped us to target our efforts. Two of these outcomes explicitly guided our PBL integrative framework:

1. Academic/Cognitive Skills: improving students' skills in writing, reading, decision-making, computer usage, and oral presentation; and
2. Critical Thinking Skills: improving students' ability to see multiple sides of issues; identify solutions to complex problems; evaluate the quality of opinions and facts.

The first and last PBL activities in our LCs help illustrate our integrative alignment. The first PBL activity in my class included a simulated U.S. Senate Subcommittee Hearing on U.S. Colonial Expansion in which two groups presented opposing arguments to the Subcommittee followed by a vote. Students then attended their first-year seminar and were challenged to defend their assigned positions further and to dig more deeply to recognize the rationale behind both perspectives. In my next class, we built on this, identifying contradictions between the two positions and constructing solution alternatives. The first-year seminar instructor also introduced current issues related to U.S. colonialism (social justice, race relations, human rights, etc.) and challenged our students' perspectives and assumptions in

order to guide them to recognize multiple points of view and their rationales. He supported the last PBL activity (Current Issue Presentation) by helping introduce students to library/research resources and by providing guidance and first-year seminar class time as the groups developed their presentations. Each group completed a practice presentation in his class and then edited their presentation as needed before presenting in my class.

Measures

Postformal Thought Questionnaire (PFT): Per the previous studies, we used the PFT (Sinnott & Johnson, 1997) to measure participants' level of postformal thinking. We administered the PFT on both the first and last day of class. The PFT included 10 statements, each representing a different operational component of postformal thinking systems. Participants responded to each of the Likert framed (7=very true to 1=not true) statements to indicate the extent to which it characterized their own thinking. The PFT has been used in numerous studies and has been found to be a moderately reliable (.63) and valid measure of postformal thinking (Cartwright, Galupo, Tryee, & Jennings, 2009). Potential scores range from 10 (indicating low levels of postformal thinking) to 70 (indicating high levels of postformal thinking). PFT scores were summed for the 10 items for each participant. The PFT may be found as Appendix B.

End of Study Questionnaire (ESQ): Per the previous studies, we administered the ESQ to participants after all other data were collected. The ESQ included five questions, two of which called for a Likert rating on participants' perception of their level of engagement in HIST 2112 (Questions 1 and 2), one of which called for a Likert rating on their perception of content relevance (Question 3), and two of which prompted participants to reflect on the extent to which their experience in the their PBL LC course expanded their ability to think critically (Questions 4 and 5). The *End of Study Questionnaire* may be found as Appendix C.

Methods of Analysis

Our methods of analysis included either a t-test or an appropriate non-parametric procedure. The assumptions of the t-test were assessed for each outcome since it is the more powerful procedure if the assumptions are met (Sawilowsky & Hillman, 1992). The average of the pre-test scores for the experimental and control group were compared using a t-test, the pre and post test scores were compared within each of the groups (experimental and control) using a paired t-test, and the normalized gain scores were compared using a t-test for two independent groups. Given that the sample sizes were relatively small for each group (sample size of 20 and 17), the medians for the measurements ESQ1 (level of engagement) and ESQ3 (level of content relevance) were compared

between the two groups using a Wilcoxon Rank Sum test since the responses did not appear to be sampled from a normal distribution. The normalized gain score is "the ratio of the actual average gain (%<post> - %<pre>) to the maximum possible average gain (100-%<pre>)" (Hake, 1998, p. 64). We compared experimental and control group responses to End of Study questions 4 and 5 to identify potential similarities and differences in comments and explanations regarding their perceptions of the extent to which their thinking skills had changed and/or evolved as a result of their PBL experiences and the extent to which these skills might be useful beyond their LC.

Results

Table 1 shows independent t-test data for PFT pretest scores for the experimental (n = 20) and control (n = 17) sections, with the control group mean slightly, but not significantly, below the experimental group, indicating the two groups were not significantly different prior to PBL treatment. Dependent paired t-test data for PFT pre to post-score comparisons reported in Table 2 show significant PFT gains for the experimental group and control group. Therefore, we rejected Hypothesis 2 and Hypothesis 3.

