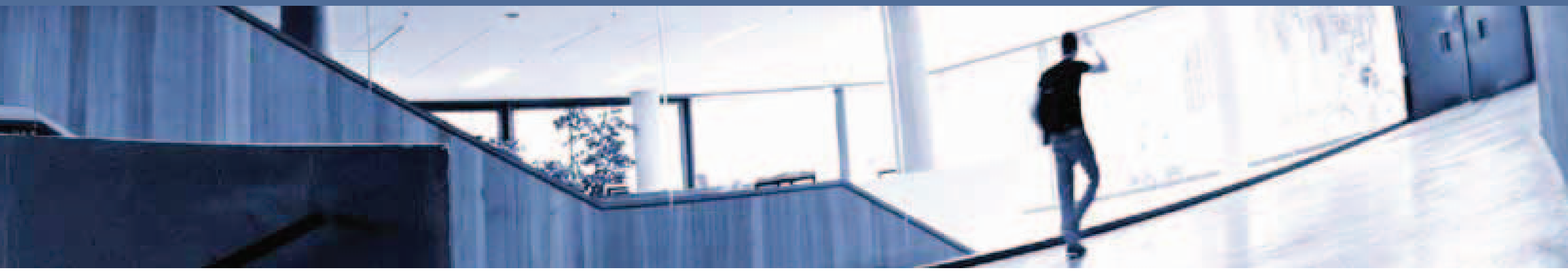
THE EFFECTS OF *PEARSON CHEMISTRY* (2012) ON STUDENT PERFORMANCE: PILOT STUDY

Final Report

June 30, 2009

Submitted by: Rebecca M. Eddy, Ph.D. &
Todd Ruitman, M.A.



COBBLESTONE
APPLIED RESEARCH & EVALUATION, INC.

COBBLESTONE APPLIED RESEARCH & EVALUATION, INC.
2120 Foothill Blvd., Ste. 202 | La Verne, CA 91750 | (800) 971-3891

Table of Contents

Executive Summary

Cobblestone Applied Research & Evaluation, Inc. conducted a pilot study of the *Pearson Chemistry* (2012) program during spring 2010. The pilot study took place in Chemistry classrooms in two high schools: one in Oklahoma and one in Washington. The purpose of the pilot study was to obtain feedback from teachers and students about the Chemistry program, to observe how the program was used in the classroom, and to understand how program use impacted students' achievement and attitudes in Chemistry.

***Pearson Chemistry* (2012) Pilot Study Chapters**

Chapter 12: Stoichiometry

Chapter 14: The Behavior of Gases

Chapter 18: Reaction Rates and

Study Description and Measures

The pilot study required that participating teachers and 176 students use three chapters from the *Pearson Chemistry* (2012) program, including chapters 12, 14 and 18. The study including tracking how teachers and students used the *Pearson Chemistry* (2012) program in their classrooms (implementation measures) and how this impacted student scores (outcome measures).

Outcome measures were administered as pretest and posttest instruments and assessed the impact on student attitides and acheivement.

- A standards-based Chemistry assessment was created using the Exam*View* software and included ten questions from each of the three pilot chapters (total 30 questions).
- The student survey included questions from the *Chemistry Motivation Questionnaire* (Glynn & Koballa, 2006), which is a published, reliable scale of student attitudes towards science.

Implementation Measures	Outcome Measures
Online teacher self-reports of classroom activities	Chemistry Content Assessment
Classroom observation sessions	Student Survey
Teacher interviews	

Demographic Information for Participating Students

	Response Options	Oklahoma (*n*=59)	Washington (*n*=103)
Gender	Male	48%	54%
	Female	52%	46%
Ethnicity	Caucasian	57%	92%
	African American	21%	-
	Hispanic/Latino	10%	5%
	Native American	7%	2%
	Multiple Ethnicity/ Other	5%	1%
Completed Algebra I	Completed	93%	100%
	Not Completed	7%	-
Completed Algebra II	Completed	25%	74%
	In Progress	45%	16%
	Not Completed	29%	10%

Percentage of Components Implemented for Chapters 12, 14, and 18

	Components	Oklahoma	Washington	Total
Chapter Components	*Big Idea* and Essential Questions	100%	100%	100%
	CHEMystery	100%	100%	100%
	Quick Lab	0%	66%	33%
	Chemistry & You: Feature Pages	100%	100%	100%
	Study Guide	100%	33%	66%
	Math Tune-Up	33%	0%	16%
	Assessment	33%	100%	66%
	CHEMystery (located in Chapter Assessment)	33%	33%	33%
	Standardized Test Prep	66%	0%	33%
Section Components	*Chemistry & You* (section opener)	100%	25%	63%
	Key Questions	100%	100%	100%
	Vocabulary	100%	100%	100%
	Sample Problem(s)	100%	100%	100%
	LessonCheck	100%	33%	66%

Study Participants

Two teachers and their students participated in the study. Both teachers were experienced given that they taught at the K-12 level for an average of 13 years and had specifically taught Chemistry for an average of 7 years. The following table summarizes characteristics of participating students who reported demographic information ($n = 172$).

Product Use in the Classroom

Research Question 1:

Are teachers able to successfully integrate features from the Pearson Chemistry *(2012) curriculum in their classrooms?*

Each week participating teachers were required to complete online logs that described activities in their classrooms. The following outlines the program components that each teacher reported after completing the online teacher logs (collapsed across chapters 12, 14, and 18).

The Understanding by Design pedagogical model is contained within the *Big Idea* and other program features. Both teachers reported using some of the online features of the program, but only one used all available online components. Both teachers expressed problems accessing the online system that included that the website was down an inability to log in because of internet browser restrictions. Given this, the usage of the online components was limited during the pilot study.

Student Achievement and Survey Results

Research Question 2:

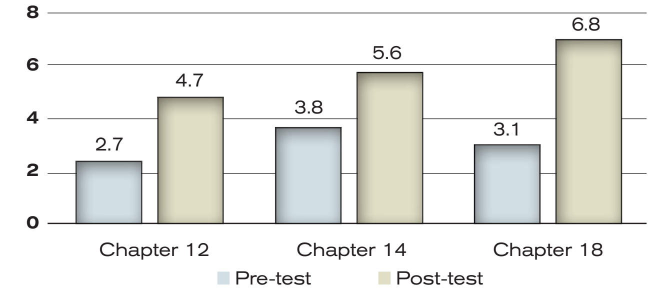
How do students using three chapters of the Pearson Chemistry *(2012) program perform from pretest to posttest on an assessment related to achievement in chemistry?*

Students completed the Chemistry content assessment and student survey before using the *Pearson Chemistry* (2012) program (pretest) and again after using three complete chapters in the program (posttest).

