A GUIDED PROBLEM-BASED LEARNING (PBL) APPROACH USING A REVERSED TEXTBOOK: AN APPLICATION TO A CORE BUSINESS ANALYSIS COURSE.

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ABSTRACT

We implemented a guided problem based learning (guided PBL) approach to teach a core business analysis course to study its effectiveness in improving learning, with special regard to critical thinking skills. To aid this approach in class, we created a reversed book that presents problems first, with blank space for students to work out problems or analyze and answer conceptual questions. Students attempt to answer questions or solve problems in class with instructor guidance as needed, before discussion of theory. We compared student learning in sections taught prior to implementing this method with those taught with this method. We found that this approach motivated the students and improved their performance on a departmental final exam by about 9% on average, or almost one letter grade. When measured on Critical Thinking questions alone, the improvement was roughly 24% on average. Finally, it also improved group task performance by 6%.

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INTRODUCTION

Improving a student’s critical thinking (CT) ability is considered an important aspect of teaching at the university level by most educators today. However, pedagogical literature suggests that there is some disagreement about what exactly CT is, and that it is used too broadly to get a clear idea of how to measure it, and therefore to know how effectively it is being taught (Lloyd & Bahr, 2010; Williams, 1999). Despite some disagreement on the definition of critical thinking, there are some accepted elements of CT that most researchers do agree upon. These include the ability to think deeply about an issue, to consider evidence for and against a proposition, and to apply reasoning skills and logical inquiry to arrive at possible conclusions. Garcia & Pintrich (1992) found that critical thinking among students in university courses is positively related to the intrinsic motivation of the students regarding learning that subject. Nargundkar & Shrikhande (2012) found that instructors that are able to motivate students better tend to be more effective in helping them learn.

Van Gelder (2005) argues that critical thinking is not a natural activity for humans, and cites Michael Shermer (2002) as saying that humans are pattern-seeking, story-telling animals that prefer simple, familiar patterns over the harder cognitive task of CT. Van Gelder (2005) further suggests that the problem with teaching critical thinking is that many teachers discuss the theory of CT rather than have their students practice it. This is ineffective, he argues, since the only way to improve CT ability is to practice doing it, as with any other skill. Bensley (2010) argues that simply providing challenging course work does not ensure that students will learn to think critically. He suggests that explicit, direct instruction of CT skills is necessary. He provides several tips for instructors to achieve this, including, once again, the idea that students must first be motivated to engage their minds with the material. Second, CT objectives must be clearly stated for the course. Meyer (2004) found that CT practice among students must be guided to be more effective.

Our approach in this study has been to implement a guided problem based learning approach in a core business analysis course for undergraduate students. The approach used is comprehensive, starting with appropriate objectives, a redesigned textbook to aid the practice of CT in the classroom, and assessment methods consistent with the pedagogy. The key research questions we wanted to answer were:

1) Does this method help students perform better overall? and
2) Does this method improve critical thinking ability in the subject?

LITERATURE REVIEW

Instructors that teach a core class in a curriculum typically run into the problem of unmotivated students, whose approach is characterized by reluctance to study a subject they perceive as not relevant to them, since they did not actively choose that course and were instead required to take
it. The motivation for such students then becomes purely extrinsic, a quest for the best grade with the least effort. Ryan & Deci (2000) argue that an effective instructor can move the student from reluctance to an acceptance of the goals set by the instructor, and even internalize them eventually. Effective teaching is thus about convincing the students about the value of the goals set, making the course relevant to the students’ lives, and thereby motivating them to engage their minds fully with the subject. Nargundkar & Shrikhande (2012), in a study of business school students, found that along with course organization and clarity, the ability to motivate students is among the most important factors that determine the millennial students’ perceptions of effective teaching.

Several approaches have been suggested in the literature to help motivate students, and one such approach is Problem-Based Learning (PBL). This constructivist approach leads to a couple of basic principles. One, anchoring learning to a larger task, and two, helping students take ownership of the learning (Savery & Duffy, 2001). The concept of designing courses and curricula around PBL has been applied in several fields of study including Engineering, Social Sciences, and Business. Norman & Schmidt (1992) reviewed the evidence and found that PBL can result in increased retention of knowledge over a longer period of time, enhances interest in the subject matter, and increases self-directed learning. The increase in problem solving ability is content specific, meaning that there is not enough evidence that the approach increase general problem solving ability in other areas than the one where the approach is used. Kirshner, Sweller & Clark (2006) on the other hand, based on their understanding of human cognitive architecture, argue that methods of instruction like PBL that include minimal guidance from the instructor are bound to be less effective than guided instruction. They recommend worked examples, which they consider to the epitome of guided instruction, to help novices learn effectively. Meyer (2004) also argues strongly against purely constructivist approaches to teaching, where the discovery of knowledge is left entirely up to the student. He cites research over three decades to emphasize the idea that a guided approach to discovery works better.

The research studies mentioned above suggested to us that for teaching a core class where students come with almost no prior knowledge of the subject, and likely with low motivation to learn it, a purely unguided PBL approach would probably not work. However, the traditional approach of lecture, followed by worked examples and then assignments does little to motivate the students to study a subject they are not interested in. The guided PBL approach provides an appropriate middle ground.

