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Measuring the Effects of Problem-Based Learning on the Development of Postformal Thinking Skills and Engagement of First-Year Learning Community Students

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Measuring the Effects of Problem-Based Learning on the Development of Postformal Thinking Skills and Engagement of First-Year Learning Community Students

Abstract
This article presents an instructional model for teaching a gateway history course that affects students by: 1) improving their ability to think at higher levels; 2) increasing engagement; and, 3) enhancing their perception of the relevancy of the course material in comparison to traditional lecture and discussion. The model includes problem-based learning, a metacognitive reflection inducing approach to discussion, and integration into a learning community (PBL LC). The researchers conducted an evaluation of the outcomes of PBL LC and compared them to the outcomes of the same course taught by model methods without the learning community (PBL History) and by traditional lecture and discussion (TLD). We used a neo-Piagetian framework for developing the metacognitive reflection approach that also identified our target for higher level thinking and adult complex problem solving ability, i.e. postformal thinking dynamics. Change in cognitive ability, engagement and perception of relevancy of the content were measured using both quantitative and qualitative techniques. The results indicated that students taught with PBL LC had the highest levels of postformal thinking change, engagement, and perception of content relevancy, with both PBL LC and PBL resulting in higher levels than TLD.

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Keywords
Problem-based Learning, Learning Communities, Postformal Thinking, Metacognitive Reflection, History Teaching, Course Engagement

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Introduction

Americans have set goals at both national and state levels to make America the country with the largest percentage, 60%, of its population having post-secondary degrees. America is a long way from achieving that goal with 38% of Americans having achieved that status by the end of 2008. During that same year, fewer than 41% of 18-24 year old Americans were enrolled in 2- or 4-year degree programs. The numbers, which varied dramatically by gender and ethnicity, resulted from both low matriculation and low year-to-year retention of students in school, particularly for minorities. Lack of educational attainment has the potential to jeopardize the future prosperity of Americans (Liu, 2011). Increased engagement and the perception of content relevance are important for academic success, including year-to-year retention, particularly for students who differ from the majority group (Kahu, 2013).

The need to improve cognitive skills has also been identified. The Association for American Colleges and Universities (AAC&U) published *College Learning for the New Global Century* (2007) to identify essential learning outcomes and guiding principles for a twenty-first-century college education. The report called for curricular and pedagogical structures that equip students with the cognitive skills necessary to understand and respond to the complex challenges of modern life. These skills include inquiry and analysis, critical and creative thinking, teamwork and problem solving "practiced extensively, across the curriculum, in the context of progressively more challenging problems, projects, and standards for performance" (p. 3).

Our teaching and research have been directed towards addressing these issues. We have designed and tested a problem-based instructional model to determine the extent to which it improves cognitive skills, engagement, and the perception of content relevancy, particularly for first-year students in gateway or survey level courses.

Literature Review

Postformal Thinking

Sinnott's (1998) work provided our framework for measuring the effects of curricular variations on thinking skills. We believe this is a useful frame because it provides the opportunity to measure thinking levels within both Piagetian and neo-Piagetian categories. However, not much research based on principles of cognitive psychology has been conducted to explore the effects of using problem based learning in college classrooms, and more specifically, within learning communities.

Sinnott (1998) asserted that the university should meet the demands of a changing world by approaching the task as one of enhancing postformal thinking or adult reasoning skills in its students. Sinnott's argument is based, in part, on the assumption that most college students lack postformal thinking skills and rely on inadequate thinking systems to address complex problems and issues. Other theorists present similar arguments (Demetriou, Spanoudis, & Mouyi, 2011; Kramer, 1983; Kramer, Kahlbaugh, & Goldston, 1992; Perry, 1970, 1981, 1999).

Our problem-based instructional model is designed to facilitate the following potential theoretical outcomes related to postformal thinking and adult reasoning:

> (1) recognition and utilization of multiple cognitive operations (intuitive, formal, relativistic, dialectical, and domain specific processes, i.e. historical thinking), and that the choice of logical systems of thinking is subjective and based on the type of problem encountered; (2) recognition that the social context of learning and problem-solving will often lead to group selection of the cognitive operations applied to a specific problem, which often leads to a collective cognition which, in itself, is a form of social learning or cognitive scaffolding (Sinnott, 1998); (3) application of knowledge and skills to construct deeper and expanded insights of course content; and (4) recognition and utilization of epistemic/metacognitive reflective skills. (Wynn, 2010, p. 10)

Engagement

Pascarella and Terenzini (2005) observed that the importance of student engagement in encouraging intellectual and academic success has been known for a long time. The construct has been defined and operationalized in a number of ways, including views that emphasize behavioral, cognitive and emotional aspects of student performance (Kahu, 2013). Kahu observed that students often experience something akin to "culture shock" when they first start college. This can happen more often with students who are different from the majority group and who arrive at college, as she describes it, "not having the necessary social, cultural, and academic capital to fit into the university culture" (p. 763). She speculates that this perspective can provide explanations for why students are engaged or alienated, and posits that educational institutions should take a holistic perspective on engagement by developing processes for "engaging students" with the outcome being "engaged students" (p. 764).

