Researcher Bio

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Lesson Plan Title, Grade Level, and Keywords: Separation and Analysis of Components of a Mixture, 8^{th} -12^{th} grade, Chemistry, Separation Techniques, Mixture, Physical and Chemical Properties

Brief Description of Research Interests:

My research focuses on crystal growth studies, nanostructuring and property analysis of alkaline earth transition metal tetrasilicates with Cr(II) and other divalent transition metals such as Fe(II), Mn(II), Co(II), and Cu(II) in square-planar coordination. The significance of this research is the presence of high spin square-planar complexes which is unusual for the most of d metal ions that have d electron configuration ≥ 4 including, but not limited to, *d4* Cr(II) and *d6* Fe(II) due to high energy separation of dx^2-y^2 orbital from rest of the d orbitals in square-planar geometry. $ACrSi_4O_{10}$ (A=Ca, Sr, Ba) are noteworthy as examples of rare, high spin Cr(II) in square-planar coordination complexes in chromium chemistry. I use high temperature solid state and fluxed-base routes to yield either polycrystalline or single crystalline products. For the product purification, I utilize different solvents to dissolve impurities and separation techniques like decanting, filtration, physical separation, etc. depending on the properties of my product mixture. I analyze structural, morphological, and electronic properties through advanced characterization methods. As properties, Cr(II) and Fe(II)/Cr(II) tetrasilicates, show magnetic and electronic properties, the possible application areas are in next generation magnetic/electronic devices.

Separation and Analysis of Components of a Mixture (8th - 12th)

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Introduction/Abstract to Lesson Plan (max. 100 Words) Include aspects of the lesson that are unique and innovative.	The lesson introduces students to the two types of mixtures, principles of separation of a mixture, and its possible real-world applications. We will discuss different separation techniques, such as filtration, decanting, distillation, etc., to isolate individual substances out of a mixture depending on their chemical and physical properties. This lesson further correlates to the separation techniques involved in a research lab, the actual difficulties a researcher may face, and ways they overcome those difficulties.
List of Standards Addressed (This should be list of all full standards addressed by the lesson.)	**Science Georgia Standards of Excellence: Chemistry** **S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.** a. Develop and use a model to compare and contrast pure substances (elements and compounds) and mixtures. (Clarification statement: Include heterogeneous and homogeneous mixtures. Types of bonds and compounds will be addressed in high school physical science.) c. Plan and carry out investigations to compare and contrast chemical and physical properties of matter. d. Construct an argument based on observational evidence to support the claim that when a change in a substance occurs, it can be classified as either chemical or physical. (Clarification statement: Evidence could include ability to separate mixtures) **SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.** c. Use mathematics and computational thinking to apply concepts of the mole and Avogadro's number to conceptualize and calculate • percent composition • mass, moles, and molecules relationships
Learning Objectives using Measurable Verbs (what students will be able to do)	• At the end of the lesson, the students will be able to identify the difference between a homogeneous and a heterogeneous mixture • At the end of this lesson, the students will be able to understand the various separation techniques and apply the scientific method to a problem • At the end of the lesson, the student will be able to analyze a mixture and calculate percent composition of each substance in a mixture
Appropriate Grade Levels	8th grade, but can scale up to 9th-12th grade

Group Size/# of students activities are designed for	Independent, 2-3 students, whole class
Setting (e.g. indoors, outdoors, lab, etc.)	Indoors, Outdoors, or in lab
Approximate Time of Lesson (Break down into 20-50 minute periods)	40 minutes altogether to prepare and check results of the experiment, 10 minutes for class discussion
Resources Needed for Students (e.g. scissors, paper, pencils, glue, etc.)	3 Cups or Beakers, 1 Magnet, 1 Funnel, 3 Tablespoons, Coffee Filters (optional), 1 Popsicle stick Water, Salt (Table Salt), Fe Fillings, Beach Sand
Resources Needed for Educators (e.g. blackboard, Powerpoint capabilities, etc.)	PowerPoint Capabilities (Optional)
Apps/Websites Needed	N/A
Lesson Activity (step by step description of activity)	Introduction • Set up the required materials for the experiment • Introduce components of the experiment
	Background • Pure substance vs mixture • Types of mixtures (homogeneous vs heterogeneous) • Separation techniques based on chemical and physical properties • Real-world application of mixtures and separation techniques
	Step by Step Activity 1. Mix one tablespoon of salt, one tablespoon of beach sand, and 1/2 tablespoon of Fe fillings in a cup 2. Weigh the total mixture (this is optional for 8th grade) 3. Develop a method to separate three components (You may ask students to develop a method in class as groupwork or ask them to develop their own plan in advance and bring it to the class). Remind them that they are given a magnet, filter papers, a funnel, and water. 4. Review the students' developed methods and discuss the lab plan which includes the following steps a) Remove Fe fillings from the mixture using a magnet b) Add water to the rest of the mixture (salt and sand mixture) and mix it well c) Seal the moistened edge of a coffee filter against the funnel and then place the funnel over one of the empty cups. The coffee filter will be in the funnel and the short stem of the funnel should touch the walls of the empty cup. Carefully and slowly pour the salt and sand mixture into the funnel. You will see salty water is collecting in the empty cup while leaving sand in the original cup or in the coffee filter. d) Leave the liquid portion (salty solution) in the sunshine or place in a hot environment. You will see the formation of salt crystals. 5. Weigh all three separated individual substances (this is optional for 8th grade)

	Reflection/Assessment • Record the modified method that you developed to separate the given mixture • What property of Fe fillings was useful to remove it from the mixture? Is it a physical or chemical property? • Which component dissolved when you added water to the mixture of salt and sand? Is it a physical or chemical property? • Identify the following mixtures as homogeneous vs. heterogeneous mixtures A. Salt and Water B. Sand and Water • From your point of view, how would you enhance the efficiency of the filtering process of the salty water and sand mixture? <u>Additional Questions for 9th-12th Grade</u> • What was the percent composition of each component in the mixture? • From your point of view, how would you improve the crystal growth of salt if you were asked to modify the salty water evaporation step?
Final Product/Assessment (e.g. quiz, presentation, essay, etc.)	Teacher may pick either a presentation or a one-page writeup of their experimental findings, in addition to an informal class discussion (similar to our research lab group meetings)