# IMPROVING TEXTBOOK READING IN A MIDDLE SCHOOL SCIENCE CLASSROOM 

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#### Abstract

Ineffective approaches for teaching with print may prevent textbook reading from being a useful learning resource in middle school. University faculty mentored a middle school science teacher as he implemented a textbook study-reading approach, PLAN (Caverly, Mandeville \& Nicholson, 1995), in 2 classes $(\mathrm{n}=33$ ). PLAN orchestrates 4 strategies through student-created mapping. After 3 months of strategy use, students gained in a self-report of strategic reading and in comprehension as reflected by maps. Post-assessment interviews revealed that the teacher had changed his instructional routine, moving through stages of strategy awareness, understanding, and adaptation. The teacher changed his expectation that students would complete textbook reading and that it increased student learning. The students changed their expectation that they could read and learn from the textbook.


Although educators have long debated the role of the textbook for learning, in middle school the science textbook appears to be an important learning resource. According to the National Assessment of Educational Progress (2000), $80 \%$ of eighth grade science teachers reported using the textbook regularly. It may play a stronger instructional role in the classroom when student prior knowledge or the teacher's relative familiarity with the topic is low (Driscoll, Moallem, Dick, \& Kirby, 1994).

Weaknesses in textbook content and ineffective approaches for teaching with print may prevent textbook reading from being effective. The American Association for the Advancement of Science (2002) reported that science textbooks do a poor job of following standards-based principles for concept learning, a reason science teachers might avoid assigning
textbook reading. In a case study of a middle school science classroom (Driscoll, et al., 1994), the teacher presented textbook reading as the learning option for "book people," a style claimed by few students according to the study results. In this classroom other sources of learning, such as hands-on activities, seemed more valued. The textbook was used for definitional level learning while hands-on activities were used for problem solving. The students' low average score ( $59 \%$ ) on a unit test of facts and vocabulary suggested that using the textbook as a dictionary was not effective.

To address some of these issues, Haury (2000) recommended that science teachers help students adopt a purposive stance and a questioning attitude for textbook reading. This stance and attitude can be operationalized in the classroom as strategies for content area reading.

## The Effectiveness of Reading Strategy Instruction

A substantial body of research documents the effectiveness of strategic reading instruction for middle school students on their comprehension of text (Trabasso \& Bouchard, 2002). Explicit strategies prompt students to engage their prior knowledge and to monitor their comprehension. Despite evidence of the effectiveness of these strategies, a number of studies (reviewed by Pressley, 2002) report that few teachers use them in their instruction. To change their instructional routines, teachers likely need added support.

Teachers looking to follow Haury's (2000) recommendation for the science classroom will find little research to recommend the most popular strategy specific to study-reading with textbooks, SQ3R, as it has not shown advantages over traditional studying or students' existing approaches (Graham, 1982). A newer strategy for comprehending and studying textbooks called PLAN has been demonstrated to be effective with middle school students (Caverly, Mandeville, \& Nicholson, 1995). It orchestrates a repertoire of strategies that have been validated with upper elementary and middle school students: relating the text to prior knowledge, questioning, summarizing (Pressley, Johnson, Symons, McGoldrick, \& Kurikta, 1989), and using imagery and setting a purpose for reading (Brown, 2002). Specifically, PLAN begins with an assessment of the reading task demand, such as taking a chapter test or writing a paper. With the task for reading in mind, students predict ( P ) the content of the text and construct
a tentative map; locate ( L ) on the map what is known by placing checkmarks and what is not known by placing question marks; add (A) notes during the reading of the textbook to confirm checkmarks and to address the question marks, and note ( N ) a re-formulated understanding by revising the map, writing a summary, or performing any other task that might be aligned with the purposes for reading. In utilizing mapping, PLAN improves upon other strategic approaches to textbook reading. The value of student construction of concept maps has been well documented for the science classroom (Al-Kunified \& Wandersee, 1990).