Student engagement has been measured at both the institutional and classroom levels. For instance, the National Survey of Student Engagement (NSSE) is a widely used and well-known measure at the institutional level. Student engagement in the classroom has been shown to be related to student

retention from year to year, persistence to graduation, and success, as measured by increased GPA (Handelsman, Briggs, Sullivan & Towler, 2005; Mosholder & Tolman, 2012; Mosholder, in press). Similarly, problem-based learning (PBL) has been shown to promote cognitive engagement (Rotgans & Schmidt, 2011).

Instructional Interventions

Intervention Timing

The timing of instructional interventions is an important consideration. The first year of college is a critical curricular focal point in guiding students toward developing critical thinking skills and encouraging them to stay in school. Moreover, potential yet critical gains in learning and cognitive development are associated with the transitional period of late-adolescence (Baxter Magolda, 2009; Parks, 2000; Pascarella, 2005; Reason, Terenzini, & Domingo, 2006; Tanner, Arnett, & Leis, 2008; Wynn, 2010).

Late adolescents often utilize a dual process model of cognition when problem-solving (Keating, 2004; Witteman, van den Bercken, Claes, & Godoy, 2009). Intuitive thinking is the first mode, governed by an "if it feels right, it's right" approach that operates in a more automatic, holistic manner. Rational or formal thinking, the second mode, is characterized as slower, more deliberative and rule-governed operations (Epstein, Pacini, Denes-Raj, & Heier, 1996; Evans, 2008; Witteman et. al, 2009). Even if late adolescents pull away from intuitive thinking to apply more ordered formal thinking in their attempt to solve a complex problem or issue, they often do so through a closed systems approach (Sinnott, 1998). A closed systems problem-solver will generally apply a practiced systematic/formal problem-solving framework based on previous experience with similar problems.

This closed systems framework typically involves a problem-solving dynamic based on a limited number of variables, with other important aspects of the problem often judged as irrelevant to the solution. Formal thinkers often expect to produce a single right answer that will apply to all similar circumstances (Wu & Chiou, 2008). Late adolescents must come to recognize the inadequacy of a formal/closed systems approach to problem solving to prompt a search for more adequate systems to solve more complex problems (Sinnott, 1998).

For the neo-Piagetians the ideal transitional dynamic of late adolescent cognition involves moving from a formal/closed systems problem-solving approach towards a relativistic thinking system, the first level of postformal thinking (Chiou, 2008; Kahlbaugh & Kramer, 1995; Kramer et al., 1992). Relativistic thinkers recognize that when a person's perspective or context changes, her/his perspective on what is true also changes (Chiou, 2008). Kahlbaugh and Kramer (1995) link the transition to relativistic thinking to the multiple challenges and complexities faced by late-adolescents and young adults.

Rather than seeing problems and issues through the lens of fixed truths—good versus bad, for example—relativistic thinkers recognize that context and contradictions are key to understanding the complexities of a problem and to developing potential resolution alternatives. Within this frame, relativistic thinkers may come to recognize that for some problems and issues no resolution may be possible (Chiou, 2008; Sinnott, 1998).

The most advanced cognitive processes associated with adult problem solving recognized by the neo-Piagetians occur within dialectical thinking, the second and final stage of postformal thinking (Basseches, 1984, 1989; Sinnott 1998). Kramer et al. (1992) describe dialectical thinking as the integration of relativistic thinking with the recognition that both sides of contradictions within a problem or issue are interrelated and connected, and are critical in the development of resolution alternatives. Inconsistencies and contradictions within problems and issues become catalysts in the application of multiple cognitive systems as dialectical thinkers seek resolutions that lead to higher levels of understanding and cognition (Ho, 2000). Dialectical thinkers also recognize that any resolution or stability that may result from dialectical problem-solving operations will be perpetually challenged by new challenges, changes, and a potential tension to resolution to tension dynamic (Blouin & McKelvie, 2012).

Learning Communities

One instructional intervention that has the ability to address these challenges is learning communities, programs explicitly designed to provide opportunities for students to practice integrative and interdisciplinary learning, fostering the development of the types of advanced cognitive skills called for in the AAC&U Report. The National Resource Center for Learning Communities (Washington Center, n.d.a) describes learning communities as classes that are linked or clustered, often around an interdisciplinary theme, and that enroll a common cohort of students, with the goals of increasing student involvement and motivation and enhancing student intellectual development. Participation in a learning community has been positively related to the development of higher order thinking and problem-solving skills (Rocconi, 2011; Pike, 1999; Zhao & Kuh, 2004).