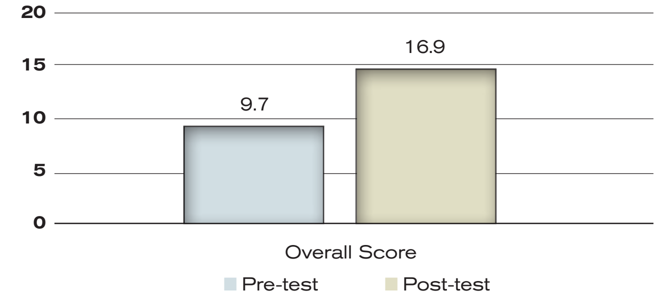
Research Question 3:

How do students using the Pearson Chemistry *(2012) program perform from pretesting to posttesting on assessments related to attitudes about science and achievement in science?*

Student Achievement Scores on the Chemistry Content Assessment by Chapter, Pretest to Postest



Student Achievement Scores on the Chemistry Content Assessment Overall, Pretest to Postest

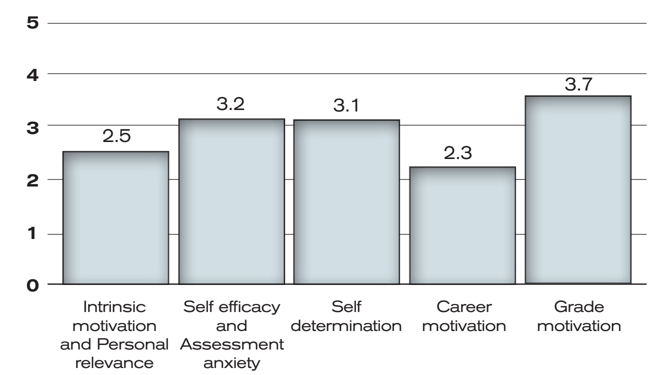


Results of a paired-samples *t*-test indicate that that students increased their score on the overall Chemistry assessment significantly from pretest to posttest at both sites, $t(145) = 18.602$, $p < .001$. All chapter subtests increased significantly as well, $p < .01$.

Students completed survey questionnaires at pretest and posttest about attitudes towards science, specifically in Chemistry. Results of the posttest surveys are presented next.

We conducted a factor analysis on all survey items, which corresponded with the published findings. Students reported higher motivation for grades than any other factor, particularly motivation for a career in science. Intrinsic motivation and personal relevance were rated the lowest of any factor.

Mean Scores on Student Posttest Survey



Research Question 4:

How well did the Pearson Chemistry *(2012) program address the four focus areas of relevance, math support, differentiated instruction and integration of technology?*

Teachers and students were asked to provide information corresponding to the four major foci of the *Pearson Chemistry* (2012) program. Teacher impressions come from teacher logs and interviews; student impressions are based on posttest survey responses.

Relevance: One teacher reported that the book was mixed in terms of relevance to students, the other teacher reported that some sections of the book such as the natural gas vehicle displayed in *Chemistry & You* (Chapter 14) elicited interest and relevance from students. Most students did not think that textbook made learning Chemistry interesting or helped them to understand how Chemistry affected their life, although one student reported “I liked the way stoichiometry was related to something we knew...cooking!” In addition, teachers reported that students did not find all chapters equally relevant. For example, many students did not like Chapter 12 (Stoichiometry) but liked Chapter 14 (The Behavior of Gases) much more and found many concepts relevant to their lives. One student wrote “my favorite part was learning about the different factors in pressure changes. They made a direct connection to what I can use them for in real life.”

Math Support: Students rated Sample Problems as one of the best elements of the program—most students thought that the Sample Problems were helpful in understanding Chemistry concepts; students also agreed that the *Pearson Chemistry* (2012) program provided them with the skills needed to succeed in Chemistry class. Students reported the following: “The sample problems helped a lot while I was studying.” And “The example problems were super great!”Another student wrote “The book doesn’t explain how to do the problems very well.” And another wrote “After my teacher taught us how to do the problems then I started liking the practice problems, but before he taught us our whole class was lost.”

Differentiated Instruction: Teachers did not report using many components to address differentiated instruction during the short pilot study. One teacher reported that he did not do anything different than he normally would for the purpose of differentiating instruction for students.

Integrated Technology: A major source of frustration for teachers and students was the lack of compatibility for their internet browser to use the online components, although they would have liked to use them. However, when teachers did use the online components, they especially liked the Virtual Labs and suggested that this was one of the strongest program components. One teacher commented specifically about the website: "I had a pretty good tutorial on the website before I started. Because of this I knew what to find. Without the tutorial it would have taken a while to figure out what all was on the website."

Product Satisfaction

Students were asked to rate how much they liked the *Pearson Chemistry* (2012) program. Students did not report liking every aspect of the program, and some students reported negative comments such as: "I liked the pictures and example problems but overall the book was vague and hard to follow."

Favorite Program Components	Least Favorite Program Components
• Quick Labs	• *Chemistry & You*: Everyday Matter
• Sample Problems	• Math Tune-up
• Key Questions	• Online: Concepts in Action
• Chapter Study Guide	• Online: Virtual Labs
• Vocabulary	
• *CHEMystery/ Big Idea*	

Positive Student Impressions about the *Pearson Chemistry* (2012) Program:

"I like the connections to life in the textbook and the problems to help you study for the tests in the study workbook."

"What I liked was it was relevant to life and there were many examples."

"I liked all of the different study problems that it gave for more practice"

"The pictures were very helpful to understand some chemistry concepts" "I liked the problems/ how they were set up. It makes converting much easier."

Positive Teacher Impressions about the *Pearson Chemistry* (2012) Program:

*"I think [*Pearson Chemistry*] does quite well. This is one book that I would actually recommend."*

"I like the Pearson [sample problems] because it just gives a short little blurb for each of the different steps and [different text] gives you huge paragraphs explaining what they are doing."

"I think it does a great job in terms of relevance."

Pearson Chemistry (2012) Pilot Study

In the past twenty years, an increasing number of high school students have taken advanced science and math classes. In fact, those taking chemistry classes went from 44% in 1990 to 55% in 2000 (National Academy of Sciences, 2009). Recently, the Chemical Sciences Roundtable held a workshop to discuss strengthening high school chemistry education. Sullivan (2009) noted that the trend in taking more advanced courses is noteworthy because taking advanced courses is related to greater college enrollment, more success in first-year college courses, and greater likelihood of advanced training in the workforce. With an increasing number of students taking advanced mathematics and science courses, but a relative shortage of qualified teachers to teach these courses, it is imperative that publishers create high-quality products that are easy for teachers to use while engaging a larger number of diverse students. The *Pearson Chemistry* (2012) program was developed to address needs of teachers and students with a focus on relevance to students' lives, math support, differentiated instruction, and integration of technology. A pilot study was conducted to assess how well the *Pearson Chemistry* (2012) program might address these goals.