The purpose of this research was to examine the effects of introducing the PLAN study-reading strategy into two middle school science classrooms taught by one of the authors of this study [Caverly], a middle school science teacher subsequently referred to as the teacher. First, we asked how this middle school science teacher would change his instruction over a school year as he was mentored in teaching with the PLAN strategy. Second, we asked whether his students were able to learn using PLAN. Finally, we wanted to know how students perceived their use of the strategy.

## Methods

The study followed a single-group pretest-posttest design that included multiple post assessments. This multiple post-test approach was used to strengthen the single-group design and because we expected a time delay between implementing the strategic reading strategies and generating benefits.

## Participants

Participants were the science teacher from a small, rural middle school and the fifteen seventh-grade and eighteen eighthgrade students in his two science classes. The teacher held a master's degree in biology and had more than three years of teaching experience. As the only science teacher for the school, he taught the same students for both fall and spring semesters. Students' scores on the district's recently administered STAR test of reading ability (Advantage Learning Systems, 1998) indicated mixed ability classes. Four students who scored third grade or below on the STAR test were eliminated from the data analyses, as they lacked basic decoding skills. The 29 students included in the analyses were categorized in roughly equal groups by gender and ethnicity (Anglo and Hispanic, though a few students were AfroAmerican).

## Data Sources

Three instruments were administered before and after four weeks of PLAN instruction by the teacher: (a) reading comprehension tests, (b) reading strategy checklists, (c) student-created concept maps. After nine months of strategy implementation, semi-structured interviews of the teacher and students were conducted and transcribed.

Textbook Chapter Reading Comprehension Tests. The teacher followed his regular instructional routine for creating chapter tests by selecting six questions from the textbook publisher's test bank. The test for one chapter served as the pretest and a test for a different chapter was the posttest. Each test balanced multiple choice, true-
false, and matching questions. The purpose of the tests was to assess students' comprehension of the textbook chapters.

Concept Maps. The students created concept maps based upon the science chapters that they were reading. These pretest and posttest assessments provided a second measure of reading comprehension and revealed information about the students' reading processes. The rubric to score these maps (see Appendix) was adapted from one developed by Stoddart, Abrams, Gaspar, and Canaday (2000).

Reading Strategy Checklist. We adapted a checklist developed by a colleague who had used it for many semesters with developmental college readers. Ten truefalse questions asked students about which strategies they used for reading a textbook chapter and for monitoring comprehension (see Appendix).

Field Notes. A notebook documented the conversations with the teacher and observations held throughout the nine months of the study.

Teacher and Student Interviews. The teacher and four of the students were interviewed nine months after the teacher introduced the PLAN strategy into the classroom. Using parallel sets of 12 openended questions, one of us (who had not worked with the teacher during the nine months) conducted an hour-long interview with the teacher while another of us conducted shorter, individual interviews with the students. The teacher selected these students because their performance fell in the middle of the range of student performance in the classes. These students were very willing to be interviewed. Questions to the teacher focused on his expectations
of students and his instructional routines. Questions to the students focused on their expectations of the textbook and their perceptions of learning from it. The transcriptions of the taped interviews were analyzed using a constant comparative method for identifying themes.

## Procedures

The study proceeded in three phases: (a) a preparation phase during which the teacher gained strategy awareness; (b) an implementation phase during which the teacher gained contextual strategy knowledge, and (c) an adaptation phase during which the teacher gained strategy control.

Preparation. The teacher had completed a summer graduate course taught by one of us (Peterson) that focused on integrating reading strategies into content area teaching. The course included the modeling of specific comprehension strategies for content learning and practice by class members in small groups. PLAN for studyreading was modeled during one class session and practiced by students using a chapter from the course textbook. After expressing interest in trying out the PLAN strategy in his classroom, the teacher was invited to participate in this study.

