Facilitating Advanced Thinking Skills through Problem-Based Learning

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Facilitating Advanced Thinking Skills through Problem-Based Learning

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Kennesaw State University
The Association of American Colleges and Universities established principles and guidelines for developing general education curricula and experiences that guide students toward
demonstrable, portable proficiencies aligned to widely valued areas of twenty-first century knowledge and skills, including the development of sustainable problem-solving skills through problem-centered work on significant issues relevant to their interests and aims (p. 3).

Our research focuses on the extent to which problem-based learning (PBL) in a learning community/history survey context can promote these proficiencies and the inherent advanced thinking skills, specifically postformal thinking.
Adolescent Cognitive Dynamics and Problem-Solving

Most Adolescents Use Dual System of Cognition When Problem-Solving

- Intuitive/Emotional Thinking (If it feels right, it’s right!)
- Formal/Analytical Thinking (often characterized by a “closed systems” approach that is absolutist in nature and often based on prior similar situations)

Example: John is known to be a very heavy drinker, especially when he goes to parties. Mary, John’s wife warns him that if he comes home drunk one more time, she will leave him and take the children. Tonight John is out late at an office party. John comes home drunk. Does Mary leave John? Closed systems response?
Recognizing the inadequacy of a formal/closed systems approach to problem-solving, what is a better approach? A postformal/open systems approach

Postformal Thinking Level 1 = Relativistic Thinking

**Relativistic Thinkers:**
- expand the lens of problem-solving beyond fixed truths or good versus bad;
- realize that context, complexities, and contradictions are key to understanding a problem/issue and central to developing possible resolution alternatives;
- recognize that some problems/issues may not have workable solutions.
Postformal Thinking Level 2 = Dialectical Thinking

Dialectical Thinkers:

• *combine* relativistic thinking with the recognition that contradictions within a problem or issue are interrelated and connected;
• use inconsistencies and contradictions as catalysts for problem-solving;
• seek to determine why opposing sides believe what they believe;
• use this knowledge to develop resolution alternatives;
• recognize that on-going changes will challenge any stability or solution reached and will often produce a tension-to-resolution-to-tension cycle dynamic.

• Does Mary leave John?  Postformal Response?
PBL can be a Catalyst for Cognitive Growth

- **Confronting** students with historical problems and issues allows instructors to guide them from formal (analytical/absolutist) thinking toward the practice and development of postformal (relativistic/dialectical) thinking skills.

- **Scaffolding Processes:**
  1. **Guided Contextualized Historical Thinking Activities:** Students gain and apply historical background knowledge to construct a more accurate and more useful interpretation of the historical problem at hand.
  2. **Guided Practice of Specific Thinking Skills:** Guiding students to practice postformal skills during PBL activities is key to helping them develop and sustain advanced thinking skills.
  3. **Guided Metacognitive Reflection and Debriefing:** Prompting students to recognize and reflect upon the postformal skills they’ve practiced helps them internalize those skills for future use.
Details of Our PBL Model

Step 1 – Introduction of the Problem: The primary focus in Step 1 is to peak student interest (create a need to know more), establish “stakeholdership,” and explicitly portray the problem/issue as multidimensional with multiple truths.

Step 2 – Initiation of PBL Events: Argumentation and Student Inquiry: Step two includes a decision-based/argumentation structure in which students generate arguments, and work to recognize conflicts and contradictions among competing positions.

Step 3 – Problem Solution: Students generate solutions/decisions and examine their “fit,” then propose the most appropriate one and evaluate its historical or potential consequences.

Step 3 ends with a guided reflection on the types of thinking strategies utilized by students, and the successes or failures of each through the use of a metacognitive reflection questionnaire.
Debriefing: Guiding Metacognitive Reflection

- Which thinking systems did you use during the problem/issue-based activity?
  - Intuitive?
  - Formal/Analytical?
  - Relativistic?
  - Dialectical?
  - Domain Specific (i.e. Contextualized Historical Thinking)?

- Which systems were more useful or successful for you during the activity and why?