Table 1
Two Sample t-test Data of the Pretest Scores for Experimental and Control Group

Group	Mean	Std Dev	df	t	Sig.
Experimental	54.75	6.84	35	0.56	0.5796
Control	53.41	7.72			

Table 2
Paired Sample t-test Data of the Pre and Post Scores for Experimental and Control Group

Group	Mean	Std Dev	df	t	Sig.
Experimental	-3.7	5.96	19	2.78	0.012
Control	-6.94	5.46	16	-5.24	<.0001

Independent t-test results reported in Table 3 show the control group with a larger PFT normalized gain but no significant difference in normalized gain scores between the two groups. The normalized gain score is a measure of potential gain on a scale of 0 to 1, with 1 representing all possible gain (Bao, 2006). Therefore, we accepted Hypothesis 1.

Table 3
Two Sample t-test Data of the Normalized Gain Score for Experimental and Control Group

Group	Mean	Std Dev	df	t	Sig.
Experimental	0.07	0.13	35	1.83	0.0754
Control	0.14	0.11			

Comparison of experimental and control group responses to ESQ questions four and five indicated that both the experimental and control group believed their thinking skills expanded, with the exception of Student #7 in the control group, who stated that he "did not try to expand that (critical thinking) ability" but, in response to question 5, that thinking skills gained would "help analyze information presented to me better." With this marginal exception, each student in both groups described how their thinking skills expanded as a result of their PBL experiences in their LC history course and how helpful these skills will be as they continue their education and their life in general. Student comments primarily focused on their increased ability to look for, and be open to, multiple, even opposing, perspectives in the problem-solving process and on their ability to seek and reach consensus when considering resolution alternatives.

For example, Experimental Student #5 stated, "Yes, I believe this course and the instructor have taught me the basics of compromise. Having an opinion on a subject, but also being able to look at a topic from another person's perspective is crucial. Compromise is what the world is struggling with today." Similarly, Experimental Student #12 stated, "Yes, doing all the exercises really helps a person think differently. These exercises help me look more in depth & see both sides of an argument when I might not have done that before." Control Student #8 responded, "I think so. It helped me with finding solutions in a group with diverse thoughts. It also showed me how important compromise is. It will definitely help me with working with people with different ideas to mine and come up with solutions that benefit both sides of an issue." And Control Student #3 observed, "Yes. I used to consider multiple sides. However, this class has taught me to dig deeper than just what another perspective is but how that perspective formed. I have applied this new process to different parts of my life and see that issues in life are much more complex than one might think and that we need to listen and consider opposing views." We found it interesting that the comments on how members of the experimental groups' thinking had changed rarely included the clinical definitions and terms associated with the postformal thinking. Instead, they used their own words to operationally describe the more advanced thinking skills they practiced and gained, as did the control group. Therefore, similarities between student comments in the experimental and control group describing changes in their thinking as a result of their PBL experiences in their LC support our acceptance of Hypothesis 1 and our rejection of Hypotheses 2 and 3.

Table 4 reports non-parametric test results comparing experimental and control group scores (Likert 1- 5) on ESQ 1 (level of engagement) and ESQ 3 (level of content relevance). We chose the non-parametric test since the responses to both questions were not normally distributed. Results show no significant difference between the two groups, with both groups reporting a similar high level of engagement (Experimental, $M = 4.35$; Control, $M = 4.25$) and a similar positive

perception of content relevance (Experimental, *M* = 4.80; Control, *M* = 4.76). Therefore, we accepted Hypothesis 4 and Hypothesis 5.

Table 4
Non-parametric Test Data of the ESQ1 AND ESQ3 for Experimental and Control Group

Group	Mean	Std Dev	df	Chi-Sq.	Sig.
ESQ1					
Experimental	0.42	1.38	1	0.9595	0.3273
Control	0.57	1.38			
ESQ3					
Experimental	0.48	0.72	1	0.0323	0.8574
Control	0.49	0.72			

Discussion

We found the results from our current study on the impact of the MRQ on postformal thinking acquisition among first-year LC students to be surprising and compelling. Current results contradicted a major assumption from the previous studies that significant postformal thinking gains reported among students were due, in part, to PBL participants gaining a working knowledge of the multiple thinking systems they practiced during their PBL activities via the reflective processes prompted by the MRQ. Our analysis of current results yielded several key insights that may help explain the similarity of postformal thinking gains by both groups. Similar high levels of engagement and perceptions of content relevance among both groups, which were comparable to the Likert means and comments reported among PBL students in the previous studies (Wynn, Mosholder, & Larsen, 2014, 2016), indicated that both groups maintained interest in the problem/issues introduced and were invested in solving the problem and practicing the cognitive skillsets that would increase their ability to effectively develop workable solution alternatives.