The general structure of a learning community offers an ideal environment to nurture and support first-year college students toward the type of meaningful learning and cognitive advancement described above. The National Resource Center for Learning Communities (Washington Center, n.d.b) advocates learning environments within a learning community context that foster "the habits of mind and skills to tackle complex real-world issues" (para. 1). Thus, there is great potential for epistemological alignment within first-year learning communities if courses are constructed around two primary bases: the cognitive needs and nature

of the late adolescent, and instructional methods that promote deep meaning and cognitive growth. We believe problem-based learning activities with a metacognitive reflection process will provide scaffolding for first-year students to develop these advanced cognitive skills, specifically, postformal operations.

Problem-Based Learning

Originally developed for medical education, problem-based learning (PBL) is a flexible instructional strategy in which students are guided to take part in the cognitive processes of advanced problem solving (Lenkauskaite & Mazeikiene, 2012). It has subsequently been used in a variety of educational settings, from middle and secondary education to higher education (Hmelo-Silver, 2004). Pascarella (2005) asserts that problem-based instructional approaches help facilitate cognitive growth during the late adolescent transitional period by prompting student learning in a constructivist and socially interactive context.

Hung (2013) defines PBL as "an instructional method aimed at preparing students for real-world settings" (p. 31). "By requiring students to solve problems as the main format of instruction, PBL enhances students' learning outcomes by promoting their abilities and skills in applying knowledge, solving problems, practicing higher order thinking, and self-directing and reflecting on their own learning…" (p. 31).

The question of whether or not PBL is more effective than traditional methods has been addressed through several meta-analyses (Albanese & Mitchell, 1993; Strobel & van Barneveld, 2009; Vernon & Blake, 1993; Walker & Leary, 2009), with some studies indicating little or no beneficial effect on student learning of content/concepts. However, the analysis of later studies involving multiple disciplines outside medical education (Gijbels, Dochy, Van den Bossche, & Segers, 2005) has shown that PBL students did as well as or better than their lecture-based counterparts (Walker & Leary, 2009). Strobel and van Barneveld (2009) note that results indicated that "PBL is significantly more effective than traditional instruction to train competent and skilled practitioners and to promote long-term retention of knowledge and skills acquired during the learning experience" (p. 55). Several researchers have argued that PBL facilitates students' content knowledge retention and enhances their ability to successfully apply problem-solving strategies in new and complex situations (Blumberg, 2000; Cognition and Technology Group at Vanderbilt [CTVG], 1997; Maxwell, Bellissimo, & Mergendoller, 2001; Mergendoller, Maxwell, & Bellissimo, 2006).

Facilitating Cognitive Growth through PBL

Wynn (2010, in press) has developed a metacognitive reflection process within our PBL model that is designed to promote cognitive growth and advanced problem-solving skills through instructor and peer modeling. When used within a

collaborative learning environment, this modeling and cognitive scaffolding prompts more capable peers to accomplish a tutorial role similar to that of the instructor. Vygotsky's (1978) social learning theory describes this relationship between instructors, tutors and learners in the context of problem-solving through the developmental concept of the zone of proximal development (ZPD). Vygotsky defines ZPD as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86).

Problem-based learning with this metacognitive reflection process built in provides multi-systematic scaffolding, a combined epistemic and metacognitive process: the instructor prompts students to reflect on the dynamics of the reasoning skills (e.g., intuitive, formal, relativistic, and dialectical) that they practice under his or her guidance during problem-solving, and subsequently to judge which systems were more useful or successful and why (Hmelo-Silver, 2004; Vukman, 2005; Wynn, 2010). Over time, this helps students develop a cognitive self-awareness that is valuable in the development of their postformal thinking/problem-solving skills as well as their ability to monitor and direct the processes of problem-solving in general (Hacker, 1998; Hmelo-Silver, 2004; Wynn, 2010).

Without opportunities for cognitive guidance and reflection in a PBL context, when closed systems problem-solvers in the classroom are confronted with a complex problem/issue, they may seek to maintain their cognitive equilibrium by sealing themselves off from different viewpoints or by rejecting formal thinking and utilizing less logical forms of thought like intuitive thinking. Thus, a PBL instructional model that explicitly prompts metacognitive reflection allows instructors to guide students' transition from formal/absolutist thinking toward the practice and development of postformal thinking by exposing them to the diverse perspectives, multiple truths, and contradictions inherent in complex problems and issues, and by providing them opportunities for careful, critical reflections as part of a modeling process (Basseches, 2005).

The effect of PBL and metacognitive reflection on the development of these cognitive skills among first-year college students and college students in general has not been studied. Therefore, based on the above literature review and our own observations of PBL and first-year learning community learning environments, our research tested the following hypotheses.

