Other references: The use of puzzles in Science Education environments. Here are some papers related to their development and implementation at different levels. These are chemistry oriented.

1. An ionic compound logic puzzle, McClure, Craig P. J. of Chem. Ed. (2009), 86(10), 1210-1211. This logic puzzle is designed to promote logical thinking skills in the application of chem. concepts in an enjoyable and challenging format. This activity also serves as a review of many topics related to ionic compds., and synthesis of these ideas is necessary for the successful completion of the activity. A student-ready version of this activity is available online for ease in integration of the activity into the classroom.
2. Elemental Chem. puzzlers, Thomas, Nicholas C. J. of Chem. Ed. (2009), 86(10), 1208-1209. Various chem. related puzzles that are most appropriate for high school chem. for good mental exercises are presented.
3. Prote-ACE. A logic puzzle to determine a polypeptide sequence, McClure, Craig P. J. of Chem. Ed. (2009), 86(4), 457. The article presents a logic puzzle that deals with the detn. of the amino acid sequence of a peptide and requires a knowledge of characteristics and structure of amino acid side chains, differentiation of amine and carboxyl termini of a peptide, and terminol. used to describe peptides.
4. Biochemistry wordsearches II, Helser, Terry L. J. of Chem. Ed. (2009), 86(4), 456. The article presents wordsearch puzzle to enhance learning biochem. vocabulary.
5. Elemental chem lab Joaquin Franco Mariscal, Antonio, J. of Chem. Ed. (2008), 85(10), 1370-1371.The article presents an interesting method for students to learn symbols and the names of about fifty elements and use of about thirty items of lab. equipment is described. The method uses a puzzle with chem. elements to teach chem. formulation.
6. Puzzling through general chemistry: A light-hearted approach to engaging students with chemistry content, Boyd, Susan L. J. of Chem. Ed. (2006), 84(4), 619-621.The article introduces puzzles designed to be used students as learning tools to teach or reinforce chem. concepts.
7. Sudoku puzzles for first-year organic chemistry students, Perez, Alice L.; Lamoureux, G. J. of Chem. Ed. (2006), 84(4), 614. The widespread popularity of the sudoku puzzles shows the attraction that solving problems with logic provides. Amino acid sudoku puzzles were developed for teaching amino acids and of functional groups in an org. chem. undergraduate class.
8. Sudoku puzzles as chemistry learning tools, Crute, Thomas D.; Myers, Stephanie A., J. of Chem. Ed. (2006), 84(4), 612-613. Sudoku puzzles were developed that use chem. terms for students to appreciate "fun" ways to do boring tasks such as memorizing fundamental chem. vocabulary. The design of Sudoku puzzles incorporate lists of chem. terms that students need to know, such as polyat. ions, org. functional groups, or strong nucleophiles. It was believed that the repetition involved in solving the puzzles would aid in memorization of these items. Furthermore, easily confused symbols that are superficially similar but different upon closer inspection such as sulfate and sulfite polyat. ions, would be ideal candidates for inclusion since students must attend to the details of each symbol to ensure no repetition.
9. Chemistry of art and color sudoku puzzles, Welsh, Michael J., J. of Chem. Ed. (2006), 84(4), 610-611. The precursor of the sudoku puzzle was first published in the United States in 1979 Howard Garns, a retired architect and freelance puzzle constructor. In Apr. 1984, the puzzle was introduced in Japan and the name "sudoku" was assigned to the puzzle. "Suuji wa dokushin ni kagiru" may be translated as "the nos. must be single" or "the nos. must occur only once". Later the name was abbreviated to sudoku (pronounced SUE-dough-coo; "su" means no., "doku" means single). Three sudoku puzzles that use that use light science and chem. terms taught in a nonmajor course are presented.
10. A disciplined Chem. puzzle, Peris, Miguel, J. of Chem. Ed. (2006), 84(4), 609. The article presents a puzzle developed as a resource for teaching intermediate chem. students. After addressing the chem. content (relying on some inorg. and org. chem. knowledge and independent or small-group research), students use general intelligence and logic skills to solve this chem. puzzle.
11. Acrostic puzzles in the classroom, Swain, Dorothy, J. of Chem. Ed. (2006), 83(4), 589. Acrostics use clues to generate words whose letters are rearranged to make a quotation about science. The author of the quotation is contained in the answers to the clues, which can comeall areas of knowledge and encourage students to think outside of their disciplinary focus. Students practice word-recall skills, spelling, and pattern recognition. Then, they have a stimulating quotation to think about, as well as the name of a noted thinker.
12. The periodic table: contest and exhibition, Silva, Aurora; Barroso, M. Fatima; Freitas, Olga; Teixeira, Salome; Morais, Simone; Delerue-Matos, Cristina J. of Chem. Ed. (2006), 83(4), 557-560. To appeal to a better understanding of the periodic table, the Instituto Superior de Engenharia do Instituto Politecnico do Porto and the Centro de Quimica da Universidade do Porto promoted a contest and exhibit with the goal of stimulating a wide