As the PBL instructor, I never used the phrases *intuitive thinking*, *formal thinking-closed systems thinking*, *postformal thinking*, *relativistic thinking*, and *dialectical thinking* nor in any way labeled the thinking processes I was modeling and prompting students to practice via PBL in a single class or activity with the control group. However, their engagement in each step of the PBL activities facilitated their applying relativistic and dialectical operations whether they could label the three steps or not: (1) look for contextual complexities and contradictions, don't just assume you fully understand the problem/issue; (2) seek to understand the rationale for multiple, even opposing perspectives, and identify the inherent contradiction(s); and (3) use your understanding of the contradiction to help formulate solution alternatives and deliberate to develop a single workable solution. As stated earlier, experimental group students rarely used the terms postformal thinking, relativistic thinking, dialectical thinking in their ESQ comments to describe changes in their thinking, which was surprising. Instead, they

operationally described the new thinking systems that they utilized in problem-solving and decision-making. In fact, both groups relied on their PBL experiences in practicing the more advanced thinking systems to construct their own operational descriptions of how their thinking changed, which aligned well with the operational definitions of postformal thinking systems. It seems that my Power Point presentation and MRQ guidance after each PBL activity fell short of matching what the experimental group learned during their PBL activities, which is a very positive outcome.

We believe the systematic process of modeling and providing cognitive scaffolding to guide students to practice the advanced thinking systems were primary factors in postformal thinking gains. For example, in Steps 2 and 3 of the first PBL activity, I guided students to be open to considering causes and origins of opposing perspectives on U.S. expansion and annexing the Philippines based the knowledge gathered and gained during their Senate Subcommittee Hearing. I did so by prompting them to offer information and explanations regarding the multiple perspectives we examined during the hearing and to assess to what extent these perspectives should be considered as we attempted to reach a decision, and specifically, which were the better points offered by both sides. I then asked them to identify key contradictions between the opposing positions. Students in both LC sections immediately identified perceptions of morality as the key contradiction. I next asked how both sides could back their position through a moral framework. Their response was that anti-expansionists believed they had a moral responsibility to uphold the basic democratic principles of the United States and not annex the Philippines even if this decision resulted in the Philippines being annexed another imperial power, while the expansionists believed they had a moral responsibility to protect the Philippines from other imperial powers while guiding Filipinos toward a more advanced and democratic society, even though the "guidance" and annexation presented an additional contradiction. Both sides believed that not taking their proposed course of action would be a moral violation against United States principles and the Filipino people. I then asked students to consider how they could use this contradiction to develop solution alternatives. Several solutions were proposed, and each was considered and deliberated. A consensus was reached to maintain a protectorate status for the Philippines while providing the resources and framework for the Filipinos to choose and develop their own form of government as soon as possible. We then compared their solution (same in both LCs) to what actually happened: the annexation of the Philippines and the subsequent war, the gaining of new markets and resources by the United States, eventual conflict with Japan, and Filipino independence in 1946. We believe this systematic PBL process, which was repeated through five subsequent activities, provided a social learning dynamic through which our first-year LC students were able to practice and gain

the more advanced, postformal, thinking systems within their ZPD to become more advanced problem-solvers.

Limitations

The results of the current study need to be carefully interpreted in light of the limitations. The limitations include the limited sample and limited number of sections studied. The limited sample size may affect generalizability of the findings along with the limited number of sections. The specific timing of the lectures/PBL activities was designed to reduce modifications to the content based on reflection and to minimize selection bias of the students. It is also important to note that I ensured that delivery of each lecture/PBL activity and assessment was exactly the same for both sections with the exception of the administration of the MRQ. This is an important feature that should be considered when designing larger studies to investigate the findings further.

Implications for Practice

Lardner and Malnarich (2008) asked the primary question that LC programs and faculty seek to effectively address: How can we best organize and teach for high-quality learning for all students? They offered key targets to guide this effort: a) increasing student engagement, b) increasing the quality of student learning, c) and doing so through relevant and meaningful integrative learning experiences that will positively connect students to their peers and instructors and guide them to acquire knowledge and cognitive skills-sets that will serve them well in class and in life in general. Our studies provide empirical evidence that PBL can be an effective method to help LC programs and faculty hit these targets. The following instructional implications are offered to help our LC colleagues integrate the PBL model.