1. There will be no significant difference in cognitive growth, as measured via pretest-posttest changes in postformal thinking skills, between students in a PBL American history-based first-year learning community and a PBL regular (non-learning community) section of the same course.

2. There will be no significant difference in cognitive growth, as measured via pretest-posttest changes in postformal thinking skills, between students in a PBL regular section of American history and the same course taught through primarily lecture/discussion.

3. There will be no significant difference in self-reported level of course engagement, as measured via an end of course questionnaire, between students in a PBL American history-based first-year learning community and a PBL regular (non-learning community) section of the same course.

4. There will be no significant difference in self-reported level of course engagement, as measured via an end of course questionnaire, between students in a PBL regular section of American history and the same course taught through primarily lecture/discussion.

5. There will be no significant difference in self-reported level of course content relevance, as measured via an end of course questionnaire, between students in a PBL American history-based first-year learning community and a PBL regular (non-learning community) section of the same course.

6. There will be no significant difference in self-reported level of course content relevance, as measured via an end of course questionnaire, between students in a PBL regular section of American history and the same course taught through primarily lecture/discussion.

Method

We evaluated our PBL instructional model in a gateway history course, America since 1890, combined with a first-year learning community (LC) under the theme, "Stepping into America's Past: What Would You Do?" (PBL LC). Two of these LCs, with 25 students in each, were included in our study, with one of the researchers teaching both LC history sections and one of the other researchers teaching the linked first-year seminar sections. We included two other curricular variables in our study: PBL instruction within a non-LC section (PBL History) that enrolled 40 students, and traditional lecture and discussion (TLD) within three non-LC sections that enrolled 50 students per section. One of the researchers developed and implemented six problem/issue-based activities in each of the three PBL sections of American history. Appendix A includes the course topical/unit outline with a list of the PBL activities. Each PBL activity took between one and three 75-minutes class periods to complete.

In addition to the PBL activities, the researcher teaching the three PBL history courses used lecture, discussion, and guided questions (Riseman & Wineberg, 2008), with a focus on establishing historical context for the PBL activities. Therefore, the full instructional dynamics of the course may be described as hybridized (Allen, Donham, & Bernhardt, 2011) or "problem-assisted learning" rather than being exclusively or purely PBL (Murray & Summerlee, 2007; Chapman, Keller, & Fournier, 2002). A broad progressive/conservative dialectical framework was also used throughout the course to examine/analyze American history during the period studied (1890 to the present).

The learning objectives of the first-year seminar linked to the two sections of the PBL American History courses included strategies for academic success, life and motivational skills, and the foundations for global learning. The researcher who taught this course also created lesson plans to focus skill development on success in the American history curriculum. In addition, students in the first-year seminar were provided opportunities to work on PBL-related assignments and to debrief and reflect upon the thinking systems they practiced in the PBL activities.

The instructor for the third curricular variable (TLD) taught the three other sections of the same American history course. This instructor primarily used the traditional lecture method. In addition, he conducted four in-class exercises using the *Taking Sides* series, for which students read scholarly essays that presented alternative yes or no viewpoints as well as supporting arguments about historical events. The instructor then asked the students to write an essay outlining and supporting their opinion on one of these issues.

Participants were included in the study based on their enrollment in the courses outlined above and their consent. The number of participants was as follows: PBL LC = 40, PBL History = 31, TLD = 35.

Details of Our PBL Model

Dolmans and Gijbels (2013) note a lack of explicit descriptions of PBL instructional models in published studies. To help address that void, we note that three cognitive-based instructional principles (Driscoll, 1994) guided the development of the PBL instructional model evaluated in this study:

1. The learning environment should be active and discovery-oriented.
2. Peer learning and social negotiation should be prominent to encourage cognitive development.
3. Problem solving and Socratic dialogue and similar instructional strategies should be used to promote cognitive development. (Downing, Kwong, Chan, Lam, & Downing, 2009, p. 619)

The first two principles are operationalized in Step 1 of the instructional model as described below. The third principle is operationalized in Steps 2 and 3, with Step 2 including a decision-based/argumentation structure (Jonassen, 2012).

The PBL procedures are generally based on Edens' (2000) three-phase PBL model and were adapted from Wynn's (in press) PBL instructional model.