and heterogeneous audience, rangingyoung children and their parents to graduate studentsseveral disciplines, to explore the nature of this icon.

13. Solving the puzzle for the Chem. formulaconstituent ions: Putting the pieces together, Harris, Michele R.; Garrett, James M. Chem. Educator (2005), 10(4), 248-249. We present a simple, brief visual aid for majors or nonmajors and a hands-on activity for nonmajors or high school students involving ionic puzzle pieces. The exercise assists students in detg. the correct stoichiometry of ionic compds. Puzzle pieces representing various cations and anions are constructedoverhead transparencies for the visual aid andbrightly colored card stock for the hands-on activity. These puzzle pieces are used to demonstrate how different ions must pair to maintain a neutral charge balance when forming ionic compds.
14. Using building-block puzzles to practice drawing organic mechanisms, Erdik, Ender, J. of Chem. Ed. (2005), 82(9), 1325-1326. A pencil-and-paper activity to aid students in writing org. reaction mechanisms was developed.
15. Exploring organic mechanistic puzzles with molecular modeling, Horowitz, Gail; Schwartz, Gary, J. of Chem. Ed. (2004), 81(8), 1136-1139. Mechanistic puzzles involving reactions not familiar to the students can be used as mol. modeling group projects.
16. Does active learning through an antisense jigsaw make sense? Seetharaman, Mahadevan; Musier-Forsyth, Karin, J. of Chem. Ed. (2003), 80(12), 1404-1407. An antisense jigsaw was successfully implemented in a graduate-level nucleic acids chem. course.
17. Spiral puzzle for organic chemistry students, Erdik, Ender, J. of Chem. Ed. (2003), 80(4), 428-430. An Ed. puzzle has been designed to test the ability of students to remember named org. reactions and reagents.
18. Electron transport wordsearch, Helser, Terry L. J. of Chem. Ed. (2003), 80(4), 419-420. An Ed.al puzzle that contains 41 names, terms, and acronyms that describe electron transport and oxidative phosphorylation is presented. The terms to find are given in a narrative clues that describes these pathways.
19. Genetic code wordsearch, Helser, Terry L.J. of Chem. Ed. (2003), 80(4), 417-418. An Ed.al puzzle that contains 30 words describing nucleotide sequences used to make proteins in all terrestrial organisms is presented. The puzzle also includes six acronyms for the nucleic acids directing this process.
20. Find the symbols of elements using a letter matrix puzzle, Kelkar, V. D. J. of Chem. Ed. (2003), 80(4), 411-413. A letter matrix puzzle related to the symbols of chem. elements is proposed as a useful tool for students to remember the symbols of elements. It may also help in testing one's knowledge about the etymol., characteristic properties, and role and applications related to the chem. of elements because one has to recognize the elements and their symbols using the clues given.
21. Letter matrix puzzle on the symbols of elements, Kelkar, V. D. J. of Chem. Ed. (2002), 79(4), 456-457. A 3 X 3-letter matrix puzzle based on the symbols of 35 elements is described. The symbols of the elements are to be written in the square or squares bearing the nos. shown in the clues, assigning only one letter to each square. Thus, the two-letter symbols may appear vertically, horizontally, or diagonally in either direction.
22. Using proverbs in chemistry, Ibanez, Jorge G. J. of Chem. Ed. (2002), 79(4), 454-455. Informal techniques have frequently been used to provide a relaxed atm. at various points in chem. courses. They offer a good opportunity to introduce, reinforce, or clarify some concepts. Anecdotes, stories, analogies, wordsearches, games, puzzles, and matching tests are among them.
23. Apparent paradoxes and instructive puzzles in physical chemistry, Bartell, Lawrence S. J. of Chem. Ed. (2001), 78(8), 1067-1069. Posing puzzles that challenge the imagination of phys. chem. students makes lectures more lively and conveys ideas in a way that makes them stick with students longer than direct statements of fact and principle. Some examples are presented which question common-sense expectations related to mass, energy, heat, work, entropy, conservation of energy, and phys. laws.
24. Stories to make thermodynamics and related subjects more palatable, Bartell, Lawrence S. J. of Chem. Ed. (2001), 78(8), 1059-1067.A collection of stories is presented to make chem. students become more interested in thermodn., surface science, and kinetic theory. The stories illustrate aspects of principles, recount the personalities of of some of the architects of thermodn. and related fields, and review steps and missteps in the development of these fields. The author also posed scientific puzzles, encouraging students to apply their imagination about how they could be resolved using the basic framework already established.
25. A puzzle concerning solution equilibria, Gans, Peter J. of Chem. Ed. (2000), 77(4), 489-490. A puzzle is presented to reinforce the understanding of simple acid-base equil. and to give students an introduction to more complicated equil.
26. Puzzles in chemistry and logic, Castro-Acuna, Carlos Mauricio; Dominguez-Danache, Ramiro E.; Kelter, Paul B.; Grundman, Julie J. of Chem. Ed. (1999), 76(4), 496-498. Puzzles requiring chem. knowledge and logic skills are presented. The puzzles were used in the Mexican Chem. Olympiad and were enjoyed first-year college chem. students at the University of Nebraska-Lincoln. The chem.-related possibilities are endless and teachers can

enhance the chem. knowledge to solve each puzzle.

27. The Chem. adventures of Sherlock Holmes: the death puzzle at 221B Baker Street, Rybolt, Thomas R.; Waddell, Thomas G. J. of Chem. Ed. (1999), 76(4), 489-493. A Sherlock Holmes mystery story is presented which can be used to teach some chem. reactions in medicinal chem. The mystery is about Holmes having an ailment which almost results in his death. The soln. was in the earthenware pots and cups given as a present to him Dr. Watson. The pots and cups contain sol. lead salts which react with the acidlemons used in making tea. Holmes was therefore afflicted with plumbism or lead poisoning.
28. Using games to teach chemistry: an annotated bibliography, Russell, Jeanne V. J. of Chem. Ed. (1999), 76(4), 481-484. Many chem. instructors employ games and puzzles to make learning chem. more fun and interesting. A list of published and com. available chem. games is presented. Topics include general knowledge, elements and at. structure, nomenclature, formulas and equation writing, chem. reactions, solns. and solubilities, org. chem., and others.
29. Extended wordsearches in chemistry, Cotton, Simon J. of Chem. Ed. (1998), 75(4), 489-490. Applications of wordsearch puzzle grids for students aged 11-16 to assist in and reinforce learning of various topics is described.
30. A Chem. Puzzle, Spencer, Harry E.; Kusdra, Leonard J. of Chem. Ed. (1998), 75(4), 487-488. A simple qual. anal. problem for identification of 2 cations and an anion in a soln. is couched in the form of a puzzle.
31. P-Chem crossword puzzle, Snead, Claybourne C. J. of Chem. Ed. (1975), 52(3), 158, 174. A crossword puzzle for instruction in phys. chem.
32. Novel type of chemistry end term assignment, Jaffe, Marvin R. J. of Chem. Ed. (1974), 51(1), 27. A crossword puzzle is given as an instructional and testing tool in a general chem. course.