PBL and Promoting Postformal Thinking Skills in Your LC: Results from the previous studies led us to assume that the metacognitive reflection/MRQ process was central to facilitating postformal thinking among first-year LC students. Results from our current study indicated that the MRQ may not have been necessary to facilitate postformal thinking skills, at least for the first-year students who participated in our study, and that modeling and cognitive scaffolding may be key factors in guiding students to effectively practice and acquire postformal operations. We believe that the structural dynamics of our LCs contributed to our results. The small number of students in both LC sections was ideal to support the social learning dynamics that we believe supported postformal thinking gains in both groups. The enrollment cap of 25 students for LCs at our university will continue to support the implementation of PBL activities and the related social learning dynamics. Current results were also encouraging regarding two

instructional challenges associated with implementing the MRQ: a) the PBL instructor's operational knowledge of the relevant thinking systems (intuitive, formal/closed systems, relativistic, and dialectical), and b) the additional instruction time necessary to implement the MRQ. If postformal thinking systems may be practiced and acquired by students through PBL social learning dynamics without implementing the MRQ, it will save instructional time and eliminate the need to formally introduce and operationally define the thinking systems.

PBL and Increased Student Engagement/Connectedness: The high level of engagement and content relevance reported by students in the current and previous studies supports the use of the PBL method as an effective strategy to increase student engagement, interest, and success in their first-year LC. The relationship between student engagement and intellectual and academic success has long been established (Pascarella & Terenzini, 2005). The social learning dynamic facilitated by the PBL method serves to engage first-year LC students in a true community of learners in which they practice discourse and gain the cognitive skillsets necessary to open their minds to diverse opinions and diversity in general in ways that can help create a sense of belonging and connectedness that may help year to year retention and academic success.

PBL as an Adaptable Method on Which to Base Integrative Assignments: We also want our LC colleagues to recognize the adaptability of the PBL model. The model can be adapted to accommodate the content, problems, and issues relevant to each discipline and can be used to guide the search for, or development of, PBL activities that may serve as purposeful integrative learning experiences. For each course, faculty can determine the number and focus problems and issues that best fit the curricular scope and sequence. Implications from the current study and the previous studies support the implementation of multiple PBL activities rather than one or two to provide enough modeling, scaffolding, and practice to guide first-year students toward applying postformal considerations/operations without assistance. Key considerations that may assist our colleagues in the development and implementation of integrative PBL experiences within their LC courses are as follows.

1. To what extent might you pull back coverage of disciplinary content to immerse students in concepts/problems/skillsets central to your discipline(s)?
2. How might you structure assignments and grading rubrics to integrate the courses in your LC in a meaningful and purposeful way, with students clearly recognizing the importance of PBL activities and related outcomes?
3. How can you align syllabi for your LC courses to support integrative PBL experiences that students will recognize and value?

LC Faculty as PBL/Cognitive Models: In this time of political polarization, PBL instructors must avoid pushing a "preferred" position or opinion in order to successfully implement PBL activities to promote postformal thinking. This can be very challenging. Instructors must model postformal operations/considerations as part of the scaffolding process, which includes being open to, and tolerant of, diverse, even opposing, opinions in order to guide the practice and acquisition of relativistic and dialectical reasoning among their students (Wynn, 2015). As stated earlier, Commons & Ross (2008) estimated that fewer than 20% of adults in developing countries have adequate thinking skills to effectively address pressing problems and issues. LC faculty must consistently earn their status as fair and open members of their community of learners in order to guide first-year LC students toward the ranks of advanced problem-solvers, thereby equipping them with the advanced cognitive systems necessary to effectively address current and future problems for the common good.

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Appendix A
HIST 2112 PBL Instructional Units

Post-Reconstruction through WWII

Unit 1: An Overview of Post-Reconstruction America (1877-1890)

Unit 1: The U.S. as an Empire: Global Power Structure (1890-1905)
PBL Activity: *The Question of U.S. Expansion: Expansionists versus Anti-Expansionists*

Unit 2: Social and Political Dynamics in the Progressive Era

Unit 3: The Nation at War
PBL Activity: *Wilson and the Paris Peace Conference: Constructing the Treaty of Versailles*

Unit 4: Economic Expansion of the 1920s, The Depression, Franklin D. Roosevelt and the New Deal
PBL Activity: *Solving the Problems of the Depression: Constructing the New Deal*

Unit 5: America and the World (1921-1945)
PBL Activity: *The Atomic Bomb: Truman's Decision and Its Impact*

The Post WWII Era and Beyond - 1945 to Present

Unit 7 - The Cold War and Beyond

Unit 8 - Civil Rights in the U.S.: Tracing Social, Economic, and Political Dynamics in the Last Half of the 20th Century
PBL Activity: *The Issue of Affirmative Action: The Atlanta Case*

Unit 9 - Challenges of the New Century
PBL Activity: *Group Solution Proposals on Current Issue: Heath Care Reform; Immigration Reform; Fiscal Policy, Regulatory Reform, Entitlement Reform; Energy/Carbon Emission Policy; Federal Minimum Wage*

Appendix B
Complex Postformal Thought (PTF) Questionnaire

Please respond to each item below by circling the number that best describes you on the following scale: 1 = Not True (of self) and 7 = Very True (of self).