Purpose of the *Pearson Chemistry* (2012) Pilot Study

The primary purpose of the pilot study was to obtain feedback from teachers and students regarding the *Pearson Chemistry* program, observe how the program was used in the classroom, and to finalize all instruments and protocols to be used during the extended *Pearson Chemistry* (2012) pilot study (to be conducted during the 2010-11 school year). This purpose was accomplished through answering the primary questions we developed with Pearson. This study focused on systematically tracking curriculum implementation, measuring students' achievement in Chemistry class, and investigating the relationship between these elements with an assessment of the students' attitudes towards and motivation in Chemistry along with other related constructs. Students and teachers also provided information for product satisfaction. Primary research questions for the pilot study were:

1. Are teachers able to successfully integrate features from the *Pearson Chemistry* (2012) curriculum in their classrooms?

2. How do students using three chapters of the *Pearson Chemistry* (2012) program perform from pretest to posttest on an assessment related to achievement in chemistry?

3. How do students using the *Pearson Chemistry* (2012) program perform from pretest to posttest on assessments related to attitudes about science and achievement in science?

4. How well did the *Pearson Chemistry* (2012) program address the four focus areas of relevance, math support, differentiated instruction and integration of technology?

Overview of the *Pearson Chemistry* (2012) Program

At the time of the pilot study, the entire *Pearson Chemistry* (2012) textbook was not available for use. Therefore, a booklet was created that bound three chapters of the *Pearson Chemistry* (2012) program for use in the classroom. Because these chapters were complete, the design and look of the booklet was the same as the complete textbook with some minor differences. Additional study materials included student workbooks and a teacher's edition booklet. The complete program is organized into 25 chapters, of which, three chapters (Chapter 12: Stoichiometry; Chapter 14: The Behavior of Gases; and Chapter 18: Reaction Rates and Equilibrium) were used for the pilot study.

The *Pearson Chemistry* (2012) program focuses on four primary areas. Each area works together to advance student understanding of Chemistry content as well as student attitudes towards Chemistry class. The four focus area and associated research questions for the study and related program components are outlined in Table 1.

There are specific features and elements in the program that were designed to support these four themes. For real world connection or relevance, each section of a chapter is introduced with a *Chemistry & You* question that identifies how the lesson might connect to students' lives. Additionally, full-page features of *Chemistry & You* inserts introduce students to examples of chemistry in technology, the environment, and careers. Math support for students was provided by inserting *Math Tune-Up* at the end of each chapter to help students recognize how to use learned math concepts in a chemistry context. Teacher's edition textbooks are enhanced with specific lesson planning helps for differentiated instruction placed at point-of-use locations throughout each chapter. Lastly, the program integrates technology by providing several online activities on its website.

Similar to Pearson's other recently revised science programs, the program incorporates the Understanding by Design (UbD) framework developed by Grant Wiggins and Jay McTighe (1998). Chapters are introduced using a *Big Idea*

Table 1. Key Focus Areas for the *Pearson Chemistry* (2012), Related Research Questions and Associated Program Components

Focus of Pearson Chemistry (2012)	Secondary Research Questions	Program Components that Address Questions
Relevance	Do students perceive the content in the Chemistry program relevant to their own lives? Do students understand how Chemistry concepts apply to the real world around them?	*Big Idea* *CHEMystery* *Chemistry & You*
Math Support	Do students understand how concepts learned in high school mathematics courses (e.g., Algebra) relate to Chemistry concepts? Do student know how to apply math skills to solve problems in Chemistry?	Sample Problems Math Tune-Up
Differentiated Instruction	Do multiple levels of students receive the support they need using the *Pearson Chemistry* program?	Teacher Edition Margin Notes
Integrated Technology	Does the technology used including Chemistry Online, make concepts more accessible or interesting for students?	Math Tutor Chem Tutor Other online resources

and *Essential Questions* designed to give students an overall objective for learning throughout each chapter. Additionally, each chapter is introduced with a *CHEMystery* that presents students with a mini-mystery to solve as they learn the concepts taught in that particular chapter. The *CHEMystery* was designed to complement the *Big Idea* by putting the overall chapter objective into a practical context.

Table 2 shows how a typical chapter was organized for the three chapters involved in the study; table 3 shows online components that were available for the pilot study.

Table 2. Pearson Chemistry (2012) Textbook Components

	Components
Chapter Components	*Big Idea* and Essential Questions
	CHEMystery
	Quick Lab
	Chemistry & You: Feature Pages
	Study Guide
	Math Tune-Up
	Assessment
Section Components	*CHEMystery* (located in Chapter Assessment)
	Standardized Test Prep
	Chemistry & You (section opener)
	Key Questions
	Vocabulary
	Sample Problem(s)
	LessonCheck

***Chemistry & You* Question**

(Chapter 12, Section 1):

How do you figure out how much starting material you need to make a finished product?

***Big Idea* (Chapter 14): Kinetic Theory**

Essential Questions (Chapter 14):

How do gases respond to changes in pressure, volume, and temperature?

Why is the ideal gas law useful, even though ideal gases do not exist?

Table 3. *Pearson Chemistry* (2012) Online Components

Online Components
Concepts in Action
Kinetic Art
Virtual Lab
Math Tutor
Online Problems
Chem Tutor

Pilot Study Description and Design

The pilot study of the *Pearson Chemistry* (2012) program was conducted at two schools in two different states (Oklahoma and Washington) in spring 2010. Specifically, teachers and students who were using a different Chemistry textbook at the beginning of the year, switched to using a bound booklet of three chapters from the *Pearson Chemistry* (2012) program. During the study, we explored teachers' implementation of the *Pearson Chemistry* curriculum and student outcomes.

Study Measures

We used a number of measures to track both program implementation (how the materials were actually used in the classroom) and student outcomes (changes in achievement or attitudes over the course of the study). Qualitative and quantitative instruments were developed and tested within the pilot study including classroom observations protocols, interview protocols, student surveys, and a Chemistry assessment.

Implementation Measures: A key to interpreting outcomes is in understanding how well the Chemistry curriculum has been implemented in each classroom. Implementation measures included classroom observations and teacher interviews. Also, teachers were required to complete weekly teacher implementation logs to track their progress with the *Pearson Chemistry* material.

Outcome Measures: The study also tracked student outcome measures; specifically, a student attitude survey and one Chemistry assessment. The outcome measures described below were administered at the beginning and end of the study.

