

DEVELOPING AN INSTRUCTIONAL MODULE

Howard Kimmel

kimmel@adm.njit.edu

John Carpinelli

Carpinelli@adm.njit.edu

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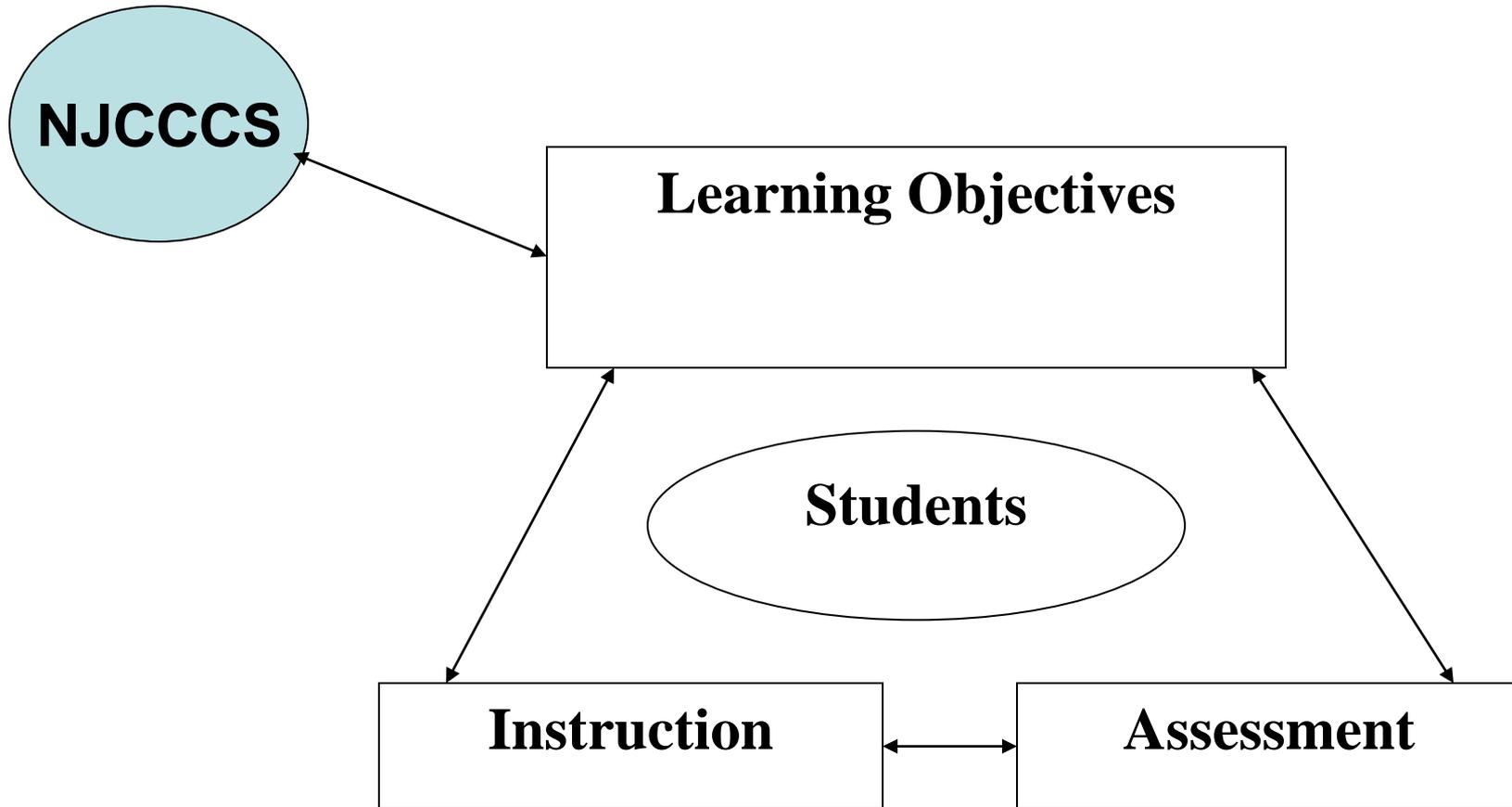
Levelle Burr-Alexander

Burr-alexander@adm.njit.edu

Center for Pre-College Programs
New Jersey Institute of Technology

Elements of Lesson/Course Design

(Felder & Brent (2003). *Journal of Engineering Education*, 92(1), 7-25)



Key Questions for Planning a Learning Experience for Students

- What do I expect students to learn?
 - Expectations
- What experiences will contribute to learning?
What must I include?
 - Experiences
- How will I know that they've learned it? How do I design my assessment to measure the learning that I want?
 - Assessment

Basic Components of a Standards-Based Lesson Plan: Learning Objectives and Outcomes

- Specification of desired skills and knowledge.
- Opportunities for students to acquire desired skills and knowledge.
- Assess and document acquisition of desired skills and knowledge.