1. I see the paradoxes in life (Paradoxes are inherent contradictions in reality.)

   1 2 3 4 5 6 7

2. I see more than one method that can be used to reach a solution or decision on a problem or issue.

   1 2 3 4 5 6 7

3. I am aware that I can decide which reality or truth to experience at a particular time; but I know that reality and truth is really multi-level and more complicated.

   1 2 3 4 5 6 7

4. There are many ‘‘right’’ ways to define any life experience; I must make a final decision on how I define the problems of life.

   1 2 3 4 5 6 7

5. I am aware that sometimes ‘‘succeeding’’ in the everyday world means finding a concrete answer to one of life’s problems; but sometimes it means finding a correct path that would carry me through any problems of this type.

   1 2 3 4 5 6 7

6. Almost all problems can be solved by logic, but this may require different types of ‘‘logics.’’

   1 2 3 4 5 6 7

7. I tend to see several causes connected with any event.

   1 2 3 4 5 6 7

8. I see that a given dilemma always has several good solutions.

   1 2 3 4 5 6 7

9. I realize that I often have several goals in mind, or that life seems to have several goals in mind for me. So I go toward more than one in following my path in life.

1 2 3 4 5 6 7

10. I can see the hidden logic in others' solutions to the problem of life, even if I don't agree with their solutions and follow my own path.

1 2 3 4 5 6 7

Appendix C
End of Study Questionnaire

Thank you for participating in this study. Please answer the 5 questions below based on your experience this semester in History 2112.

1. Rank your level of engagement (active participation) in your History 2112 course. (1 = not engaged, 5 = fully engaged).

   1 2 3 4 5

   Explain your response.

2. How does your ranking of engagement in your 2112 course compare to other history courses you've taken (in college or high school)?

   Explain your response.

3. Rank the level of relevancy of the content of this course. How relevant were the topics (content areas)? (1 = irrelevant, 5 = very relevant).

   1 2 3 4 5

   Explain your response.

4. Do you believe you have expanded your ability to think critically as a result of History 2112? If so, can you explain the how your thinking has changed and/or evolved?

5. To what extent do you believe you may utilize the thinking skills you may have gained in History 2112 last semester as you continue your education and life in general?

   Explain your response.

Appendix D
Metacognitive Reflection Questionnaire

Please respond to each statement below by circling the number that best describes the thinking/reasoning you used during this activity.
1 = Never (N) 2 = Rarely (R) 3 = Occasionally (S) 4 = Somewhat Often (SO)
5 = Often (O) 6 = Very Often (VO)

N R S SO O VO

1. I used intuitive or emotional thinking (It felt right.) as I reached a conclusion or decision on this problem/issue. (Intuitive Thinking)
1 2 3 4 5 6

2. I used logical-analytical thinking (application of logical operations) to compare the problem at hand with similar problems/issues I've experienced in the past as I reached a similar correct conclusion or decision on this problem/issue. (Formal/Closed Systems Thinking)
1 2 3 4 5 6

3. I recognized that often there is no "correct" answer when dealing with complex problems/issues like this one. (Postformal Thinking: Relativistic)
1 2 3 4 5 6

4. I considered context, multiple causes, multiple points of view, and conflicting/contradicting ideas about what is true and relevant related to this problem/issue as I reached a conclusion or decision. (Postformal Thinking: Relativistic)
1 2 3 4 5 6

5. I searched for and used inconsistencies and contradictions inherent in this problem/issue, sought to understand why those contradictory perspectives exist, and sought to use this understanding as part of the problem-solving process. (Postformal Thinking: Dialectical)
1 2 3 4 5 6

6. I considered how change could affect this problem/issue and possibly my opinion/decision. (Postformal Thinking: Dialectical)
1 2 3 4 5 6

Please respond to the following question on the back of this questionnaire.

7. Describe the various thinking systems you utilized during this problem-based activity, (from those listed above, and from more discipline specific processes like historical thinking, mathematical computation/estimation, etc.) How significant were these processes in helping you solve the problem or make a decision?