- *Student Survey:* Student surveys were administered as both a pretest and posttest to assess attitude change over the duration of each study. The survey included the *Chemistry Motivation Questionnaire* (Glynn & Koballa, 2006), which is a published, reliable scale of student attitudes towards science, and can be customized to address attitudes towards Chemistry. Subscales on the Science Motivation Questionnaire included: intrinsic motivation and personal relevance; self-efficacy and assessment anxiety; self-determination, career motivation, and grade motivation. An additional subscale was created to assess teacher influence on student attitudes. The posttest included additional questions regarding product satisfaction for the *Pearson Chemistry* (2012) program.
- *Chemistry Assessment:* A standards-based assessment was developed by Pearson for the pilot study from Exam*View* (exam creation software) to test students on content specific to the Chapters 12, 14, and 18 of the textbook. Although this was not a standardized, normed instrument, we tracked student growth from pretest to posttest during the pilot study which included 10 items for each of the three pilot chapters (30 items total).

Description of Study Activities

A summary of study activities and corresponding dates can be found in Table 4. As mentioned previously, teachers used the program during the second half of the school year. Teachers and students in the Washington site used the program for approximately 10 weeks; while teachers and students at the Oklahoma site used the program for approximately 12 weeks. Other study activities included setup at each site, teacher training and student testing.

A Cobblestone researcher was present at each product training session to provide the study orientation immediately before or after the product training. The pretest assessment and student survey were distributed by each site the first week of the study before instruction from the *Pearson Chemistry* (2012) program began. The post-test assessment and student survey were distributed

Table 4. Timeline of Study Activities

	February	March	April	May
Study Orientation & Product Training	→			
Student Pre-testing	→			
Use of *Pearson Chemistry* (2012) Program	→	→	→	→
Classroom Observations & Teacher Interviews		→		
Student Posttesting				→

immediately following the last day of instruction for Chapter 18. Scheduled observations were conducted by researchers at each site. During the observations, each teacher was observed in one to two sections throughout the day. A detailed description of the observation findings is described in more detail in the Pilot Study Implementation section of this report.

Description of Site Demographic Characteristics

Table 5 provides information about the two participating school sites. Brief descriptions of each site are also included next. Although most students at both sites were self-identified as White/Caucasian, the Oklahoma site includes a more ethnically diverse environment.

Table 5. School Level Demographic Characteristics for Participating Sites

Demographic Characteristics		Oklahoma	Washington
School Site		Site 1	Site 2
Location*		Suburban	Rural
School Size*		1100	1300
Ethnicity Measure*	% Caucasian	58%	89%
	% Hispanic/ Latino	7%	4%
	% African American	21%	1%
	% Other Ethnicity	14%	6%
Economic Measure*	% Free & Reduced Lunch	38%	19%
Community Measure**	% Age 25+ With College Degree	42%	13%
	Median Household Income	$37,000	$54,000

** Information obtained from each state's department of education or district websites*

***US Census 2000.*

Oklahoma High School- Site 1: The Oklahoma site was a secondary school serving approximately 1,100 students. The school resided in a suburban community located very close to the metropolitan area of Tulsa. The community was primarily Caucasian (58%) and had a median household income of approximately $37,000. The student-teacher ratio was 15 - 1 on average.

Washington High School- Site 2: The Washington site was located in a rural area, approximately 45 miles from Seattle. It was a secondary school serving approximately 1,300 students. It was primarily Caucasian, and had a student - teacher ratio of 18 - 1 on average. Its students were eighty-nine percent Caucasian and four percent Hispanic/ Latino.

Description of Student Participants

Table 6 summarizes the demographic characteristics of students from the two pilot sites that completed pretest survey. There were approximately equal numbers of male and female students at both sites. Consistent with the ethnic distributions within the two communities included in this study, students were primarily of Caucasian descent and spoke English as their primary language; however the Oklahoma site provided a much more diverse sample. Given the low number of students from minority ethnic groups in the sample we were not able to conduct subgroup analyses for each group.

Description of Teacher Participants

Two Chemistry teachers participated in the study. Both teachers were experienced given that they taught at the K-12 level for an average of 13 years and had specifically taught Chemistry for an average of 7 years. One teacher had a Bachelor's degree in Science Education, and the other had a specific teaching credential.

Pilot Study Implementation

The following section provides an account of how the program was implemented in classrooms during the pilot study. Data were obtained from a combination of sources, including classroom observations, analysis of reported weekly teacher logs, and informal teacher interviews.

Implementation Guidelines: Guidelines for using the *Pearson Chemistry* curriculum were reviewed during the study orientation sessions. Appendix A shows the implementation guidelines used throughout the pilot study. These guidelines were developed with the cooperation of the research team and Pearson's editorial/product management team. During the study overview, teachers were provided with the guidelines along with a detailed description of the study activities, timelines, study purpose, research questions, and expectations for participation. This session also included training on how to complete the online teacher implementation logs (described in the next section). During the program training, the Pearson trainer integrated the implementation guidelines into her presentation while

Table 6. Demographic Characteristics of Participants

	Response Options	Site 1 (n=59)	Site 2 (n=103)
Gender	Male	48%	54%
	Female	52%	46%
Ethnicity	Caucasian	57%	92%
	African American	21%	-
	Hispanic/Latino	10%	5%
	Native American	7%	2%
	Multiple Ethnicity/Other	5%	1%
Completed Algebra I	Completed	93%	100%
	Not Completed	7%	-
Completed Algebra II	Completed	25%	74%
	In Progress	45%	16%
	Not Completed	29%	10%

providing an overview of key components of the textbook, online resources, and ancillary materials. The following section describes how well teachers adhered to implementation guidelines established in the study.

Research Question 1:

Are teachers able to successfully integrate features from the Pearson Chemistry *(2012) curriculum in their classrooms?*

Product Use in the Classroom: Each week participating teachers were required to complete online logs that described activities in their classrooms. Each chapter follows the same format so the data were collapsed to review the total amount of implementation for all three chapters (Chapters 12, 14, and 18). Table 7 outlines the program components that each teacher reported after completing the online teacher logs. The table shows the percentage of chapter components the teachers taught from all three chapters during the pilot study. A full account of each teacher's implementation is available in Appendix B. Both teachers were able to complete all lessons or sections in all three chapters; however, the teachers did not complete all of the chapter and section components. Overall, the Oklahoma teacher was able to cover more of the chapter components and all of the section components during the pilot study.

Both teachers reported using some of the online features of the program. Only the Oklahoma teacher reported using all of the online components (see Table 7) at least once during the study. The Washington teacher reported using the online study guide. Both teachers expressed problems accessing the online system because the website was down and also unable to successfully log in because of internet browser restrictions. Given this, the usage of the online components was limited during the pilot study.