> Step 1 – Introduction of the Problem: The primary focus in Step 1 was to pique student interest (create a need to know more), establish "stakeholdership," and explicitly portray the problem/issue as multidimensional. Problems/issues were introduced through story-telling, video clips, data presentations, and readings. Students were guided to recognize that the problem/issue has more than one "right" answer and opposing positions. For example, the introduction of the first PBL activity in the PBL sections of the American history course in the current study involved sharing a story (with illustrations) of a U.S. merchant ship encountering an uncharted Pacific island that could be very useful as a U.S. colony. The class then identified how different groups—i.e., U.S. expansionists, U.S. anti-expansionists, the natives on the island, other colonial powers—would see this encounter. Students were then able to identify the issue/problem to be resolved as: Should the U.S. annex the island as a colony?
>
> Step 2 – Initiation of PBL Events-Argumentation and Student Inquiry: Step two included a decision-based/argumentation structure (Jonassen, 2012) in which students generated arguments and worked to recognize conflicts and contradictions among competing positions. This was done primarily through historical simulations and current issue presentations at the end of the course. For example, the first PBL activity included a U.S. Senate Sub-Committee Hearing on U.S. Expansion. The class was divided into Expansionists, Anti-Expansionists, and Senators in order to outline a rationale and gain support for their assigned position on the problem/issue. Senators ultimately voted on the status of the newly discovered Pacific island after hearing both arguments (to take or not take the island). At the conclusion of the simulation, students identified both what they had learned about the problem/issue and the inherent contradictory or opposing positions and what additional information they needed in order to develop potential alternatives/solutions to the issue of U.S. expansion.

> Step 3 – Problem Solution: Students generated solutions/decisions, examined their "fit," and then proposed the most appropriate one and evaluated its historical or potential consequences. For example, after the vote in Senate subcommittee hearing, students used the contradictions identified between the opposing positions and their understanding of the context of the issue applied to the actual decision by the U.S. to annex the Philippines after the Spanish-American War. Students then constructed a solution alternative, deciding that the Philippines should be offered territorial rather than colonial status in 1899, with a timeline for independence established by U.S. and Filipino representatives. This solution was compared to the actual outcome of U.S. annexation of the Philippines in the short and long term. A concluding opinion essay was assigned at the end of the activity, followed by a debriefing session that included a review of the content, concepts, and skills encountered and used during the activity.

Step 3 ended with a metacognitive reflection questionnaire (Appendix B) that provided a guided reflection on the successes and failures of each of the thinking strategies utilized by students (Wynn, 2010; Wynn, in press). For example, as students reflected on their thinking during Step 2 of the PBL activity, many recognized that their efforts to persuade the Senators to vote for their assigned positions (Expansionists or Anti-Expansionists) had prompted intuitive/emotional thinking along with logical analysis, and some recognized that intuitive/emotional thinking made it harder for them to consider the validity of the opposing position. Several Senators in the activity recognized they were utilizing more relativistic thinking as they considered the complexities of the issue, identifying or empathizing with both sides and multiple perspectives as they constructed a rationale for their vote during Step 2. Students also noted they had been prompted to practice relativistic and even dialectical thinking during Step 3 of the activity, in that they utilized contradictions they identified as inherent in the issue—as well as the multiple perspectives involved—in the process of constructing and selecting a solution alternative.

Measures

We used the Postformal Thought (PFT) Questionnaire (Sinnott & Johnson, 1997) to measure participants' level of postformal thought. We administered the PFT on both the first and the last day of classes. The questionnaire included 10 statements representing different operations of postformal thinking. Participants responded to each statement by indicating the extent to which it characterized their own thinking (7=very true to 1=not true).

Cartwright, Galupo, Tyree, and Jennings (2009) tested the reliability and construct validity of the PFT and found it to be a moderately reliable (.63) and valid measure of postformal thought. For this study, scores were summed for the 10 items for each participant. Potential scores range from 10, indicating low levels of postformal thought, to 70, indicating high levels of postformal thought (Cartwright et al., 2009). The PFT is included as Appendix C.

An end of study questionnaire (ESQ) was administered to participants after all other data were collected. The ESQ included five questions, two of which called for a Likert rating on their level of engagement in the history course (Questions 1 and 2), one that called for a Likert rating on the level of relevance of course content and topics (Question 3), and two that prompted participants to reflect on the extent to which their experience in the history course expanded their ability to think critically (Questions 4 and 5). The ESQ is included as Appendix D.

Methods of Analysis

We measured the development of postformal thinking skills, engagement, and perception of content relevancy with each of the curricular variables using both quantitative and qualitative methods. A one-way ANOVA was used to analyze data from the ordinal variables. We used directed content analysis to analyze Questions four and five of the ESQ (Hsieh & Shannon, 2005). Researchers use directed content analysis when "prior research exists about a phenomenon that…would benefit from further description" (p. 1281). This approach has also been referred to as deductive category application (Mayring, 2000). Using the literature review as a starting point, two of the researchers identified key concepts and variables of four categories of problem-solving thinking systems to be used as initial coding categories: 1) intuitive, 2) analytic, 3) relativistic, and 4) dialectic. These categories proved difficult to use in practice, so they were collapsed into operational definitions for two problem-solving systems: closed systems (CS) and postformal operational (PF) (Potter & Levine-Donnerstein, 1999). These operational definitions are presented in Appendix E.