Assessment - Provide assessment tools/activities for teachers to assess the learning objectives described earlier.

How do you know if the students “got it” during the lesson and after the lesson? Assessments should gauge what the students know about the topic at the beginning, and whether the students *met the learning objectives* at the end.

Educational Standards and Indicators

- List up to 4 indicators of the standards that students would learn as a result of completing this lesson or activity.
- Treat the indicators like learning objectives, and it should be clear in the curriculum where students will learn them.
- Listing skills and/or knowledge from the indicators that students will actually learn from the educational experience.

OUTCOMES TEMPLATE

- **TOPIC:**
- **SKILL/KNOWLEDGE TO BE ACQUIRED (LEARNING OBJECTIVES):**
- **STANDARD(S) & PERFORMANCE INDICATOR(S):**
- **HOW WILL SKILL/KNOWLEDGE BE ACQUIRED (INSTRUCTION):**
- **HOW WILL STUDENTS DEMONSTRATE ACQUISITION OF SKILL/KNOWLEDGE (ASSESSMENT):**

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MODULE DEVELOPMENT – OUTCOMES MATRIX

	MODULE	LESSON # 1	LESSON # 2
Topic Title			
Learning Objectives Students will be able to:			
Standard(s) and Performance(s) Indicators			
Learning Experience (Instructional Plan - Summary)			
Student Assessment (Demonstration of Acquired Skills & Knowledge)			

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MODULE DEVELOPMENT – OUTCOMES MATRIX

	Lesson Details
Topic Title	Communication and Documentation in Science
Learning Objective(s) Students will be able to:	Construct a device or object using a given bag of materials. Describe the construction of the device or object that will allow other students to create that product.
Standard(s) & Performance Indicator(s)	NJCCCS 5.1.12.D1: Engage in multiple forms of discussion in order to process, make sense of, and learn from others' ideas, observations, and experiences. NJCCCS 5.1.12.D2: Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams. CCS-ELA.W.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Learning Experience (Instructional Plan - Summary)	Teams will construct a device and document how they made their construction. Another team will try to recreate the construction of the other team.
Student Assessment (Demonstration of Acquired Skills & Knowledge)	The documentation of the construction of the device is used by another time to successfully construct the same device.

Visual Models of Solutions and Concentrations

An Educator's Reference Desk
Lesson Plan

Lesson Plan #:AELP-CHM0050



Lesson Topic: Models of Solutions and Concentrations

- **OBJECTIVES:** Students will be able to:
 - Discuss pure solutions.
 - Discuss dilute solutions.
 - Discuss concentrated solutions.
 - Discuss the volumetric changes which occur.
 - Apply use of the model to future learning.
- **Classroom activities:**
 - Students are provided with two beakers, each containing different size plastic spheres.
 - The volume of the spheres in each beaker is measured.
 - The smaller spheres are poured into the beaker of larger spheres and the volume of the mix of spheres is measured.

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MODULE DEVELOPMENT – OUTCOMES MATRIX

Title	Models of Solutions and Concentrations
Brief Description (one sentence)	A hands on model to work with which will demonstrate the manner in which solutions are formed.
Learning Objective(s) Students will be able to:	<ul style="list-style-type: none"> - Discuss pure solutions. - Discuss dilute solutions. - Discuss concentrated solutions. - Discuss the volumetric changes which occur. - Apply use of the model to future learning
Standards & Performance Indicators	<p>(2009) 5.1.8.A.3 Use scientific principles and models to frame and synthesize scientific arguments and pose theories.</p> <p>(2005) 5.1.8.B.3. Collect, organize, and interpret the data that result from experiments.</p> <p>(2005) 5.6.6.A.3. Describe the properties of mixtures and solutions, including concentration and saturation.</p>

Preparing Learning Outcome Chart

Behavioral Verb	Content Skills & Knowledge	Performance Indicator	Student Work Products
What action will students take to acquire the content skills and knowledge?	What are the specific content knowledge & skill the students will acquire as a result of learning?	What is the performance indicator the students will use to show acquisition of knowledge?	What are the student work products that will be used to assess their acquired content skills and knowledge?