Classroom Observations: Classroom observations were conducted at each school during March 2010 by Cobblestone researchers. A Pearson representative also attended the Oklahoma site visit. During the observations, researchers documented classroom activities carefully on an observation protocol form. A revised protocol will be used in the 2010-11 pilot study. The following is a brief summary of the visits to each of the sites.

Table 7. Percentage of Chapter Components of Pearson Chemistry (2012) Implemented for Chapters 12, 14, and 18.

	Components	Site 1	Site 2	Total
Chapter Components	*Big Idea* and Essential Questions	100%	100%	100%
	CHEMystery	100%	100%	100%
	Quick Lab	0%	66%	33%
	Chemistry & You: Feature Pages	100%	100%	100%
	Study Guide	100%	33%	66%
	Math Tune-Up	33%	0%	16%
	Assessment	33%	100%	66%
	CHEMystery (located in Chapter Assessment)	33%	33%	33%
	Standardized Test Prep	66%	0%	33%
Section Components	*Chemistry & You* (section opener)	100%	25%	63%
	Key Questions	100%	100%	100%
	Vocabulary	100%	100%	100%
	Sample Problem(s)	100%	100%	100%
	LessonCheck	100%	33%	66%

Oklahoma High School- Site 1. There was one teacher with a total of three sections that participated at this location where two of the three sections were observed by researchers. The same lesson (students reviewed a worksheet from the Study Workbook) was observed in both classrooms; however, there were notable differences between the two groups most likely due to the type of students that were assigned to the different classes, that is, one class was for lower-level students. Some of the lower-level students were quite vocal about not enjoying the *Pearson Chemistry* program. Overall, this group of students seemed to view the *Pearson Chemistry* program as more difficult than their previous Chemistry textbook. Also, only about half of the class showed engagement during the lesson while the higher-level students had about 80 percent student engagement during the lesson.

Washington High School- Site 2. The teacher and classes observed at this site included two sections of the regular Chemistry course. During the class sessions, the teacher and students focused on a lesson related to Chapter 18, section 3 (Reversible Reactions and Equilibrium). The teacher demonstrated a reversible reaction using chemical in a beaker while students watched the demonstration. The teacher also lectured during the class to cover main points of the lesson and referred to key questions in 18.3, such as "What happens at the molecular level in a chemical system at equilibrium?" Students referred to their textbooks and were assigned use of the Student Notebook for homework. In both class periods, students were generally engaged with the lesson and appeared to like the demonstration of reversible reactions made by the teacher. Part of the class period also included a review of the Sample Problem in section 18.2, reviewed at the beginning of class.

Summary: Both pilot teachers used a majority of program components during the study, as indicated by the online logs and classroom observations, therefore the answer to the first research question is yes—they were able to successfully integrate elements of the program into their classrooms. Although most students were engaged in the classroom lessons during observations, the lowest level students appeared less engaged and expressed frustration at using the program. The inability to use many of the online components served as a source of frustration for teachers and students, as this was the major portion of the program that participants were not able to successfully implement.

Research Question 2:

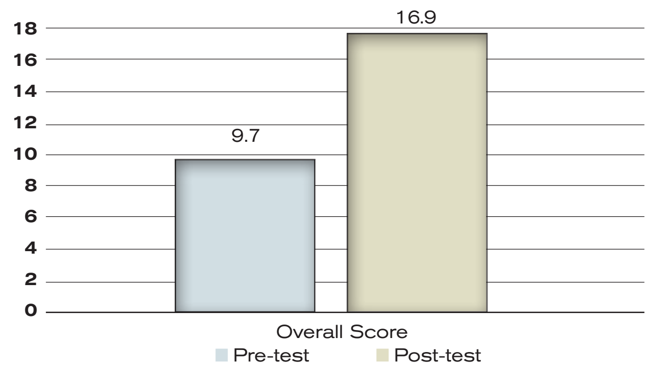
How do students using three chapters of the Pearson Chemistry *(2012) program perform from pretest to posttest on an assessment related to achievement in chemistry?*

Chemistry Assessment Results

The second research question compares student outcomes on the Chemistry assessment. We conducted comparisons between pretests and posttests for overall results, for each teacher, and for each chapter. A total of 146 students (47 Oklahoma students, 99 Washington students) completed both the pretest and posttest for the Chemistry assessment.

Figure 1 illustrates scores on the Chemistry assessment. A paired-samples t test was conducted to investigate whether there were differences from pretest to posttest on this assessment. Results show an overall significant increase from pretest to posttest, $t(145) = 18.602$, $p < .001$. This result suggests overall students' chemistry content knowledge in Stoichiometry, Behavior of Gases, and Reaction Rates and Equilibrium improved significantly using the *Pearson Chemistry* (2012) program.

Figure 1. Pretest and Posttest Scores on the Chemistry Assessment (*N*=146)



We also analyzed student performance on the assessment for each teacher. The results are similar to the overall results above in that students from both teachers show an increase from pretest to posttest, OK teacher: $t(46) = 8.031$, $p < .001$; WA teacher: $t(98) = 17.988$, $p < .001$.

Because the Chemistry assessment consisted of 10 questions from each chapter used in the study, an analysis of the growth within each chapter was performed. The results are consistent with the previous analyses. The results are shown in Figure 2 in which students improved significantly from pretest to posttest in each chapter using the *Pearson Chemistry* (2012) program.

Figure 2. Pretest and Posttest Scores on the Cells Assessment by Chapter (*N*=146)

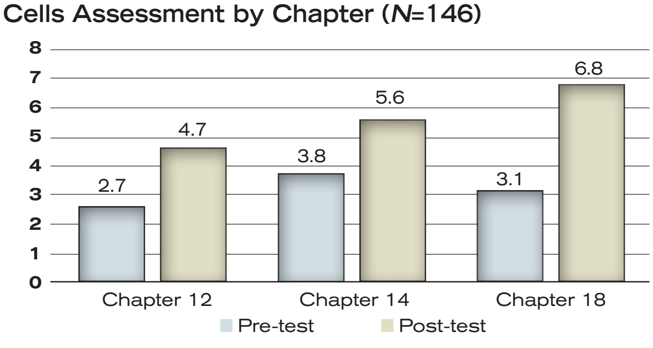


Table 8. Chemistry Assessment Results by Level of Analysis.