Student responses were coded as self-reported PFT experience if the comment indicated the utilization of characteristics of relativistic and/or dialectical operations. The results were given to the third researcher for statistical analysis. A 75 percent agreement was necessary for a comment to be deemed as PF. A dichotomous nominal variable was established (one = self-reported PFT-related experience in question four or five, zero = no self-reported PFT-related experience in question four or five) in order to cross-tabulate results. Questions four and five of the ESQs were coded individually by two of the researchers and two student researchers.

Results

Postformal Thinking Skill Development

The results of the pre- and post-administrations of the PFT are shown in Tables 1 and 2. Table 1 shows the mean difference between time 2 and time 1 in the same units as the Likert scale of the instrument, i.e., 1 through 7. Table 2 shows the normalized gain score, which is a measure of potential gain on a scale of 0 to 1, with 1 representing all possible gain (Bao, 2006). Hake (1998) defines the normalized gain score as "the ratio of the actual average gain (%<post> - %<pre>) to the maximum possible average gain (100-%<pre>)" (p. 64).

Table 1
One-way ANOVA Data of the Net Postformal Gain Scores of Students in the Three Curricular Variables

Variable	df	Mean	F	Sig.
PBL LC	2	4.25	4.23	.017
	103			
PBL History		2.71		
TL		0.29		

Table 2
One-way ANOVA Data of the Normalized Postformal Gain Scores of Students in the Three Curricular Variables

Variable	df	Mean	F	Sig.
PBL LC	2	.094	4.56	.013
	103			
PBL History		.060		
TL		.008		

As can be seen from these data, increases in post-formal thinking ability occurred, with the PBL LC group having significantly greater gain than either the PBL History or the TLD group. Therefore, we reject our first hypothesis. In addition, the PBL History group had a significantly greater increase than the TLD group, leading us to reject Hypothesis 2.

The results of the directed content analysis of questions 4 and 5 of the ESQ are presented in Table 3. The pattern observed with the pre- and post-administration of the PFT is observed with this data as well, with the greatest

frequency occurring in the PBL LC group and the smallest frequency occurring in the TLD group, which also supports the rejection Hypothesis 1 and Hypothesis 2.

Table 3
One-way ANOVA Data of Responses to Questions Four and Five on the End of Study Questionnaire

Variable	df	Mean	F	Sig.
PBL LC	2 97	0.95	13.6	.000
PBL History		0.72		
TL		0.43		

Note. One = self-reported postformal thinking experience based on comments from ESQ questions four or five; Zero = no self-reported postformal thinking experience based on comments from ESQ questions four or five.

There was a notable difference in the responses of students in the PBL LC and PBL History sections on their potential use of the thinking skills they practiced, with PBL student comments indicating a higher level of postformal thinking. Typical examples from the PBL LC group include:

> Student 107: Yes, I have always considered both sides of a situation, but never thought to go in depth on why they have these beliefs. I think it will be very helpful with political decisions. The last section of current issues made us use the skills we learned throughout the semester and apply them to current issues. Now when making decisions for who [sic] to vote for and their policies, I have a new understanding of the approach.

> 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.

These statements indicate the use of dialectical thinking, the highest level of postformal thinking. Students' comments from both the PBL LC and PBL History were very similar. Two examples are included on the next page.

> 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.
>
> Student 163: Yes, it's is easier for me to look at more possible solutions and other sides of arguments now. I will definitely continue to use these skills. I understand how valuable this skill is now by seeing how it helps when trying to make decisions.

The statements made by students in the TLD sections were, by comparison, more indicative of relativistic thinking, the first level of postformal thinking, e.g.:

> Student 209: I definitely have a better grasp of history since the Civil War and now. The Taking Sides book encourages looking at both sides of the issue.
>
> Student 264: Yes, I think of the last few presidents very differently; knowing what they did for the country. I wrote a paper in this class and it taught me how to think both sides of a situation.

Engagement

Student responses to the question about course engagement (question one) from the ESQ are presented in Table 4. The mean responses follow the same pattern observed with postformal thinking development, with PBL LC students reporting the highest level of engagement, followed by PBL History students. Therefore, we rejected Hypothesis 3 and Hypothesis 4.

Table 4
One-way ANOVA Data of Responses to Question One on the End of Study Questionnaire

Variable	df	Mean	F	sig
PBL LC	2 102	4.34	10.1	.000
PBL History		3.97		
TL		3.41		

Note: Likert scale with 1 indicating not engaged with the course and 5 indicating fully engaged.

Content Relevancy

Question three on the ESQ asked students to rate the relevancy of the content of the course. Again, the same pattern emerges, with the PBL LC students responding with significantly higher ratings than the PBL History or TLD and with TLD receiving the lowest student rating. The differences with this measurement are much less dramatic than those observed with the data reported in Tables 1 through 4. However, the difference in means was significant, leading us to reject Hypothesis 5 and Hypothesis 6.