**IMPLEMENTATION OF GUIDED PBL IN THE CLASSROOM**

We implemented this approach to teaching in a course titled Business Analysis, a core course for undergraduate business students. The course objectives, broadly, are to help students learn how to analyze business situations, apply quantitative models as needed with the aid of spreadsheets, and interpret model results to support business decision making (a course like this may typically be labeled Decision Sciences in many institutions). Students are evaluated, among other things, on the basis of a departmental final examination that includes questions at various levels of learning, including CT. Students are also required to work on two projects during the semester where they demonstrate their ability to analyze a business situation, build spreadsheet models for profitability analysis and forecasting, and write a report detailing their analyses and
recommendations. This task requires students to demonstrate critical thinking in the business domain. However, left alone to pursue that, they would not have the skills to do so. We use a guided PBL approach to help students develop the skills needed.

In order to implement the guided problem solving method in the classroom, we added one key innovation – a reversed textbook that we created. Typical texts begin with general explanations, usually abstract, show some examples of worked problems, and then have exercises at the end of the chapter. Thus, a traditional textbook encourages instructors to follow an order of instruction that begins with a straight lecture on the concepts, definitions, procedures, formulas, and then move towards practical application. This however, is contrary to the idea of Problem Based Learning, which requires that a problem be introduced first. Our innovation, therefore, was to create a book that began with questions, and had blank space for students to answer conceptual questions or attempt to work out the problems. The second half of the book had some theoretical discussion, detailed answers to the conceptual questions, as well as the solutions to the problems. In essence, this book enables the instructor to reverse the order of instruction in the classroom to motivate learning.

A typical class session might begin with a business situation (please see General Motors problem in the Appendix as an example). Students are introduced to the general situation, and immediately asked to attempt to solve a certain problem in the book (or discuss a conceptual issue). The instructor makes a deliberate effort to guide the students by offering insights on the problem relevance and value that can be created by solving it. However, no specific explanation is provided as to how to do it. When the semester begins, the problems are usually of a kind that about half the class might be able to solve using their prior knowledge of algebra and general business sense. Students are then encouraged to talk with their neighbors in class to see if together they can solve the problem. They are aware that the answers are available in the back, but are encouraged not to look at the answers. After a few minutes, the instructor discusses the problem and the solution with the entire class, and helps them to think about how it might apply in various business situations, as well as providing any theoretical underpinnings as needed.

**HYPOTHESES**

Based on the literature in this area we would expect that students will perform better overall in the course due to increased motivation to learn.

**H1:** The introduction of the Guided PBL approach with the Reversed Textbook will improve student learning.

Similarly, we expect that students will display improved critical thinking skills individually as a result of having practiced it in the classroom and outside of it via assignments in the book designed to help them do so.

**H2a:** The introduction of the Guided PBL approach with the Reversed Textbook will improve critical thinking at the *individual* level.
Individual critical thinking skills do not necessarily translate to improved teamwork. Star individuals may in fact perform poorly on teams since a star may tend to be domineering and alienate team members. Other factors such as lack of cohesiveness of the team or free-loading by other members may counteract any improvement in individual ability. However, as part of the in-class instruction for this course, cooperation was encouraged in class discussions in an effort to build teamwork. We therefore hypothesize that this approach to teaching will improve performance in the group project tasks as well, since each student would presumably have better CT skills to contribute.

H2b: The introduction of the Guided PBL approach with the Reversed Textbook will improve critical thinking at the group level.

METHODOLOGY

We conducted a controlled experiment to test the effectiveness of this method. We applied this method of teaching to a core Business Analysis course that has multiple sections offered throughout the year. We compared the final examination scores for students who did or did not receive this method of teaching. The final examination has questions at different levels of learning: Knowledge, Comprehension, and Critical Thinking, based on Bloom’s taxonomy. To eliminate the variations due to instructor, we collected data on sections taught by the same instructor. To control for student ability differences, a pretest was conducted at the beginning of the semester for all the Before and After sections. No statistically significant difference was found, ensuring that student ability was controlled for.

To address the first hypothesis, we looked at the overall final examination performance of students in four sections (n=154 students across all sections) of the course taught in the year before the new method was implemented and three sections (n=114 students across all sections) in the year after the implementation. For the rest of the paper, we refer to these groups of students as the Before and After groups.

For hypothesis 2a, it was necessary to look at the students’ individual performance on critical thinking tasks. We looked at the performance of students on the final exams only on questions that were rated by the instructors as being at a critical thinking level.

Students in this course are also assigned two group projects (groups of 3 or 4 students) that require application of the concepts taught in the course to a real-life situation. Students conduct spreadsheet analyses and write a report that demonstrates their critical thinking abilities. For Hypothesis 2b, we compared the Before and After student scores on the projects.