Learning Outcome: Students are able to
 (behavioral verb) + (specific content skills/knowledge) + (performance indicator) + (student work product).

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MODULE DEVELOPMENT – OUTCOMES MATRIX

Title	Models of Solutions and Concentrations
Brief Description (one sentence)	A hands on model to work with which will demonstrate the manner in which solutions are formed.
Learning Objective(s) Students will be able to:	
Standards & Performance Indicators	(2009) 5.1.8.A.3 Use scientific principles and models to frame and synthesize scientific arguments and pose theories. (2005) 5.1.8.B.3. Collect, organize, and interpret the data that result from experiments. (2005) 5.6.6.A.3. Describe the properties of mixtures and solutions, including concentration and saturation.

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MODULE DEVELOPMENT – OUTCOMES MATRIX

Title	Models of Solutions and Concentrations
Learning Objective(s) Students will be able to:	
Learning Experience (Instructional Plan - Summary)	Students are provided with two beakers, each containing different size plastic spheres. The volume of the spheres in each beaker is measured. The smaller spheres are poured into the beaker of larger spheres and the volume of the mix of spheres is measured.
Student Assessment (Demonstration of Acquired Skills & Knowledge)	

Lesson Topic: Mass Transfer

- **Aim:** This practical aims to determine the rate of dissolution of boiled sweets in water and the factors which affect it.
- **Classroom activities:**
 - Rate of dissolution of a sucker is measured by measure the change in diameter as a function of time under different conditions.
 - A beaker of cold water is stirred at different stirrer speeds.
 - Rate of dissolution is measured at different temperatures.

Lesson Topic: Mass Transfer

- **Analysis:** Compare the change in diameter for the different conditions studied. Then try to determine relationships for the rate of dissolution of the sucker, using what you know about diffusion and mass transfer.
- **Discussion:** Explain the differences between the results and how the relationships you have found account for these differences.

Lesson Topic: Mass Transfer

- Quality of Lesson. Is it a good lesson?
- Learning Objectives?
- Assessment?
- Does the lesson need to be modified?

Lesson Topic: Mass Transfer

- Weaknesses:
 - Lacks specific statement of learning objectives.
 - Lacks specific statement of nature of student work product for assessment.
- Strengths. Provides opportunity for students:
 - to investigate a phenomenon, and collect, organize, and interpret the data that result from the experiments.
 - Conduct experiments that involve dependent & independent variables.
 - Collect and analyze data with emphasis on reproducibility of data and constraints on data collection.

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MODULE DEVELOPMENT – OUTCOMES MATRIX