Table 5
One-way ANOVA Data of Responses to Question Three on the End of Study Questionnaire

Variable	df	Mean	F	sig
PBL LC	2 100	4.77	3.58	.032
PBL History		4.72		
TL		4.34		

Note. Likert scale with 1 indicating the course content was irrelevant to the student and 5 indicating that the content was very relevant.

Discussion

The data on the effects of our instructional model, both within a learning community and in a non-LC setting, are compelling. Our use of the PBL model correlated with greater effects on thinking skills and with greater engagement. In addition, students in sections in which the model was used found course content to be more relevant. We believe these results have broad implications for teaching and learning in general in college gateway/survey courses. However, the implications for the first-year LC are even more compelling.

The significantly greater gain between pretest and posttest means on the PFT by the LC group is an indication that a first-year learning community is indeed an ideal setting to promote more advanced thinking skills when those skills are specifically identified and targeted for cognitive scaffolding.

We believe several factors help explain the results. First, late adolescence is a critical/transitional period for cognitive development (Baxter Magolda, 2009; Parks, 2000; Pascarella, 2005; Reason, et al., 2006; Tanner, et al., 2008; Wynn, 2010). Late adolescent first-year college students may be developmentally suited

for the explicit modeling and cognitive scaffolding that occurs through our PBL model (Wynn, 2010).

Second, the two instructors worked closely to integrate topics, including building flexibility around the use of class time. If the American history course instructor was short on time in completing a PBL activity, students were able to work on PBL related assignments in their first-year seminar. The thinking systems employed during the activities were also a specific focus in their first-year seminar, which addressed the themes of academic success, life and motivational skills, and the foundations for global learning. In other words, the thinking systems students practiced in their American history course were reinforced in their first-year seminar.

Third, the limit on class size (25 students) and sense of community in our LCs may help explain the postformal gain results. Facilitating PBL activities and engaging students in the related collaborative/social learning dynamics is simply easier and more efficient with 25 students than with 40. Both LC cohorts in our study took two classes together, which we believe enhanced classmate familiarity and collaboration. This familiarity may have enhanced the PBL environment and may also have been a factor in the PBL LC groups' perspective on level of engagement compared to the PBL History group. We were also very encouraged by the postformal gains made by the PBL History group compared to the TLD group, indicating that our PBL model has a significant effect on the development of postformal thinking skills in a non-LC learning environment, even with a larger number of students.

Our PBL model's impact on student reported level of engagement and course relevance was also encouraging. In addition to the class size and sense of community factors discussed above, we believe the primary difference in level of engagement among students in the PBL History and TLD groups may be explained by the explicit learner-centered structure of the PBL instructional model, in contrast to the more instructor-centered structure in TLD. Based on past course evaluations, both American history instructors may be judged as very engaging and dynamic lecturers. However, our instructional model placed students at the center of six PBL learning experiences, prompting them to work together in a social learning dynamic to define the problem/issue as multidimensional, gather relevant information, argue multiple perspectives or positions, posit and select solution alternatives, consider how change might affect the solutions chosen, and then reflect on the thinking systems they practiced during activities. The ESQ question defined engagement as "active participation," which aligned more closely with the social learning dynamics experienced by PBL students compared to the more teacher directed lecture/discussion method and the *Taking Sides* activities experienced by the TLD students.

We believe the higher level of engagement among PBL students in general may have impacted their perception of course content relevance. As well, PBL students were confronted with current domestic political/social issues during the last unit of their course and developed solution alternatives for these issues, which prompted them to relate course content utilized in previous activities and topics to issues that more directly affect their lives.

In summary, we believe the first-year learning community offers an epistemologically aligned learning environment to promote cognitive growth, specifically, postformal thinking through PBL and metacognitive reflection. Our PBL model is explicitly designed to take advantage of the critical period of cognitive development associated with the late adolescence and the first year of college by guiding students to recognize and practice postformal thinking skills, skills that are necessary to effectively confront the complex challenges they will face as they continue their academic careers and to effectively deal with the complex and often contradictory issues they will inevitably face in their lives in general. We are hopeful that our pilot study will provide faculty, staff, and administrators in first-year and LC programs with a different and useful perspective on the impact of PBL and cognitive scaffolding on the development of advanced thinking skills among students, a common general education goal of most colleges and universities.

The Coverage Challenge

One challenge with PBL and many other learner-centered lessons is that they typically take more instructional time than covering the same material in a lecture. Weimer (2013), in her essays on learner-centered teaching, points out that the desire by faculty to cover all of the content in courses "strongly influences, if not dictates, most instructional decisions" (p.46). She suggests learner-centered objectives. A "less is more" instructional mindset helps facilitate PBL instructional planning toward a deep teaching approach through which students construct deeper understandings of content and develop applicable domain specific and broader cognitive skills (Wynn, 2010; Wynn, in press). For example, rather than a strict chronological coverage approach, the focus of PBL activities in all three PBL courses in this study was immersion in key turning points in American history. Gateway/survey course instructors are often hesitant to break away from a strict coverage model; we hope the results of our study will prove persuasive.

