Supplementing Information

Supplementary Table 1. General Chemistry Textbooks Evaluated and Analyzed in this Study

Title and Citation	Author/s	Edition (Year of Publication)	Relevant Chapters
Chemistry: The Central Science Brown et al. (2015)	Theodore L. Brown H. Eugene LeMay, Jr. Bruce E. Bursten Catherine J. Murphy Patrick M. Woodward Matthew W. Stoltzfus	13th ed. (2015)	Preface (pp. xx-xxix) Ch 1: “Introduction: Matter and Measurement” (pp. 2-39) Ch 2: “Atoms, Molecules, and Ions” (pp. 39-79) Ch 6: “Electronic Structure of Atoms” (pp. 213-255)
Chemistry Chang (2010)	Raymond Chang	10th ed. (2010)	Preface (pp. xxi-xxxii) Ch 1: “Chemistry: The Study of Change” (pp. 2-39) Ch 2: “Atoms, Molecules, and Ions” (pp. 40-77) Ch 7: “Quantum Theory and the Electronic Structure of Atoms” (pp. 274-321)
Chemistry for Changing Times Hill et al. (2013)	John W. Hill Terry W. McCreary Doris K. Kolb	13th ed. (2013)	Preface (pp. xiii-xxiii) Ch 1: “Chemistry” (pp. 1-40) Ch 2: “Atoms” (pp. 41-60) Ch 3: “Atomic Structure” (pp. 61-88)
Chemistry: Principles and Reactions Masterton et al. (2012)	William L. Masterton Cecile N. Hurley Edward J. Neth	7th ed. (2012)	Preface (pp. xv-xxv) Ch 1: “Matter and Measurements” (pp. 1-26) Ch 2: “Atoms, Molecules, and Ions” (pp. 27-59) Ch 6: “Electronic Structure and the Periodic Table” (pp. 155-189)
Chemistry: The Molecular Nature of Matter and Change Silberberg (2009)	Martin S. Silberberg	5th ed. (2009)	Preface (pp. xvi-xxvii) Ch 1: “Keys to the Study of Chemistry” (pp. 2-39) Ch 2: "The Components of Matter" (pp. 40-88) Ch 7: "Quantum Theory and Atomic Structure" (pp. 268-301) Ch 8: "Electron Configuration and Chemical Periodicity" (pp. 302-339)
Chemistry Zumdahl and Zumdahl (2014)	Stephen S. Zumdahl Susan A. Zumdahl	9th ed. (2014)	Preface (pp. ix-xx) Ch 1: “Chemical Foundations” (pp. 1-41) Ch 2: “Atoms, Molecules, and Ions” (pp. 42-80) Ch 7: “Atomic Structure and Periodicity” (pp. 295-350)

Supplementary Table 2. Sample Excerpts per Criterion
(unless otherwise indicated, italics and emphases are from the original text)