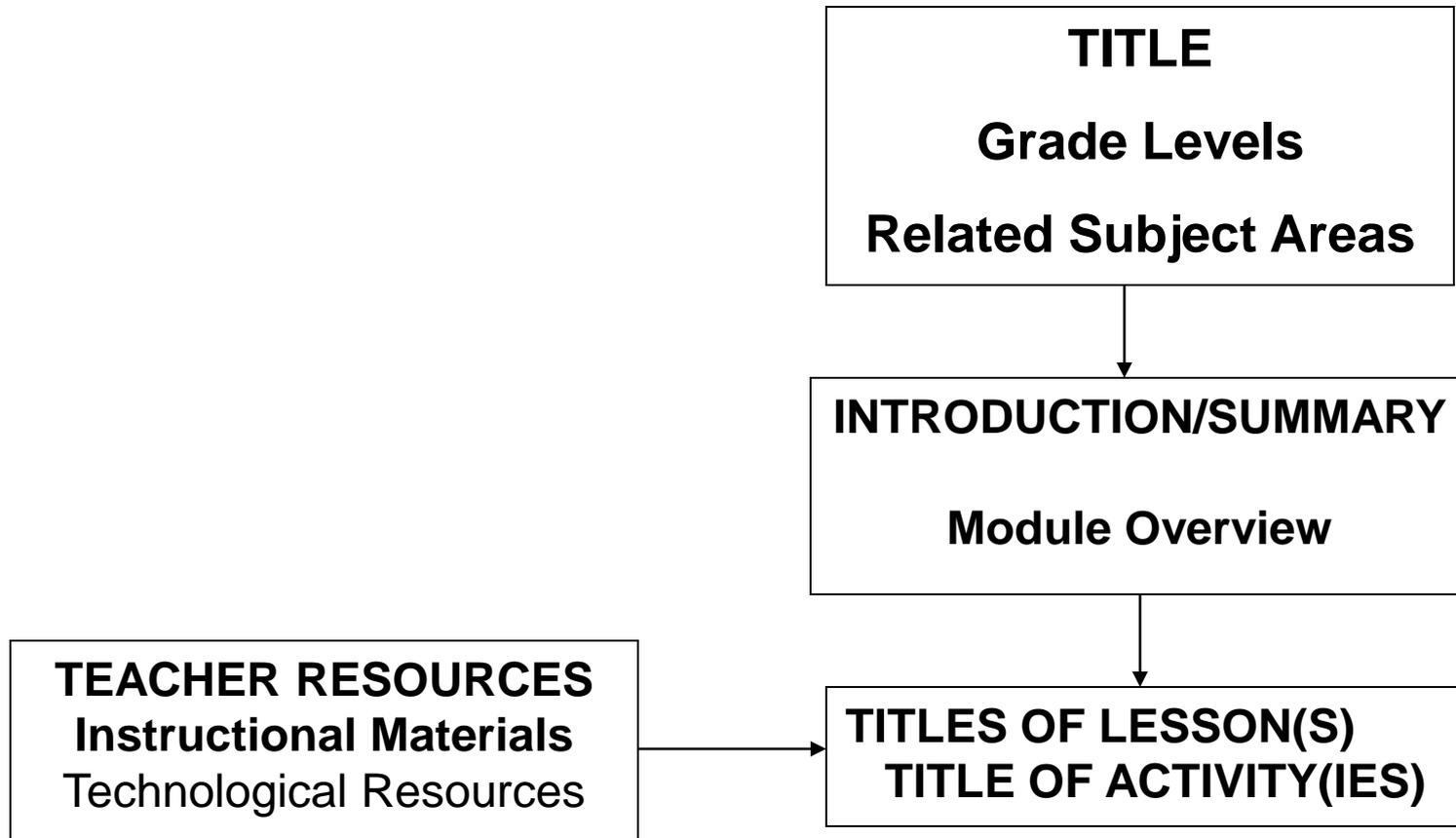
Title	Mass Transfer
Brief Description (one sentence)	The rate of dissolution of a sucker is being measured at different temperatures, and at different stirring rates for a given temperature.
Learning Objective(s) Students will be able to:	
Standards & Performance Indicators	(2009) 5.1.8.B.1. Design investigations to collect, analyze, and evaluate evidence as part of building models and explanations. (2005) 5.1.8.A.3. Recognize that the results of scientific investigations are seldom exactly the same and that replication is often necessary. (2005) 5.1.8.B.3. Collect, organize, and interpret the data that result from experiments. (2005) 5.6.6.A.3. Describe the properties of mixtures and solutions, including concentration and saturation.

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MODULE DEVELOPMENT – OUTCOMES MATRIX

Title	Mass Transfer
Learning Objective(s) Students will be able to:	
Learning Experience (Instructional Plan - Summary)	The rate of dissolution of a sucker is being measured at different temperatures, and at different stirring rates for a given temperature. For a given run, students measure the change in the diameter of the sucker over time, without stirring, at a slow stirring rate, and at a faster stirring rate. Measurements are done at two different temperatures.
Student Assessment (Demonstration of Acquired Skills & Knowledge)	

THE BIG PICTURE

COMPONENTS OF A UNIT/MODULE



A series of two or more learning activities, or lessons, designed to help students explore specified key concepts to be taught

- Specification and organization of the key concepts to be learned.
- Definition of learning objectives that clearly state what students should know and be able to do at the end of the module.
- Identify and sequence lessons that develop the desired level of understanding.
- Within the module, each lesson should include learning objectives and desired outcomes of the lesson that are aligned with those of the module.

Engineering Lesson Plans on the Web

IEEE -

TryEngineering: www.tryengineering.org

National Science Digital Library (NSDL) –

TeachEngineering: www.teachengineering.org

<http://nsdl.org/browse/?subject=All> (STEM)

The Educator's Reference Desk - AskEric

<http://www.eduref.org/Virtual/Lessons/>

TEACHENGINEERING WEBSITE

Exploring the structure of a Curricular Unit

TE Curricular Unit: Mixtures and Solutions



TE Curricular Unit: Mixtures and Solutions Summary

Introductory concepts of mixtures and solutions & how mixtures and solutions, and atoms and molecules can influence new technologies developed by engineers. :