Level of Analysis		N	Pretest		Posttest		df	t
			M	SD	M	SD		
Overall		146	9.65	3.20	16.92	2.48	145	18.602
Chapter	Ch 12	146	2.66	1.57	4.71	2.09	145	10.418
	Ch 14	146	3.82	1.61	5.62	1.77	145	10.97
	Ch 18	146	3.12	1.71	6.75	1.92	145	17.68

Summary: Students significantly increased scores from pretest to posttest on the Chemistry assessment demonstrating that the use of the *Pearson Chemistry* (2012) program was effective in improving their knowledge in Stoichiometry, the Behavior of Gases, and Reaction Rates and Equilibrium. Students in both teachers' classes increased significantly, as well as overall student performance with in each chapter. The overall results, including significance levels for each chapter, are summarized in Table 8.

Research Question 3:

How do students using the Pearson Chemistry *(2012) program perform from pretest to posttest on assessments related to attitudes about science and achievement in science?*

Student Survey Results

For the student survey, we used the *Chemistry Motivation Questionnaire* (Glynn & Koballa, 2006) in addition to other items we created for this study. We completed a factor analysis (see Appendix C) using the posttest survey data that showed consistent results as those obtained by the original survey author in a follow-up study seeking validation of the *Chemistry Motivation Questionnaire* (Glynn, Taasoobshirazi, & Brickman, 2009). These published results estimated five distinct factors within the *Chemistry Motivation Questionnaire*: intrinsic motivation and personal relevance; self-efficacy and assessment anxiety; self-determination; career motivation; and grade motivation. The factor of teacher influence was not present in the original document, but was constructed by Cobblestone researchers. The composite factor results from pretest to posttest are provided in Table 9.

Overall Analyses: As can be seen from Table 9, student scores decreased from pretest to posttest in all areas. Paired-samples *t* tests were conducted to assess these differences in student attitudes from pretest to posttest for the six composite factors. The first three factors (i.e., intrinsic motivation and personal relevance, self-efficacy and assessment anxiety, self-determination) showed significant decreases from pretest to posttest. The remaining factors showed essentially no changes in students' attitudes. While we expected student attitudes to improve from pretest to posttest, this was not observed. It is possible that use of the program fostered more negative attitudes about science,

Table 9. Descriptive Statistics for Students on Each Composite Factor Derived from Student Survey

Composite Factors	Pre-test Mean (Std. Deviation)	Post-test Mean (Std. Deviation)	Difference
Intrinsic Motivation and Personal Relevance	2.66 (.75)	2.51 (.72)	-.15*
Self-Efficacy and Assessment Anxiety	3.52 (.73)	3.16 (.76)	-.36*
Self-Determination	3.33 (.70)	3.13 (.71)	-.20*
Career Motivation	2.44 (1.1)	2.40 (1.0)	-.04
Grade Motivation	3.79 (.65)	3.75 (.69)	-.04
Teacher Influence	3.84 (.83)	3.77 (.89)	-.07

Note. Chapter Survey responses were provided on a scale of one to four (One = Strongly Disagree, Four = Strongly Agree)

** Differences from pretest to posttest were significant at the p < .05 level* however, a more likely explanation is that the timing of the posttest (near the end of the school year) was generally a more stressful time for students and a combination of factors, not just use of the pilot study materials, resulted in more negative attitudes toward the end of the study. This will be explored further during the additional Chemistry pilot study that will be conducted during 2010-2011.

Relationship between Student Attitudes and Achievement

We conducted correlational analyses of student achievement scores on the Chemistry assessment and composite factors derived from the student survey to assess if higher achieving students expressed more positive or more negative attitudes at posttest. The only relationships that were discovered between the achievement scores on the Chemistry Assessment and the six composite factors discussed above were significant relationships posttest *self-efficacy and assessment anxiety* composite scores. There was also a relationship between assessment scores and *grade motivation* composite scores on the posttest only (all significant relationships, $p < .001$, for r). This finding is not surprising considering students that scored higher on the Chemistry Assessment reported less test anxiety and greater motivation for good grades on the student surveys.

Research Question 4:

How well did the Pearson Chemistry *(2012) program address the four focus areas of relevance, math support, differentiated instruction and integration of technology?*

Focus Areas of *Pearson Chemistry* (2012)

The *Pearson Chemistry* (2012) program includes a focus on four primary areas. Each area works together to advance student understanding of Chemistry content as well as student attitudes towards Chemistry class. The four focus areas are:

1. **Relevance**. Do students perceive the content in the Chemistry program relevant to their own lives? Do they understand how Chemistry concepts apply to the real world around them? Use of specific sections of the text such as the *Big Idea, CHEMystery, Chemistry & You*, address relevance questions.
2. **Math support.** Do students understand how concepts learned in high school mathematics courses (e.g., Algebra) relate to Chemistry concepts? Do students know how to apply math skills to solve problems in Chemistry? Features such as the *Sample Problem* allow exploration of the extent to which math support in the *Pearson Chemistry* program is adequate for addressing student math needs.
3. **Differentiated Instruction.** Do multiple levels of students receive the support they need using the *Pearson Chemistry* program? Instructive features in the teacher's edition textbook provide guidance for targeting students at multiple levels.
4. **Integrated Technology.** Do program features that integrate technology into Chemistry lessons through the *Pearson Chemistry* program such as *Math Tutor* and *Chem Tutor*, and other online resources allow for an efficient student experience with the material? Does the technology used including Chemistry Online, make concepts more accessible or interesting for students?

Teachers and students were asked to provide information corresponding to the four major foci of the *Pearson Chemistry* (2012) program. Teacher impressions come from teacher logs and interviews; student impressions are based on survey responses.

Relevance: The student survey contained specific statements to address the students' views on the strength of their Chemistry textbook in addressing relevance (e.g., My Chemistry textbook helps me understand how chemistry affects my life). Students responded to these statements for their pre-study Chemistry textbook (pretest survey) in addition to the *Pearson Chemistry* program (posttest survey) which provided researchers with a comparison between the *Pearson Chemistry* textbook and the other textbooks students had used. The results showed no difference between pretest and posttest for responses dealing with relevance indicating that, overall, the three chapters from the *Pearson Chemistry* program did not make chemistry concepts appear any more relevant to students' lives.

One teacher reported that the book was mixed in terms of relevance to students, the other teacher reported that some sections of the book such as the natural gas vehicle displayed in *Chemistry & You* (Chapter 14) elicited interest from students and did make content more relevant to them. Most students did not think that the textbook made learning Chemistry interesting or helped them to understand how Chemistry affected their life, although one student reported "I liked the way stoichiometry was related to something we knew...cooking!" In addition, teachers reported that students did not find all chapters equally relevant. For example, many students did not like Chapter 12 (Stoichiometry) but liked Chapter 14 (The Behavior of Gases) much more and found many of these concepts more relevant to their lives. One student wrote "my favorite part was learning about the different factors in pressure changes. They made a direct connection to what I can use them for in real life."