NOS Dimension	Rating	Excerpt
(1) Tentative	Satisfactory and Explicit (S)	(1.1) "Scientists organize the knowledge they accumulate on a framework of detailed explanations called theories. A **theory** represents the best current explanation for a phenomenon, but it is always *tentative*. In the future, a theory may have to be modified or even discarded as a result of new observations, for the body of knowledge that is rapidly growing and always changing." (Hill et al., 2013, p. 6)
	Mention and Implicit (M)	(1.2) "We will be encountering many theories as we proceed through this book. Some of them have been found over and over again to be consistent with observations. However, no theory can be proven to be absolutely true. We can treat it as though it is, but there always remains a possibility that there is some respect in which a theory is wrong." (Brown et al., 2015, p. 15)
(2) Empirical	Satisfactory and Explicit (S)	(2.1) "An experiment is a clear set of procedural steps that tests a hypothesis. Experimentation is the connection between our hypotheses about nature and nature itself. Often, hypothesis leads to experiment, which leads to revised hypothesis, and so forth. Hypotheses can be altered, but the results of an experiment cannot. An experiment typically contains at least two **variables,** quantities that can have more than a single value. A well-designed experiment is **controlled** in that it measures the effect of one variable on another while keeping all others constant. For experimental results to be accepted, they must be *reproducible*, not only by the person who designed the experiment, but also by others. Both skill and creativity play a part in experimental design." (Silberberg, 2009, p. 13)
	Mention and Implicit (M)	(2.2) "In the past 200 years, a great deal of experimental evidence has accumulated to support the atomic model. This theory has proved to be both extremely useful and physically reasonable. When atoms were first suggested by the Greek philosophers Democritus and Leucippus about 400 B.C., the concept was based mostly on intuition. In fact, for the following 20 centuries, no convincing experimental evidence was available to support the existence of atoms. The first real scientific data were gathered by Lavoisier and others from quantitative measurements of chemical reactions. The results of these stoichiometric experiments led John Dalton to propose the first systematic atomic theory. Dalton's theory, although crude, has stood the test of time extremely well." (Zumdahl and Zumdahl, 2014, p. 296)
(3) Model-Based	Satisfactory and Explicit (S)	(3.1) "Formulating conceptual models, or **theories,** *based on experiments* is what distinguishes scientific thinking from speculation. As hypotheses are revised according to experimental results, a model gradually emerges that describes how the observed phenomenon occurs. A model is not an exact representation of nature, but rather a simplified version of nature that can be used to make *predictions* about related phenomena. Further investigation refines a model by testing its predictions and altering it to account for new facts." (Silberberg, 2009, p. 13)
	Mention and Implicit (M)	(3.2) "Bohr's theory for the structure of the hydrogen atom was highly successful. Scientists of the day must have thought they were on the verge of being able to predict the allowed energy levels of all atoms. However, the extension of Bohr's ideas to atoms with two or more electrons gave, at best, only qualitative agreement with experiment. Consider, for example, what happens when Bohr's theory is applied to the helium atom. For helium, the errors in calculated energies and wavelengths are of the order of 5% instead of the 0.1% error with hydrogen. There appeared to be no way the theory could be modified to make it work well with helium or other atoms. Indeed, it soon

		became apparent that there was a fundamental problem with the Bohr model. The idea of an electron moving about the nucleus in a well-defined orbit at a fixed distance from the nucleus had to be abandoned." (Masterton et al., 2012, p. 163)
(4) Inferential	Satisfactory and Explicit (S)	(4.1) "One of life's most important activities is solving problems—not 'plug and chug' exercises, but real problems—problems that have new facets to them, that involve things you may have never confronted before. The more creative you are at solving these problems, the more effective you will be in your career and your personal life. Part of the reason for learning chemistry, therefore, is to become a better problem solver. Chemists are usually excellent problem solvers because to master chemistry, you have to master the scientific approach. Chemical problems are frequently very complicated—there is usually no neat and tidy solution. Often it is difficult to know where to begin." (Zumdahl and Zumdahl, 2014, p. 5)
	Mention and Implicit (M)	(4.2) "The purpose of this course is to make you think like a chemist, to look at the *macroscopic world*—the things we can see, touch, and measure directly—and visualize the particles and events of the *microscopic world* that we cannot experience without modern technology and our imaginations. At first some students find it confusing that their chemistry instructor and textbook seem to be continually shifting back and forth between the macroscopic and microscopic worlds. Just keep in mind that the data for chemical investigations most often come from observations of large-scale phenomena, but the explanations frequently lie in the unseen and partially imagined microscopic world of atoms and molecules. In other words, chemists often *see* one thing (in the macroscopic world) and *think* another (in the microscopic world). Looking at the rusted nails in Figure 1.2, for example, a chemist might think about the basic properties of individual atoms of iron and how these units interact with other atoms and molecules to produce the observed change." (Chang, 2010, p. 7)
(5) Technological Products	Satisfactory and Explicit (S)	(5.1) "How do fireworks produce their brilliant colors and loud bangs? Actually, only a handful of different chemicals are responsible for most of the spectacular effects. To produce the noise and flashes, an oxidizer (an oxidizing agent) and a fuel (a reducing agent) are used. A common mixture involves potassium perchlorate ($KClO_4$) as the oxidizer and aluminum and sulfur as the fuel. The perchlorate oxidizes the fuel in a very exothermic reaction, which produces a brilliant flash, due to the aluminum, and a loud report from the rapidly expanding gases produced. For a color effect, an element with a colored emission spectrum is included. Recall that the electrons in atoms can be raised to higher-energy orbitals when the atoms absorb energy. The excited atoms can then release this excess energy by emitting light of specific wavelengths, often in the visible region. In fireworks, the energy to excite the electrons comes from the reaction between the oxidizer and fuel." (Zumdahl and Zumdahl, 2014, p. 300, excerpt from text box "Chemical Connections: Fireworks")
	Mention and Implicit (M)	(5.2) "Not all radiation sources produce a continuous spectrum. When a high voltage is applied to tubes that contain different gases under reduced pressure, the gases emit different colors of light. The light emitted by neon gas is the familiar red-orange glow of many "neon" lights, whereas sodium vapor emits the yellow light characteristic of some modern streetlights. When light coming from such tubes is passed through a prism, only a few wavelengths are present in the resultant spectra. Each colored line in such spectra represents light of one wavelength. A spectrum containing radiation of only specific wavelengths is called a **line spectrum.**" (Brown et al., 2015, p. 219)