1. Explores the fundamentals of atoms and their structure and the building blocks of matter (protons, electrons, neutrons).
2. Examines the properties of elements and the periodic table & the concepts of physical and chemical properties.
3. Introduces the properties of mixtures and solutions, including a comparison of different mixtures and solutions, their properties and their separation qualities

TE Curricular Unit: Mixtures and Solutions

- **Related Lessons**

- The Fundamental Building Blocks of Matter **Unrelated**
- Understanding Elements
- Mix It Up

- **Related Activities**

- Engineering and the Periodic Table **Unrelated**
- Gumdrop Atoms
- Messin' with Mixtures

Lesson: The Fundamental Building Blocks of Matter

Learning Objectives: Students should be able to:

1. Define a molecule.
2. List the basic components and structure of the atom.

Activity: Gumdrops Atoms

Learning Objectives: Students should be able to:

1. List the basic components and structure of the atom
2. Identify the electrical charge of an atom and its subatomic particles
3. Explain how engineers use their knowledge of atoms to create new technologies

TE Lesson: Mix It Up

Learning Objectives - The students should be able to:

- Compare and contrast mixtures and solutions.
- Discuss methods for separating mixtures and solutions into their original components.
- Describe several engineering applications for mixtures and solutions.

Assessment

- Students categorize mixtures vs. solutions
- Concept Juggle
- Engineering/Writing Application
- *Bingo* (Vocabulary terms)

TE Activity: Messin' with Mixtures

Students investigate the properties of a heterogeneous mixture, trail mix.

Learning Objectives - Students should be able to:

- Discuss properties of mixtures and solutions.
- Discuss methods for separating mixtures and solutions into their original components.
- Describe several engineering applications for mixtures and solutions.

Assessment

- *Worksheet.*
- Engineering Application: Students write a "report" regarding the contaminated soil.

TE Lesson & Activity

- Learning Objectives - Students should be able to:
 - Discuss properties of mixtures and solutions.
 - Discuss methods for separating mixtures and solutions into their original components.
 - Describe several engineering applications for mixtures and solutions.
- Standards - TE Lesson: Mix It Up
 - 5. All matter is made up of atoms that are comprised of protons, neutrons and electrons and when a substance is made up of only one type of atom it is an element (Grades 6 - 8) [2007]
 - 5. There are interrelationships among science, technology and human activity that affect the world (Grades 6 - 8) [2007]
- Standards - TE Activity: Messin' with Mixtures
 - 2.1. Students know that matter has characteristic properties, which are related to its composition and structure. (Grades 0 - 12) [1995]
 - Standard 5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world. (Grades 0 - 12) [1995]

Educational Standards - Colorado Science

Lesson: Mix It Up

2.5. All matter is made up of atoms that are comprised of protons, neutrons and electrons and when a substance is made up of only one type of atom it is an element (Grades 6 - 8) [2007]

5.5. There are interrelationships among science, technology and human activity that affect the world (Grades 6 - 8) [2007]

Standard 2: 2. Mixtures of substances can be separated based on their properties (for example: solubilities, boiling points, densities and specific heat) (Grades 6 - 8) [2007].

Activity: Messin' with Mixtures

2.1 Students know that matter has characteristic properties, which are related to its composition and structure. (Grades 0 - 12) [1995]

Standard 5: Students know and understand interrelationships among science, technology, and human activity and how they can affect the world. (Grades 0 - 12) [1995]

Educational Standards - New Jersey Science TE Lesson & Activity

- Learning Objectives - Students should be able to:
 - Discuss properties of mixtures and solutions.
 - Discuss methods for separating mixtures and solutions into their original components.
 - Describe several engineering applications for mixtures and solutions.
- Standards and Indicators – NJ Adopted 2002
 - 5.6.4.A.1. Sort materials based on physical characteristics that can be seen by using magnification.
- Standards and Indicators – NJ Adopted 2009
 - 5.2.2.A.1. Sort and describe objects based on the materials of which they are made and their physical properties.

RET 2012 – Assignment #3

- **Compose** an Outcomes Matrix to present your thoughts on the revision of your selected concept from Assignment #1 based on the Standards-based Lesson Planning presentation.

How to reach us....

- Howard Kimmel

Kimmel@adm.njit.edu

- John Carpinelli

Carpinelli@adm.njit.edu

- Levelle Burr-Alexander

Burr-alexander@adm.njit.edu

**New Jersey Institute of Technology
Center for Pre-College Programs
Central Avenue Building - 2nd Floor
University Heights
Newark, New Jersey 07102
(973) 596-6445**

Q & A