- MRQ (See research articles)

• This metacognitive reflection process helps guide students to develop a cognitive self-awareness related to complex problem-solving/postformal thinking.
PBL Activities

Activity 1: The Question of U.S. Expansion: Expansionists v. Anti-Expansionist

Activity 2: Wilson and the Paris Peace Conference: Constructing the Treaty of Versailles

Activity 3: Solving the Problems of the Depression: Constructing the New Deal

Activity 4: Using the Atomic Bomb: Truman’s Decision

Activity 5: The Issue of Affirmative Action: The Atlanta Case

Activity 6: Current Issue Presentations

*Patient Protection and Affordable Care Act (P.L. 111-148)
*Debt Reduction, Federal Spending, Entitlements, and Taxes
*Immigration Reform
*Energy Policy (Cap and Trade)
*Minimum Wage
Video Clip – Maka Island PBL Activity
Overview of Research Model and Results

Study 1 – (2013-2014)
Study 2 – (2014-2015)
Research design – Study 2
Curricula and subjects (fall of 2014 mimics fall of 2013)
- Two learning community sections consisting of a survey American history taught using PBL methods plus first-year seminar
  - A first year seminar including learning and motivation strategies, citizenship, and opportunities to reflect on the PBL activities
  - Both curricula were taught by research team members
  - Totaled 47 students (43 participants)
- A section of the same survey American history course (stand alone)
  - Taught using the same PBL methods by the same research team member from the learning community
  - 40 students (36 participants)
- Two sections of the same survey American history course
  - Taught using traditional lecture and dissertation (TLD) by a colleague
  - 224 students (118 participants)
Quantitative methods and measures

- Postformal thought questionnaire (PFT)
  - 10 statements representing different postformal thought operations
  - 7 point Likert scale indicating the degree to which the statement represented student thinking
  - Administered pre- and post course
  - Mean gain and normalized gain scores (actual/possible) and ANOVA were used to compare groups in Study 1, independent t-test and mean gain and normalized gain scores (ANOVA) were used in Study 2 to compare PBL and TLD groups.
  - Questions 1 and 3 of the end of study questionnaire (ESQ) rated by students using 5 point Likert scales
    - Q1 – level of engagement with the history class
    - Q3 – level of relevancy of the content of the history class
  - Dichotomous scores (0=no; 1=yes) and ANOVA were use to compare groups in Study 1, independent t-test of means was used to compare groups (PBL and TLD) in Study 2.
Research design (continued)

- Mixed methods and measures
  - Directed content analysis (deductive category application) was used to define two operational definitions of problem solving systems
    - Closed systems (CS)
    - Postformal operational systems
  - Questions 4 and 5 of the end of study questionnaire (ESQ) were open ended and were coded by two researches and two student researchers and the results were analyzed for validity by a third researcher (3 of 4 agree at 75% level)
    - Q4 – ability to think critically as a result of the course
    - Q5 – utility of thinking skills gained in education and beyond
Postformal thinking results – Study 2

Pretest PFT independent t-test means of the PBL sections (n = 64) and TLD sections (n = 109) indicated that there were no significant difference in PFT scores at the beginning of the study.

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>M</th>
<th>STD</th>
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</thead>
<tbody>
<tr>
<td>PBL Sections</td>
<td>64</td>
<td>50.77</td>
<td>7.61</td>
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<tr>
<td>TLD Sections</td>
<td>109</td>
<td>51.12</td>
<td>6.32</td>
</tr>
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</table>
Postformal thinking results – Study 2 (cont.)

Posttest PFT independent t-test means of the PBL sections \((n = 64)\) and TLD sections \((n = 109)\) showed significantly greater PFT scores for the PBL group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>(n)</th>
<th>(M)</th>
<th>STD</th>
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<tr>
<td>PBL Sections</td>
<td>64</td>
<td>54.52</td>
<td>6.45</td>
</tr>
<tr>
<td>TLD Sections</td>
<td>109</td>
<td>51.76</td>
<td>8.02</td>
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</table>

One way ANOVA for normalized gain scores showed a significantly greater net mean gain of 3.75 between pre- and posttest PFT scores in the PBL sections compared to a .64 mean gain in the TLD sections \(F(1, 171) = 8.84, \ p < .003,\) and a significantly greater normalized gain in the PBL sections (.079) than TLD sections (.025), \(F(1, 171) = 5.85, \ p < .017.\)

*We also analyzed PFT data to determine if there were mean gain differences between the smaller PBL learning community sections and the regular PBL section. There was no significant difference, with net gain means of 3.23 and 4.38 respectively.
Independent t-test means of the direct content analysis of ESQ Q4 (ability to think critically as a result of the course) showed a significantly greater mean of self-reported postformal thinking experiences in the PBL sections than in the TLD sections.

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<th>Variable</th>
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<tr>
<td>PBL Sections</td>
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<td>.87</td>
<td>.34</td>
</tr>
<tr>
<td>TLD Sections</td>
<td>118</td>
<td>.24</td>
<td>.48</td>
</tr>
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</table>

\[ t(193) = 10.95, p < .000 \]
Student comments on the impact of PBL on their thinking (ESQ question 4)

The common themes noted from PBL student comments included their ability to recognize and better understand multiple truths or perspectives when confronted with a complex problem or issue, and the importance of utilizing multiple perspectives in the problem-solving and decision-making process. PBL students also recognized the applicability of postformal thinking systems beyond the confines of their U.S. history survey course.