ANALYSIS AND RESULTS

H1: We conducted a two-sample t-test to test for differences in the final exam scores of the Before and After sections. The results are shown below:

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>154</td>
<td>114</td>
</tr>
</tbody>
</table>

671850-5
<table>
<thead>
<tr>
<th>Mean Departmental Final Exam Score</th>
<th>68.44</th>
<th>77.02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Deviation</td>
<td>11.99</td>
<td>11.34</td>
</tr>
</tbody>
</table>

\[ p < 0.0001 \]

H1 was thus supported. As the table above shows, in the year prior to using this approach, the average student score in our sections on the departmental final exam was around 68%. The average final exam score climbed to about 77% in the year after implementing this method of teaching, and has consistently remained at that level for about 5 years since. This is an improvement of almost one letter grade on average.

**H2a:** On average, 20% of the questions on the final examination require some critical thinking ability. The results of the average student performance on these questions are shown below:

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>154</td>
<td>114</td>
</tr>
<tr>
<td>Mean Score on critical thinking questions only</td>
<td>34.9%</td>
<td>58.0%</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>24.8</td>
<td>18.5</td>
</tr>
</tbody>
</table>

\[ p < 0.0001 \]

H2a was thus supported. The results show that student performance on critical thinking problems did improve significantly due to the guided PBL approach.

**H2b:** Data were also collected on student performance on the team projects, and the results of the comparison for the *Before* and *After* groups are shown below:

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>154</td>
<td>114</td>
</tr>
<tr>
<td>Mean Score on critical thinking questions only</td>
<td>79.6%</td>
<td>85.7%</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>5.5</td>
<td>4.9</td>
</tr>
</tbody>
</table>

\[ p < 0.0001 \]

H2b was thus also supported by the data. Critical thinking ability in group tasks showed significant improvement.

**DISCUSSION**

Improving critical thinking ability is undoubtedly one of the key goals of most educational institutions. However, the results generally seem to be lacking, based on some recent studies. According to a Taylor (2010), a Wall Street Journal survey of college recruiters, critical thinking is an area most in need of improvement among college graduates.

Many universities are making efforts in various disciplines to improve critical thinking among students through a variety of initiatives. Aside from active learning techniques within a class, ideas like interdisciplinary courses are being implemented, to mimic more of what a student is likely to encounter after college. Real-life issues in business rarely restrict themselves to a single
domain. One may need a combination of leadership skills, analytical ability, and knowledge of finance, for instance, in tackling a particular problem. However, students typically learn these topics independently of each other, and many never make the connection between them. Making each class more relevant by discussing all aspects of a real situation (even if the focus of the course is on one particular aspect) can make the whole learning process more relevant and meaningful to students.

We found that the guided PBL approach we used worked well in terms of engaging the students with the materials presented with help of reverse book. Besides the objective data on student performance, we received several positive comments from students regarding this approach to teaching overall, as well as the reversed textbook. Overall effectiveness scores on student evaluations of instruction also improved significantly.

**Potential Use by Other Faculty**

We believe that this approach is easily usable by faculty in any field. While the basic PBL approach is not new, we made sure we provided sufficient guidance to students to make it less daunting in a core course. The key innovation was our creation of the book that presented problems first. We found that the book helps students overcome any fear of trying to solve unfamiliar problems on their own, since they know they have the answers anytime they want. It frees the instructor to play the role of relating the concepts to student’s lives and the business world, achieving the tasks of anchoring problems to the real world as well as encouraging students to take ownership of their learning.

**REFERENCES**


APPENDIX

Without any prior discussion of any theoretical approach, the class is asked to solve a business problem like the following one.

**GM is considering designing a new automobile. Their options are a design based on current gasoline engine technology as well as a government proposed “Green” technology. The development costs and the wholesale price (all in thousands of dollars) of the cars are as shown in the table below:**

<table>
<thead>
<tr>
<th></th>
<th>Gasoline Technology (numbers in $ thousands)</th>
<th>“Green” Technology (numbers in $ thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesale Price/vehicle</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Variable Cost/vehicle</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Fixed Cost</td>
<td>100,000</td>
<td>200,000</td>
</tr>
</tbody>
</table>

You are in the White House and want to encourage all automakers to adopt the “Green” technology. You cannot provide capital upfront for fixed (development) costs, due to political reasons. However, you can provide a subsidy to GM for every car sold. How large would you have to make the subsidy if the above numbers were true?

The problem uses a very recent economic and policy issue that motivates students to think about larger problems facing business and society. The instructor merely facilitates discussion and students are encouraged to make a decision/recommendation. They may approach the problem whichever way they want, and may interact with the professor and ask questions. Students work in iterations and by a bit of trial and error. The instructor provides guidance or asks questions in turn to keep class discussions focused on getting to the solution of the problem. Over the past five years, we have had the experience in our classes that there are always some students who will figure out how to solve the problem, and rest of the class very quickly catches up with them. They enjoy this self-discovery and get excited about tackling other similar problems.

This problem is formally known as a **Crossover Point** analysis. Without even introducing the term, if students are asked after solving the problem what they would call it, more often than not students do come with names that involve the words ‘cross-over’ and ‘level’ or ‘point,’ having understood that the essence of solving the problem is finding the point where two profit lines cross each other on a graph. The instructor then completes the discussion by asking students and/or illustrating other applications of this particular type of analysis, or alternate approaches to subsidies, like tax breaks for consumers.