<u>*Math Support:*</u> Students rated Sample Problems as one of the best elements of the program—most students thought that the Sample Problems were helpful in understanding Chemistry concepts; students also agreed that the *Pearson Chemistry* (2012) program provided them with the skills needed to succeed in Chemistry class. Students reported the following: "The sample problems helped a lot while I was studying." And "The example problems were super great!"Another student wrote "The book doesn't explain how to do the problems very well." Another wrote "After my teacher taught us how to do the problems then I started liking the practice problems, but before he taught us our whole class was lost."

The student survey also contained response items to compare math support in the *Pearson Chemistry* program to the textbooks students had been using prior to the pilot study. Again, the results indicated no difference in the students' view on how well each program performed on providing sufficient math support for Chemistry.

<u>*Differentiated Instruction:*</u> Teachers did not report using many components to address differentiated instruction during the short pilot study. One teacher reported that he did not do anything different than he normally would for the purpose of differentiating instruction for students. This focus area will be more fully explored during the 2010-11 pilot study.

<u>*Integrated Technology:*</u> A major source of frustration for teachers and students was the lack of compatibility for their internet browser to use the online components, although they would have liked to use them. However, when teachers did use the online components, they especially liked the Virtual Labs and suggested that this was one of the strongest program components. One teacher commented specifically about the website: "I had a pretty good tutorial on the website before I started. Because of this I knew what to find. Without the tutorial it would have taken a while to figure out what all was on the website."

Primarily as a result of the browser restrictions, most students did not use the online services outside of the classroom; therefore, we had very little feedback from students about how well the *Pearson Chemistry* program was able to integrate the online components of the program.

Product Satisfaction

Although student achievement increased significantly during the pilot study, students were more likely to express negative views about their Chemistry class and textbook. However, test results indicate that most students did not like their Chemistry class and Chemistry textbook at the beginning of the study (using another program) and use of the *Pearson Chemistry* (2012) program produced *less negative* ratings of their class and textbook. For example, students were asked to respond to the statement: "I like my current Chemistry textbook." The results showed at pretest (i.e., the rating of students' previous textbook) that 77 percent of the students indicated that they disagreed with this statement; thus, a large majority reported disliking their current text. However, the percentage of students that disagreed to the statement fell to 59 percent when students were rating the *Pearson Chemistry* (2012) program. While most students continued to dislike the textbook they were using, the results indicated a trend toward more students enjoying the Pearson program in comparison to their previous textbooks. This result becomes more notable considering the participating teachers indicated that the first chapter used in the pilot study (Chapter 12: Stiochiometry) was the *most difficult* concept for students to grasp regardless of the textbook being used which could account for some students' negative view of the program.

Students were asked to rate how much they liked the components of the *Pearson Chemistry* (2012) program. A summary of program components that students liked and disliked is presented in Table 10.

Students also completed short surveys at the completion of each chapter (see Table 11). For example, 66% of students agreed or strongly agreed that the Sample Problems were helpful in understanding concepts in Chapter 18; approximately 60% of students agreed or strongly agreed with this statement for Chapters 12 and 14. Overall, Chapter 12 was

Table 10. Student Favorite and Least Favorite Program Components

Favorite Program Components	Least Favorite Program Components
• Quick Labs • Sample Problems • Key Questions • Chapter Study Guide • Vocabulary • *CHEMystery/ Big Idea*	• *Chemistry & You*: Everyday Matter • Math Tune-up • Online: Concepts in Action • Online: Virtual Labs

Table 11. Student Results form Chapter Surveys

Survey Question	Chapter 12 (*n* = 123)	Chapter 14 (*n* = 116)	Chapter 18 (*n* = 122)
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)
What I learned in this chapter makes me interested to find out what I will learn in the next chapter.	1.92 (.810)	2.12 (.728)	N/A
I can see why I should know about at least one thing in this chapter.	2.61 (.864)	2.56 (.844)	2.66 (.726)
The sample problems were helpful when learning concepts of this chapter.	2.65 (.928)	2.66 (.904)	2.79 (.877)
This chapter helped me understand how chemistry can be used in my own life.	1.99 (.879)	2.06 (.824)	2.15(.855)

Note. Chapter Survey responses were provided on a scale of one to four (One = Strongly Disagree, Four = Strongly Agree)

rated the lowest in comparison to the other chapters in terms of relevance to their lives.

We also assembled a collection of student comments regarding the parts of each chapter that were their favorites. Examples of student comments can be found in Table 12.

Summary: In general, students did not strongly like the *Pearson Chemistry* (2012) program, but a large number felt more positive about the *Pearson Chemistry* (2012) program in comparison to a competitor textbook used before the pilot study. Despite not generally liking the program some students reported that they liked the Sample Problems (math support) and many found book content to be directly related to some aspect of their lives (relevance). Students and teachers would have liked to use many of the online components and were frustrated by technology issues.

Table 12. Student Comments Regarding Favorite Parts of Each Chapter

Chapter	"What is your favorite part of the chapter?"
Chapter 12: Stoichiometry	"I liked the review at the end. It really helped to assess what you knew/didn't know." "The sample problems were helpful, could have had more explanation for process of solving the problem." "Good pictures and the sample problems were very helpful. The format of the chapter is well-structured."
Chapter 14: The Behavior of Gases	"My favorite part was learning about the different factors in pressure changes. They made a direct connection to what I can use them for in real life." "Seeing how what we were learning is actually used in everyday life." "The example problems were super great!" "I liked the equations. I disliked the organization of the sample problems."
Chapter 18: Reaction Rates and Equilibrium	"I liked the sample problems. They helped me understand the chosen topic and assigned learning target." "I think the questions/problems were relevant to lessons and prepared me well for tests."

References

Glynn, S. M., & Koballa, T. R. Jr. (2006). Motivation to learn in college science. In J.J. Mintzes & W.H. Leonard (Eds.), *Handbook of College Science Teaching* (pp. 25 – 32). Arlington, VA: National Science Teachers Association Press.

Glynn, S. M., Taasoobshirazi, G., & Brickman, P. (2009). Science motivation questionnaire: Construct validation with nonscience majors. *Journal of Research in Science Teaching*, *46*, 127 – 146.

National Academy of Sciences. (2009). National Research Council (US) Chemical Sciences Roundtable. *Strengthening high school chemistry education through teacher outreach programs*. A Workshop Summary to the Chemical Sciences Roundtable. Retrieved online June 20, 2010 http://www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=nap12533

Roberts, D. A. (2007). Scientific literacy / science literacy. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of Research on Science Education* (pp. 729 – 780). Mahwah, NJ: Lawrence Erlbaum Associates.