(6) Instrumentation	Satisfactory and Explicit (S)	(6.1) "Mass spectrometry is also used in structural chemistry and separations science to measure the mass of virtually any atom, molecule, or molecular fragment. The technique is employed by biochemists determining protein structures, materials scientists examining catalyst surfaces, forensic chemists analyzing criminal evidence, pharmaceutical chemists designing new drugs, industrial chemists investigating petroleum components, and many others. In fact, John B. Fenn and Koichi Tanaka shared part of the 2002 Nobel Prize in chemistry for developing methods to study proteins by mass spectrometry." (Silberberg, 2009, p. 55, excerpt from text box "Tools of the Laboratory: Mass Spectrometry")
	Mention and Implicit (M)	(6.2) "Relative masses of individual atoms can be determined using a mass spectrometer. Gaseous atoms or molecules at very low pressures are ionized by removing one or more electrons. The cations formed are accelerated by a potential of 500 to 2000 V toward a magnetic field, which deflects the ions from their straight-line path. The extent of deflection is inversely related to the mass of the ion. By measuring the voltages required to bring two ions of different mass to the same point on the detector, it is possible to determine their relative masses." (Masterton et al., 2012, p. 33)
(7) Social and Societal Dimensions	Satisfactory and Explicit (S)	(7.1) "Fundamentally, chemists do three things: (1) make new types of matter: materials, substances, or combinations of substances with desired properties; (2) measure the properties of matter; and (3) develop models that explain and/or predict the properties of matter. One chemist, for example, may work in the laboratory to discover new drugs. Another may concentrate on the development of new instrumentation to measure properties of matter at the atomic level. Other chemists may use existing materials and methods to understand how pollutants are transported in the environment or how drugs are processed in the body. Yet another chemist will develop theory, write computer code, or run computer simulations to understand how molecules move and react on very fast time scales. The collective chemical enterprise is a rich mix of all of these activities." (Brown, et al., 2015, p. 6, excerpt from "Chemistry Put to Work: Chemistry and the Chemical Industry")
	Mention and Implicit (M)	(7.2) "The development of science has been irregular and sometimes even illogical. Great discoveries are usually the result of the cumulative contributions and experience of many workers, even though the credit for formulating a theory or a law is usually given to only one individual. There is, of course, an element of luck involved in scientific discoveries, but it has been said that "chance favors the prepared mind." It takes an alert and well-trained person to recognize the significance of an accidental discovery and to take full advantage of it. More often than not, the public learns only of spectacular scientific breakthroughs. For every success story, however, there are hundreds of cases in which scientists have spent years working on projects that ultimately led to a dead end, and in which positive achievements came only after many wrong turns and at such a slow pace that they went unheralded. Yet even the dead ends contribute something to the continually growing body of knowledge about the physical universe. It is the love of the search that keeps many scientists in the laboratory." (Chang, 2010, p. 9)