- Student #19-PBL Section 1 - “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.”

- Student #39-PBL Section 2 – “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.

- Student #85-PBL Section 3 – “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.”
One way ANOVA data of the net postformal gain scores of students in the three curricular variables. Gains were significantly greater in the PBL LC, which were greater than the gains in the PBL History sections. PBL History had significantly greater gains than the Control (TLD History)

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>Mean</th>
<th>F</th>
<th>Sig.</th>
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</thead>
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<td>PBL LC</td>
<td>2</td>
<td>4.25</td>
<td>4.23</td>
<td>.017</td>
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<td></td>
<td>103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PBL History</td>
<td></td>
<td>2.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLD History</td>
<td></td>
<td>0.29</td>
<td></td>
<td></td>
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</table>
One way ANOVA data of the normalized postformal gain scores (total potential gain realized) of students in the three curricular variables.

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<th>df</th>
<th>Mean</th>
<th>F</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>PBL LC</td>
<td>2, 103</td>
<td>.094</td>
<td>4.56</td>
<td>.013</td>
</tr>
<tr>
<td>PBL History</td>
<td></td>
<td>.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLD History</td>
<td></td>
<td>.008</td>
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</table>
Postformal thinking results – Study 1 (cont.)

One way ANOVA data of responses to questions 4 and 5 on the end of study questionnaire with 1= an indication of postformal thinking and 0=no indication of postformal thinking. The hierarchy observed with PFT gain scores is also observed with these data

<table>
<thead>
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<th>df</th>
<th>Mean</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBL LC</td>
<td>2</td>
<td>0.95</td>
<td>13.6</td>
<td>.000</td>
</tr>
<tr>
<td>PBL History</td>
<td>0</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLD History</td>
<td>0</td>
<td>0.43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Course engagement – Study 2

Independent t-test means of the direct content analysis of ESQ Q1 (level of engagement or active participation – 5 point Likert scale with 5 being fully engaged) showed a significantly greater mean of self-reported ratings in the PBL sections than in the TLD sections.

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<th>M</th>
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</thead>
<tbody>
<tr>
<td>PBL Sections</td>
<td>78</td>
<td>4.25</td>
<td>.73</td>
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<tr>
<td>TLD Sections</td>
<td>116</td>
<td>3.29</td>
<td>1.06</td>
</tr>
</tbody>
</table>

$t(191) = 6.87 \ p < .000$
Course engagement – Study 2 (cont.)

Comparison of PBL and TDL student comments to their self-rating for ESQ 1 (level of engagement or active participation) who rated themselves level 4 or 5 (fully engaged) demonstrated a difference in how students defined engagement

◦ e.g. PBL student #125: “I was actively forming opinions on subjects through information presented by classmates as well as by my instructor, unlike previous courses I have taken where all information presented comes from a singular source, the teacher.”

◦ e.g. TDL student #136: “I came to almost every class this semester except maybe two. I take notes and have done well on tests. If I wasn’t engaged, I would not being doing well.”
Perceptions of content relevance – Study 2

Independent t-test means of the direct content analysis of ESQ Q3 (content relevance – 5 point Likert scale with 5 being very relevant) showed a significantly greater mean of self-reported ratings in the PBL sections than in the TLD sections.

<table>
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<th>M</th>
<th>STD</th>
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</thead>
<tbody>
<tr>
<td>PBL Sections</td>
<td>78</td>
<td>4.77</td>
<td>.51</td>
</tr>
<tr>
<td>TLD Sections</td>
<td>116</td>
<td>4.13</td>
<td>1.24</td>
</tr>
</tbody>
</table>

$t(191) = 4.24 \ p < .000$
PBL student comments on content relevance (ESQ question 3)

The PBL course was designed to guide students not only to connect the past to the present, but also to apply the advanced problem-solving skills gained through confronting contextualized historical problems to current issues, including:

• The Affordable Care Act;
• Immigration Reform;
• Debt, Spending, Taxes, and a Balanced Budget Amendment;
• Climate Change-Cap and Trade;
• and Minimum Wage.

In general, PBL student comments indicated that their high ranking of content relevance was due to their recognition of this dynamic.