Sullivan, K. (2009). *Science and science education in the United States*. National Research Council (US) Chemical Sciences Roundtable. Retrieved online June 30, 2010 from http://www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=nap12533&part=ch2

Wiggins, G., & McTighe, J. (1998). *Understanding by design*. Association for Supervision and Curriculum Development: Alexandria, VA.

Appendix A. *Pearson Chemistry* (2012) Pilot Study Implementation Guidelines

The following guidelines are intended to be followed by all participating teachers in the *Pearson Chemistry* pilot study. Some aspects of the program are required to ensure all students receive program features that important to the study.

Required

- Exclusive use of *Pearson Chemistry* (2012) text for the duration of the pilot study
- Cover chapters 12, 14, and 18
- Use available online resources
- Work through the ***CHEMystery*** (beginning and end of each chapter)
- Introduce chapter using ***Big Idea*** and revisit questions and prompts throughout chapter
- Cover multiple **Sample Problems** for each chapter
- Cover multiple ***Chemistry & You*** components for each chapter
- ***Chemistry & You*** question at beginning of each section
- ***Chemistry & You*: Chemistry Careers*** with accompanying student activity
- ***Chemistry & You*: Everyday Matter*** with accompanying student activity
- ***Chemistry & You*: Technology*** with accompanying student activity
- Use the online **Virtual ChemLab Demo*** at least once throughout the study duration
- Use the **Student Workbook** for at least one chapter of instruction

Recommended

- Work through **Key Questions** at the beginning of each section and throughout text
- Review the **Vocabulary** for each section
- Have students complete the **Lesson Check** after each section
- Complete multiple **Small-Scale Labs**
- Complete multiple **Quick Labs**
- Chapter **Study Guide**
- Chapter **Assessment**
- **Standardized Test Prep** at end of each chapter

Appendix B. Component Coverage by Teacher

	Components: Chapter 12	OK Teacher	WA Teacher
Chapter 12 Components	*Big Idea*	X	X
	CHEMystery	X	X
	Quick Lab		
	Chemistry & You: Everyday Matter	X	X
	Chemistry & You: Chemistry Careers	X	
	Chemistry & You: Technology	X	
	Study Guide	X	X
	Math Tune-Up	X	
	Assessment	X	X
	CHEMystery (located in Chapter Assessment)	X	
	Standardized Test Prep	X	
Section Components 12.1	*Chemistry & You* (section opener)	X	X
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	X
Section Components 12.2	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	
Section Components 12.3	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	

	Components: Chapter 14	OK Teacher	WA Teacher
Chapter 14 Components	*Big Idea*	X	X
	CHEMystery	X	X
	Quick Lab		X
	Chemistry & You: Everyday Matter	X	
	Chemistry & You: Chemistry Careers	X	X
	Chemistry & You: Technology	X	X
	Study Guide	X	
	Math Tune-Up		
	Assessment		X
	CHEMystery (located in Chapter Assessment)		
	Standardized Test Prep		
Section Components 14.1	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	
Section Components 14.2	*Chemistry & You* (section opener)	X	X
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	
Section Components 14.3	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	X
Section Components 14.4	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	X

	Components: Chapter 18	OK Teacher	WA Teacher
Chapter 18 Components	*Big Idea*	X	X
	CHEMystery	X	X
	Quick Lab		X
	Chemistry & You: Everyday Matter	X	X
	Chemistry & You: Chemistry Careers	X	
	Chemistry & You: Technology	X	
	Study Guide	X	
	Math Tune-Up		
	Assessment		X
	CHEMystery (located in Chapter Assessment)		X
	Standardized Test Prep	X	
Section Components 18.1	*Chemistry & You* (section opener)	X	X
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	X
Section Components 18.2	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	
Section Components 18.3	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	
Section Components 18.4	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	
Section Components 18.5	*Chemistry & You* (section opener)	X	
	Key Questions	X	X
	Vocabulary	X	X
	Sample Problem(s)	X	X
	LessonCheck	X	

Appendix C. Factors Derived from Student Post-test Survey

Extraction Method: Principal Component Analysis

Rotation Method: Varimax Rotation with Kaiser Normalization

Six Factors Extracted

Factor 1: Intrinsic Motivation and Personal Relevance (Cronbach's alpha = .90)

- I enjoy learning Chemistry (.69)
- The Chemistry I learn relates to my personal goals (.78)
- I think about how the Chemistry I learn will be helpful to me (.79)
- The Chemistry I learn is more important to me than the grade I receive (.58)
- I think about how I will use the Chemistry I learn (.71)
- I find learning Chemistry interesting (.66)
- The Chemistry I learn is relevant to my life (.79)
- The Chemistry I learn has practical value for me (.79)
- I like Chemistry that challenges me (.67)
- Understanding Chemistry gives me a sense of accomplishment (.50)

Factor 2: Self-Efficacy and Assessment Anxiety (Cronbach's alpha = .88)

- I am nervous about how I will do on Chemistry tests (reversed; .83)
- I become anxious when it is time to take a Chemistry test (reversed; .42)
- I worry about failing Chemistry tests (reversed; .85)
- I am concerned that the other students are better in Chemistry (reversed; .70)
- I hate taking Chemistry tests (reversed; .69)
- I am confident that I will do well on Chemistry labs and projects (.06)
- I believe I can master the knowledge and skills in the Chemistry course (.49)
- I am confident I will do well on Chemistry tests (.62)
- I believe I can earn a grade of "A" in Chemistry class (.21)

Factor 3: Self-Determination (Cronbach's alpha = .74)

- If I am having trouble learning Chemistry, I try to figure out why (.62)
- I put enough effort into learning Chemistry (.63)
- I use strategies that ensure I learn Chemistry well (.73)
- I prepare well for the science tests and labs (.68)

Factor 4: Career Motivation (Cronbach's alpha = .88)

- I think about how learning Chemistry can help me get a good job (.80)
- I think about how learning Chemistry can help my career (.85)

Factor 5: Grade Motivation (Cronbach's alpha = .55)

- I like to do better than the other students on Chemistry tests (.76)
- Earning a good Chemistry grade is important to me (.52)
- I expect to do as well as or better than other students in Chemistry class (.72)
- I think about how my Chemistry grade will affect my overall grade point average (.47)
- It is my fault, if I do not understand Chemistry (.22)

Factor 6: Teacher Influence (Cronbach's alpha = .81)

- My teacher expects me to do well in my chemistry class (.62)
- My Chemistry teacher explains concepts clearly (.85)
- My teacher inspires me to do my best in Chemistry (.88)
- My teacher makes learning about Chemistry fun (.84)

COBBLESTONE
APPLIED RESEARCH & EVALUATION, INC.
2120 Foothill Blvd., Ste. 202 | La Verne, CA 91750 | (800) 971-3891