Implementation. During three months of the fall semester, the teacher met weekly, a total of over 15 hours, with two of us (Caverly and Radcliffe) subsequently referred to as the mentors. During the meetings, the mentors and the teacher held in-depth discussions of the processes of strategic textbook reading and the challenges of implementing it in a middle school classroom. Concurrently, the teacher taught the PLAN strategy in his seventh-
and eighth-grade science classes through the following major steps (a) PLAN was introduced as a new way for students "to read hard material in the science textbook", (b) the teacher illustrated how to create concept maps on the board, (c) the students created concept maps in groups and then individually, and (d) the students individually completed the four steps in the PLAN strategy based on content in their science textbook. The instruction followed Pearson and Gallagher's (1983) steps of explicit instruction, by modeling the strategy for students, providing scaffolding during guided practice, and structuring time for independent strategy use for students to internalize the processes.

Adaptation. In the spring semester, the teacher did not meet with the mentors, but remained in email contact. At this point, the teacher focused on integrating PLAN into his instructional routine and on promoting in students the idea of adapating it to be an individual "plan" for strategic textbook reading.

## Findings

## Changes in the Teacher's Perception of the Textbook

The field notes recorded the teacher's perceptions of textbook readings. Before his participation in the study, the teacher doubted the effectiveness of textbooks for science learning. His own experience had not been positive: "When I was in school the word textbook was like a four letter word" and he did not know how to teach well with the it: "I hadn't realized that I had no experience with someone teaching me how to read and understand a science
textbook." Compounding these doubts about the relative importance of the textbook was his preparation for teaching science: "Doing experiments is what science is all about." This preparation was supported by his teaching experience: "Before I taught here, I taught at a projectbased learning school and textbooks were completely forbidden."

## Changes in the Teacher's Instruction

Three findings emerged from analysis of the transcript of the interview conducted at the end of the study. In comparing his teaching of a unit the previous spring with the teaching of the same unit with PLAN strategy, these changes were evident at the adaptation phase.

1. The teacher had integrated the PLAN strategy into his instructional routine. "I will begin [the unit] with the PLAN strategy... Near half way in the first period. [I'll say] 'This is your assignment is to read the first section. I want you to do the $P$ the $L$ and at least get started on the $A$., We kind of got in the routine." In class, he leads a discussion of what students already know. Students then have about 20 minutes to get started. They take their books home to complete their PLAN maps and return with them the next day for a grade.
2. He modified the strategy in three ways. First, he used PLAN as a way for students to build background knowledge from the textbook: "The textbook now has become a background knowledge thing." The background knowledge increased student preparation for unit activities: "They come to class ready to discuss and learn things." His second modification was to allow students to choose a mapping format:
"Some of the seventh graders like Inspiration (2003), a mapping program with the concept maps on the computer. So some of them have moved on to that while others like doing it by hand." His third modification was that in the " N " step he assigned students to answer the comprehension questions at the end of the section. "Part of the thing I did with the note thing was to ask yourself, did you get out of the reading what the author wanted you to get? And the way to do that is to look at your concept map and look at the question and [ask] do you have the information the author is trying to get you to get."
3. His expectations of his students had changed. "The things that I teach are the same and I use the same materials but my expectations are different."

## Effectiveness of strategy for student learning

Comprehension tests. Students' scores on comprehension tests and reading strategy checklists were analyzed using a paired t-test statistic (two-tailed). Differences in the students' scores on the 10 -point reading comprehension pretest ( $M=4.9$ ) and posttest ( $M=3.9$ ) were not statistically significant, $t(22)=1.427, p=.167$. Although the slight drop in scores was not statistically significant and too small to be practically significant, this result was unexpected and inconsistent with other findings in this study. The small number of test questions and possible differences in student prior knowledge of the chapter topics may have confounded the results.

Concept maps. Beginning with the first PLAN map, students were able to accurately represent the major headings and subheadings of the chapter. Content accu-
racy remained stable from the first to the final PLAN maps, with an average of $98 \%$ propositions recorded correctly. What did increase was the percentage of propositions that reflected paraphrasing of content and higher order thinking (a growth of $9 \%$ to $14 \%$ ). There was also a decline in the percentage of propositions that were simply copied from the text (a decline from $91 \%$ to $86 \%$ ).

Reading checklists. Comparison of the students' performance on the 10 -item reading strategy checklist revealed a statistically significant difference, $t(22)=-2.102, p=$ .047 , between the pretest ( $M=5.5$ ) and posttest ( $M=6.4$ ) scores. This small gain in reading strategy scores was supported by the teacher's and students' responses in interviews that investigated the expanded use of reading strategies.

Teacher Interview. Analysis of interview transcripts revealed four findings from the teacher's perspective on the effectiveness of PLAN.

1. He saw improvement in his students' learning. "They were coming in with more understanding of the material." He saw that "mean grades of the class increased" because students were better prepared for the labs. At the same time he came to believe that the publisher-provided chapter tests were inadequate measures of student learning: "By talking to them on what they learned, I know they have learned more than what they can write on a test."
2. His students moved from needing group support with strategic reading to being independent in their strategy use and able to do the reading as homework. "First, I was teaching group concepts but by Feb-
ruary they could do them individually."
3. He believed the benefits to students in using PLAN developed over time: "I use 12 weeks [in the fall] teaching it. [After winter break] we do a refresher PLAN strategy. That is actually where I really start seeing the benefits of it, after we came back and reviewed it again. They had some time to absorb it and think about it and to see."
4. At the end of the Adaptation phase, he observed that students were more willing to complete the textbook reading. In discussing his teaching of the same unit during the previous academic year he stated: "I assigned but it wasn't getting done." In discussing his teaching this spring he said: "We stand outside the classrooms in between classes and students will run up to you and ask you if they need their textbooks today. [It's] the way they ask question, "do we have to have our textbooks today?" versus "do we need our textbooks today?" I think that portrays the kind of attitude shift away from it is not your enemy...[when they get an assignment] instead it's I can do that, I understand that, I can answer those questions."

Student interviews. Analysis of interview transcripts revealed three findings from the students' perspectives on the effectiveness of PLAN.

1. The students saw PLAN as part of the classroom routine. They said the teacher prompted them to use the PLAN strategy when the took their science book home to read, and when they created concept maps. All students reported that they took their book home to read twice a week. Some days they were assigned to read a whole chapter at home, other times to read a chapter that was started in class using PLAN.

One student said: "We have our PLAN thing [to do]; [we] do the webs". In some cases the concept maps were completed in class, other times the students prepared them while reading at home. A student explained one of the steps: "I start out looking at the main titles in the chapter, and then I break it off into sub-titles, and then I will read each paragraph to put information in [into the concept map]".
2. The students emphatically reported an increase in their reading since implementing the PLAN strategy: "I have read a lot more this year." Consistently, the interviewed students explained that they had become better readers. "I think I am a lot better, better reader." They elaborated, sharing that they understood more of what they read and that they were using elements of the PLAN strategy. One student explained: "I can understand it a lot better because doing concept maps helped me." In response to an inquiry about changes in reading, another student shared that she used to be scared to read textbooks and did not have any confidence, but now "I like to read." She reported that in addition to reading more in her science book than a year ago, she now reads more in social studies and other subjects.
3. Consistent with the teacher's description, the four interviewed students reported that they were doing well in science; two students explained that their grades had improved during the academic year. Strategic reading appeared to be contributing to their success. Three students explained that they liked to read and that it was helpful: "I like reading the chapters, I like understanding where I got it","it helps me leam", and "I feel like I get a lot from reading
my textbook".

## Discussion

This study reveals how a middle school science teacher implemented strategic reading instruction through a collection of strategies for study-reading called PLAN. It reports the subsequent gains in his students' willingness and ability to learn from textbook reading. Consistent with the case study of Driscoll, et al. (1994), this teacher was reluctant to rely on textbooks for learning and did not expect his students to be successful in reading a science textbook. More than adding a teaching strategy to his repertoire, he had to overcome his negative perceptions and experiences related to using textbooks to teach science. The short chapter tests, only six-questions from the publisher test bank, may have reflected his low expectation that students would read the text or that the test would be a valuable assessment.

Consistent with the research of Caverly, Mandeville, and Nicholson (1995), the middle school students in the current study benefited from their use of PLAN as documented by the concept maps. Their posttest scores on the reading strategy checklist indicate that they also engaged in additional reading strategies, such as summarizing what they had read. The students interviewed reported that reading their science textbook helped them to leam science.

A major finding in this study was that adopting this strategic reading strategy in a middle school science classroom involved substantial time and effort by the teacher to modify his instructional routine. He had to develop skills in strategic reading instruction and gain confidence that
students' would learn from his delivery of it. Over a nine-month period, he progressed through three stages as he implemented PLAN: (a) awareness of the strategy, (b) a deeper knowledge and understanding of both why and how to teach it, and (c) control of it to meet his students needs for learning science content. Scaffolds in this process included a summer graduate course in reading strategies and 15 meetings with two mentors during the fall school term. Consistent with Pressley (2002), this teacher developed in his ability to teach students effective study-reading strategies from simply being aware of the need to teach them, to understanding how to teach them, to the control of teaching them as demonstrated by both his choice to continue to teach them and his willingness to adapt them to fit his needs.

A second major finding in this study was that the benefits of learning the strategies for textbook reading took time to develop. After four weeks of strategy instruction and implementation, the students did not gain on the textbook chapter test, but did improve in their ability to represent the details and to translate the content into their own words through concept maps. They also reported that they were reading more strategically. The teacher believed the students needed more than four weeks to intemalize the processes. During the following semester (with the same students in class), he observed that they understood more than what was on the chapter test, as they were better prepared for lab work and better able to use science vocabulary. At the end of the nine months, he saw increases in his students' science grades, which he attributed to their
better performance in the lab work.
The students reported that they read more often than in the previous school year and they found reading more enjoyable. PLAN engages students in taking responsibility for reading skills by requiring concrete evidence of their reading in the form of a map. In contrast, SQ3R prompts in-the-head operations that may be difficult for the student and teacher to monitor. The teacher reported that students shifted from initially relying on his instruction about PLAN to relying on small group support, and finally to independent use of the strategy. This sequence follows Pearson and Gallagher's (1983) steps of explicit instruction.

Finally, this study documents the process of strategy control by the teacher. In the spring semester, after mentoring had ended, the teacher revised the "Note" step in PLAN. (Recall, the Note step is map revision or content reformulation.) Instead, the teacher assigned students to read and answer the comprehension questions at the end of the chapter. Yet the teacher presented this traditional assignment in a way that prompted students' metacognition: he asked them to compare their maps to what the textbook author saw as most important, as expressed in the chapter questions. A second modification was his focus on using the strategy for building background knowledge in preparation for lab work. This modification shows that the teacher re-defined his purpose for having students read the textbook based upon his observations of what they were learning by using the strategy.

## Conclusions

Textbook reading in this middle school
science classroom changed from being an assignment that students were not expected to complete to one that students completed and from which they learned science content. The teacher's expectations of students moved from doubt to confidence that they would read the textbook. Over a period of nine months, the teacher's classroom routine changed to include strategic reading instruction for the use of textbooks through a study-reading strategy called PLAN. Students changed their learning strategies by completing concept maps at home on textbook chapters. The teacher moved through three stages: (a) strategy awareness, (b) understanding, and (c) control, while the students progressed from observing the teacher model PLAN to using it in small groups, to individual classroom practice and homework.

After four weeks of strategy implementation, an evaluation of the students' concept maps indicated an increase in the use of higher order thinking. They gained in their self-reported use of reading strategies. The teacher observed deeper improvement after several months of implementation. At the end of the year, students reported that they were reading their textbooks more often and were understanding more of what they read. Consistent with prior studies, such as Trabasso and Bouchard (2002), we concluded that strategic reading instruction helped students learn from their textbooks.

In this study the teacher modified the strategy to suit his instructional needs. We believe that this adaptation phase is important, specifically that strategic reading instruction must be integrated into the teacher's instructional routine. For exam-
ple, using PLAN as a vehicle for students to develop general knowledge and concepts served to link textbook reading and the hands-on activities that are often preferred in teaching science.

Although these findings support and extend prior research about PLAN (Caverly, et al., 1995), they are limited by several factors. First, some of the findings are based on the teacher's and students' perceptions of the implementation. The four week time span between pre- and posttests likely was not enough time to show the full benefit of the strategy adoption and adaptation. The study is also limited because the approach was to compare the same students' performance over time; the use of a quasi-experimental research design is recommended for future investigation.

Implementation took considerable time and effort; a year's commitment and a combination of graduate coursework and mentor support. Therefore, teacher-educators need to evaluate whether reading workshops or a single reading strategy course are sufficient to enable participants to implement complex new strategic reading routines, such as the PLAN strategy.

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## Appendix

Concept Map Rubric

| Accuracy Depth Complexity |  |  |  |  |  |  |  |  |  |  |  |
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| 3. |  |  |  |  |  |  |  |  |  |  |  |

Each map was scored by categorizing map nodes and links into proposition units， formed by two nodes（bubbles on the con－ cept map）connected by a link．Each
proposition was numbered starting with first level links from the super－ordinate node，then second level，and so on．If par－ tially illegible，the text was rewritten．If
completely illegible, the proposition was classified as "Don't Know."

Each proposition was scored using the following categories (adapted from Stoddart, et al., 2000).

## I. Content Accuracy

1. Accurate: Correct statement confirmed by text and expert

- for example, - "acceleration equals net force divided by mass"

2. Partially accurate: Correct statement but only partially correct

- for example, - "Newton's law states a net force changes the velocity of an object"

3. Common knowledge: Common or popular knowledge not stated in the text

- for example, - "Newton's Apple" (TV show)

4. Inaccurate: Misconception or confusion

- for example, - "the lower the mass
the greater the inertia"
or, inappropriately linked
- for example, - linked to superor-
dinate when should be linked to coordinate concept

5. Affective: Statements that express emotions, feelings, or personal thoughts

- for example, - "boring!"

6. Question: Proposition in form of question that cannot be judged

- for example, - "mass vs. acceleration?"
(Also, don't classify in the Depth of Explanation or Complexity categories)

7. Don't know: Cannot be scored because
the meaning of the proposition is unclear or scorer has insufficient knowledge

- for example, - "Newton developed" Cannot be scored because unintelligible due to handwriting or spelling - for example, - "dsjalf dasfa werter" (Also, don't classify Depth of Explanation or Complexity categories)


## II. Depth of Explanation

1. Basic descriptions: Statements copied directly from the text - for example, - "a force that resists motion between two surfaces that are in contact"
2. Higher order descriptions: Explanations that paraphrase the text or add function or purpose, such as "how" or "why" - for example, - "the rougher the surfaces the greater the friction"

## III. Complexity

1. Simple Elaboration: The proposition is a single subject-object clause

- for example, - "Newton's Laws of Motion" are "First Law", "Second Law", "Third Law"

2. Compound Elaboration: contains one or more dependent clauses as explanations

- for example, - "An object will not change its motion unless a force is acted upon it"

> code
date

Directions: Carefully read the following statements and honestly respond to them using the scale below. Circle either A or B
$A=Y e s, I$ did this in preparation for this quiz
$B=N o, I$ did not do this in preparation for this quiz
A. B. 1. I made predictions about what the author would say next or what would happen next.
A. B. 2. I connected ideas from my own experience to what I read.
A. B. 3. I figured out new words by the ones around them.
A. B. 4. I created a map of the ideas from the reading.
A. B. 5. I created examples from my own experience to help my understanding.
A. B. 6. I memorized key terms.
A. B. 7. I reviewed the passage after reading to make sure I understood.
A. B. 8. I skipped parts I didn't understand.
A. B. 9. I tried to put the important ideas in my own words.
A. B. 10. I identified the purpose the author had for writing.

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