• For example, PBL student #19 stated, “In this class we have dealt with immigration, civil rights, and even ISIS. It [content] was very relevant because we dealt with these topics using the same lens as we did when dealing with historical events.”
Conclusions, Discussion, and Implications for General Education
Conclusions – Study 2

The results of this study (Wynn, et al., 2016) confirm the findings of our previous study (Wynn et al., 2014)

Our PBL instructional method, which includes metacognitive reflection, has a significant relationship with the development of postformal thinking skills compared to a TLD method in a U.S. History survey course context.
Basseches (2005) and Sinnott (1998) argued that individuals must be confronted by the diverse perspectives, multiple truths, and contradictions inherent in complex problems and issues in order to first recognize the inadequacy of formal/absolutist thinking, and second, to begin seeking more adequate/advanced thinking systems.

- Our PBL model was designed prompt metacognitive reflection to guide students toward the recognition and practice of multiple thinking systems and to judge the extent to which these systems are adequate for successfully addressing complex problems and issues.

- After an initial thinking systems tutorial at the end of the first PBL activity, followed by the administration of the metacognitive reflection questionnaire after each of the first three PBL activities, most students began recognizing the dynamics of intuitive, analytical, relativistic, and dialectical thinking without the use of the questionnaire.

- We believe this working knowledge of the multiple thinking systems practiced in advanced problem-solving helps explain the greater postformal thinking gains among PBL students.
Recommendations

Class Size and Content Coverage

The social learning dynamics that are so critical to the success of PBL activities are more easily facilitated in smaller classes (Wynn, 2010, 2015; Wynn et al., 2014).

- TLD student #163 framed the impact of class size on engagement in the following comment on ESQ question one: “It is hard to be fully engaged in a course that covers so much material and has such a large class size. We are only given the ability to take notes and give a few responses.”

- We concur with this observation and recommend that the chronological coverage approach be significantly adapted to accommodate a workable number of activities if instructors want to implement PBL.

- Each instructor should select “turning-point” problems and issues on which to develop PBL activities, and should determine the number of activities to include, recognizing that confronting students with multiple problems or issues may be necessary to facilitate more adequate and sustainable thinking skills.

- We recommend a maximum 40-student class size for PBL sections.
Recommendations

Current Issues

• We also recommend that current issues be included as the basis of PBL activities during the last phase of a PBL-based U.S. History II survey course; students may apply the postformal problem-solving skills to current issues in the manner that they practiced with historical issues.

• PBL student comments on ESQ question three clearly indicated that students attributed content relevance, in part, to their engagement with contemporary problems and issues that may directly affect their lives.

• This focus also aligns well with the AAC&U (2015) general education principle cited earlier regarding students gaining proficiencies “through problem-centered work on significant issues relevant to their interests and aims” (p. 3).

• Confronting current issues may also help students recognize the applicability of postformal thinking systems and even historical inquiry, beyond the confines of their U.S. history survey courses.
Limitations

• Two different instructors taught the PBL and TDL sections, possibly leading to the occurrence of uncontrolled extraneous events.

• The relatively small sample size in both the PBL and TLD sections may limit the generalizability and utility of the findings.

• The large class size in both TLD sections could affect the success of TLD instructors facilitating more advanced thinking skills, engagement, and perceptions of content relevance among students.

• Studies measuring outcomes in PBL and TLD sections of similar size should be conducted. We also note the fact that the two smaller PBL sections were affiliated with learning communities, which may be a confounding variable.
Challenges and Implications for General Education

• Time Developing PBL Activities
  • Convincing colleagues that less coverage and more of a PBL focus on key turning points in history really may help facilitate deeper, more meaningful learning, and the development of more advanced thinking skills.
  • We recognize that U.S. history survey course instructors, and survey course instructors in general, 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 is offered to introduce the thinking systems involved in problem solving and decision making and to facilitate reflective discussions. Instructors do not have to be experts to guide the process.
Challenges and Implications for General Education

We encourage other SoTL scholars in history and other disciplines to test the impact of PBL and metacognitive reflection on their survey course students.

As stated earlier, AAC&U (2015) is calling for problem-based college curricula to guide students toward the development of useful and sustainable problem-solving skills.

We believe general education curricula should provide meaningful and relevant experiences that promote demonstrable and sustainable proficiency in postformal thinking.

We offer our PBL instructional model as an option that survey course instructors may use to facilitate these skills.

In this time of intense political polarization, and given the ever-increasing issues that affect the well-being and security of all of us, such cognitive and deliberative capacities are sorely needed.
Questions and Links

Presentation Slides: [http://tinyurl.com/PBL-Thinking-Skills](http://tinyurl.com/PBL-Thinking-Skills) - Password: Wynn1

PBL Activities: [HIST 2112 PBL Activities](http://histr2112.pblactivities.com) - Password: Wynn1

Research Articles: