Appendix 1: A topic list/course learning objectives for both Introduction to Inorganic Chemistry groups described three main categories: transition elements and coordination chemistry, solid state materials and covalent molecular substances.

Online Course Learning Objectives	Face-to-Face Course Learning Objectives
Covalent Molecular Substances • Review and strengthen knowledge associated with drawing proper Lewis structures and using Lewis structures to predict 3-dimensional shapes using VSEPR theory. • Review of fundamental covalent bonding issues in simple compounds. **Solid state Materials** • Develop fundamental knowledge of crystal lattices and packing arrangements, and apply this knowledge to monatomic (one type of atom) solids. • Develop fundamental knowledge of packing in ionic solids, composed of both cations and anions. • Examine band theory, one way to describe the bonding in extended solids. • Examine an extension of band theory, as applied specifically to semiconductors. **Transition Elements and Coordination Chemistry** • Develop fundamental knowledge of transition metal complex ions, including composition (metals ions and ligands) and basic 3-dimensional structure types. • Examine structural isomerism in transition metal complexes. • Examination of crystal field theory, which is one way to describe the bonding in a complex ion. • Examine the consequences of crystal field theory in transition metal complexes. • Understand and differentiate between inner and outer sphere electron transfer reactions of complex ions. • Understand the mechanism of ligand substitution in a square planar complex and predict the products of such reactions using the kinetic trans effect.	**Covalent Molecular Substances** • Identify the number of valence electrons in a molecule or ion and draw the Lewis Structures for the molecule or ion. • Use VSEPR to predict molecular geometry. • Predict if a molecule is polar or non polar. • Identify approximate bond angles given a chemical formula. • Be able to draw the energy level diagrams for molecules and ions related to diatomic molecules or ions discussed in class. • Know the principles of MO theory discussed in lecture: identify which atomic orbitals an element has using its electron configuration, know how molecular orbitals are formed, know how to identify the names, shapes and energies of molecular orbitals formed. **Solid State Materials** • Distinguish among and characterize the various types of crystals: ionic, metallic, covalent, and atomic/molecular. • Know the differences in bonding for: main group compounds vs. ionic solids. • Identify and characterize common A-type structures by the number of spheres per unit cell. Calculate the density given the edge length OR calculate the edge length from the density. Be able to convert between atomic radius and edge length for A type solids. • Identify and characterize common AB type structures by the number of formula units per unit cell. • Understand the correlation between bonding and the melting point of ionic and metallic solids. • Draw a z-level diagram for a given solid. • Describe the basic features of band theory. • Characterize normal spinel and Perovskite structures and provide a rationale for the structure of a given compound based on chemical formula or unit cell provided.

Appendix 1 Continued: A topic list/course learning objectives for both Introduction to Inorganic Chemistry groups described three main categories: transition elements and coordination chemistry, solid state materials and covalent molecular substances.

Online Course Learning Objectives	Face-to-Face Course Learning Objectives
Main group non-metals • Review of the periodic trends in atomic properties that are associated with fundamental physical and chemical properties, as well as an examination of the fundamental redox and acid-base trends of elements and simple compounds. • Understand the chemistry of representative compounds of Group 5 and 6 within the framework of the periodic trends. • Understand and predict the structural chemistry of representative compounds of group 5 and 6. • Describe the atmospheric chemistry of sulfur oxides in the context of acid rain.	**Transition Elements and Coordination Chemistry** • Know the names and formulas for common ligands and their denticity. • Given the formula for a coordination complex, identify the metal and its oxidation state, the ligands, the coordination number and coordination geometry, and the overall charge on the complex. • Predict the incidence of linkage isomers that occur with the common ambidentate ligands. • Given the molecular formula of a complex, determine whether isomers are possible, and draw their structures. • Know the shapes of the five *d* orbitals. • Draw an energy level diagram representing splitting of the metal *d* orbitals by the ligand fields in: octahedral, square planar, tetrahedral, compressed and elongated octahedral and other geometries discussed in lecture. • Explain how factors such as the type of geometry, the size and charge of the metal ion, and the size and charge of the ligand should affect the magnitude of the crystal field splitting energy. • Rationalize why so many coordination compounds are highly colored and how these colors can, in some cases, be simply related to the size of crystal field splitting energy. • Predict the number of unpaired electrons and calculate the spin-only magnetic moment. • Knowing the number of unpaired electrons, predict if the complex is diamagnetic or paramagnetic. • Identify kinetic and thermodynamic effects of coordination compounds and dissociative or associative mechanisms for substitution reactions.

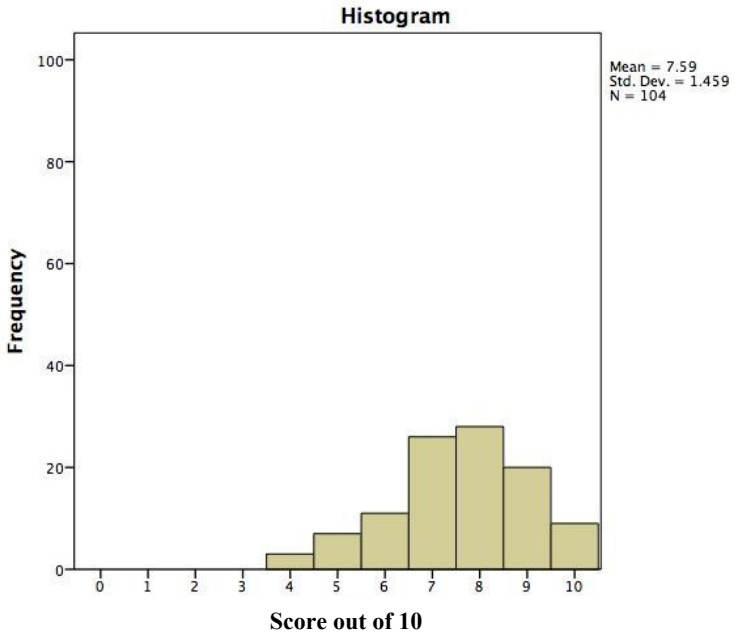
Appendix 2: Example multiple choice exam question.

Example of a multiple-choice exam question given to both groups to test the learning objective: Predict the geometric structures of transition metal complexes.

Consider the two isomeric complexes $[Cu(H_2O)_5(NO_2)]^+$ and $[Cu(H_2O)_5(ONO)]^+$. These two complexes contain the ambidentate nitrite ligand. Which of the statements below best describes these two isomers?

A. These two complexes are linkage isomers.
B. These two complexes are geometric isomers.
C. These two complexes are optical isomers.
D. These two complexes are ionization isomers.

Appendix 3: Graph showing the exam score data in a histogram.



Appendix 4: Number of Students Who Withdrew (W) or Received a Failing grade of D or F.

Group	n	D	F	W
Online	45	0	2	3
Face-to-Face	64	3	1	0