Limitations

There are a number of threats to internal validity. Intact classes were used, which may have led to biased or otherwise differential self-selection. Three

different instructors participated in the study, possibly leading to the occurrence of uncontrolled extraneous events. Further, our measures rely on students' self-reports, which may have resulted in answering in a perceived socially acceptable way. Since the study was conducted in history sections, the work may not be generalizable to other subjects. Research participation was low in the three TLD sections, with only 35 of 150 students completing useable questionnaires. Relatedly, the number of participants in the study in general was too small to show significance using multivariate analysis.

Implications for Practice and Future Research

Our instructional model was constructed using learning theory and has proven, within the limitations of our study, to have greater effects on thinking skills, engagement, and content relevance when compared to traditional instruction. In order to develop postformal problem-solving skills, students must be able to recognize inherent thinking systems. 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 metacogntive reflection questionnaire provided in Appendix B 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.

Our future research plans include a second iteration of the current study with a larger number of participants in the control group sections of the American history course, as well as incentives for completion of all questionnaires. The second study will include the forced-choice version of the Social Paradigm Belief Inventory (Kramer, et al., 1992), along with the PFT questionnaire, to expand the measurement of participants' level of postformal thought. We also plan to extend the application of our mixed method direct content analysis to video recordings of all three phases of PBL activities to identify student comments that indicate postformal operational characteristics. In addition, we plan to share our results with colleagues from other fields who teach survey courses or courses with high withdrawal and failure rates with the hope of convincing them to modify their approaches in ways that are more student-centered both in terms of methods and content.

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Appendix A
HIST 2112 PBL LC and PBL History Instructional Units

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 War Era and Beyond - 1945 to Present

Unit 6 - The Cold War and Beyond

Unit 7 - 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 8 - Challenges of the New Century
PBL Activity – *Student Decisions on Current Issues: The Affordable Care Act; Immigration Reform; Debt, Spending, Taxes, and a Balanced Budget Amendment; Climate Change and Cap & Trade*

Appendix B
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 made a decision on this problem/issue. (Intuitive Thinking)

   1 2 3 4 5 6

2. I used logical-analytical thinking (application of logical operations) to develop a correct solution as I made a decision on this problem/issue. (Formal Thinking)

   1 2 3 4 5 6

3. I considered context, multiple causes, multiple points of view, and conflicting 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

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

   1 2 3 4 5 6

5. I recognized that often there is no “correct” answer when dealing with complex problems/issues like this one. (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?

Appendix C

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 D
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).

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 E
Operational Definitions: Closed Systems and Postformal Operational

Closed Systems can be identified by the following characteristics:

- Focus on a limited number of aspects to the exclusion of other potentially useful aspects
- Use of a familiar problem solving framework
- Expectation of a single right answer applicable to all similar circumstance

Analytical/Formal (Closed Systems) Problem-Solving - A closed systems problem-solver will generally apply a practiced systematic/formal problem-solving framework based on previous experience with similar problems to solve the problem at hand. This framework involves a problem-solving dynamic based on a limited number of variables, with other important aspects of the problem often judged as irrelevant to the solution. This causes formal thinkers to expect to produce a single right answer that will apply to all similar circumstances.

People are using Postformal Problem-Solving when they recognize some or all of the following:

- What is considered to be true can change when perspective and context change
- Contradictions are often critical to understanding the complexities of a problem
- The sides surrounding contradictions are interrelated and must be accommodated in the development of resolution alternatives
- Some problems and issues don't have simple and neat solutions
- Even though a solution to a messy, real-life problem is identified, there will always be new challenges as the world and the people involved change.

Relativistic thinkers recognize that, as a person's perspective or context changes, so too does her/his perspective on what is true. Rather than seeing problems and issues through the lens of fixed truths and/or good vs. bad, relativistic thinkers recognize that context and contradictions are key to understanding the complexities of a problem, developing potential resolution alternatives, and recognizing the fact that no resolution may be possible for some problems and issues. Dialectical thinking involves the integration of relativistic thinking with the recognition that both sides of contradictions within a problem/issue are not only interrelated and connected but are also critical in the development of resolution alternatives. Inconsistencies and contradictions within problems and

issues become catalysts in the application of multiple cognitive systems as dialectical thinkers seek resolutions that lead to higher levels of understanding and cognition. Dialectical thinkers also recognize that any resolution or stability that may result from dialectical problem-solving operations will be perpetually challenged by new challenges, changes, and a potential tension to resolution to tension dynamic.