Effective Science-Teaching Strategies for Students with Special Needs

Lynne E. Houtz, MS, PhD
Professor of Science & Math Education
Creighton University

Nebraska Summit on Math & Science Education
Lincoln, Nebraska
December 8, 2014
Objectives

As a result of this presentation, the participant will be able to ...

• Identify the teaching and learning challenges in classrooms with students with learning challenges related to physical, mental, social or emotional/behavioral disabilities.

• Identify the teaching and learning challenges with students of differing cultural and linguistic backgrounds, and recognize how those challenges appear similar to learning disabilities.

• See science as a curriculum area for successfully dealing with the challenges.

• Implement specific systemic solutions and research-based teaching strategies that lead to student academic and social success.
“Science is for all students.”

(National Research Council, 1996)
Next Generation Science Standards

For the student groups that have traditionally been underserved in science education, the NGSS offer both learning opportunities and challenges.

“Non-dominant groups:”

• Economically disadvantaged students;
• Racial or ethnic minority students;
• Students with disabilities;
• English language learners;
• Girls;
• Students in alternative education programs;
• Gifted and talented students.

“All Standards, All Students:” Making the Next Generation Science Standards Accessible to All Students.

P. 27

Houtz 2014
Overarching Strategies for all underserved student groups in science education.

• Value and respect the experiences that all students bring from their backgrounds.
• Make diversity visible.
• All students should “see themselves” in the science curriculum.
• Connect science to students’ sense of “place” as physical, historical and sociocultural dimensions.
• Work to dissolve the disconnect between home/community and classroom/school.
Capitalize on “Funds of Knowledge”

- Culturally based understandings and abilities that develop over time in family and neighborhood contexts, and the social and intellectual resources contained in families and communities can serve as resources for academic learning.
- Effective teachers ask questions that elicit students’ funds of knowledge related to science topics.
- Use cultural artifacts and community resources in ways that are academically meaningful and culturally relevant.

Houtz 2014
Allocate Resources for Science Teaching & Learning

School resources constitute essential elements of a school’s organizational context for teaching and learning.

- Human resources
- Material resources
- Social resources

- In schools and classrooms where non-dominant students reside, resources are often scarce, forcing allocations of the limited resources for some areas (e.g., reading and math) and not others (e.g., science and non-tested subject areas).

Houtz 2014
CHALLENGES IN DIVERSE CLASSROOM COMMUNITIES

Language Problems

- Limited English proficiency
- Language processing - auditory, verbal, visual, communication

Learning Skills Problems

- Attention
- Motivation “reluctant learners”
- Self-regulation
- Independent Learning
- Memory
- Organization
- Perceptual Abilities
- Reasoning
- Survival Skills

Houtz 2014
Results

Academic Difficulties

Social-Emotional-Behavioral Problems

Houtz 2014
Culture Influences
Teaching and Learning

• Different rules for appropriate communication
• Different cognitive processing
• Different rules for social behaviors
Second Language / Second Culture Acquisition

Involves learning different ways of

• Thinking
• Interacting
• Communicating
Second-Language Acquisition

Requires the following:

– Linguistic and cultural proficiency
– Precise knowledge and control of meaning of words
– Careful intonation
– Mastery of subtle behaviors associated with the new culture

(Diaz-Rico, 2004)
Why do Culturally/Linguistically Diverse Students Struggle in Science?

• Difficulty with learning requirements of science classroom:
  – Empirical knowledge
  – Language
  – Social behaviors
Other Possible Reasons for their Struggle

• Stress related behaviors
  – e.g., fatigue, difficulty paying attention
• Memory overload
• Feelings of inadequacy
• Disability

Houtz 2014
Comparing Characteristics of Students with LD and 2nd Language Learners

**Students with LD**
- Memory difficulty
- Poor language ability
- Attention problem

**2nd-Language Learners**
- Memory overload
- Limited knowledge of 2nd language
- Demands for competing attention

Houtz 2014
Characteristics

Students with LD

- Poor perceptual abilities
- Poor social skills
- Poor academic performance

2nd-Language Learners

- Difficulty perceiving nuances of culture and language
- Poor academic performance

Teachers are not prepared to teach science to learners who are Culturally and Linguistically diverse!
Why Science?

• Science provides knowledge about the world and how it functions.

• Science helps students better understand their world.
Components of Science Learning

- KNOWING SCIENCE
- Vocabulary and knowledge
  - Building on prior knowledge
  - Using appropriate vocabulary
  - Understanding concepts & relationships

Houtz 2014
Why Science continued....

• Science shows students cause-effect relationships.

• Science provides a context for language development.

Houtz 2014
Why Science continued...

- Science increases the development of scientific process skills:

<table>
<thead>
<tr>
<th>Observation</th>
<th>Experimentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification</td>
<td>Modeling</td>
</tr>
<tr>
<td>Inference</td>
<td>Patterning</td>
</tr>
<tr>
<td>Prediction</td>
<td>Problem Solving</td>
</tr>
<tr>
<td>Hypothesizing</td>
<td>Questioning</td>
</tr>
<tr>
<td>Measurement</td>
<td>Reasoning</td>
</tr>
<tr>
<td>Collecting &amp; Interpreting data</td>
<td>Researching</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
</tr>
</tbody>
</table>

Houtz 2014
Components of Science Learning

• DOING SCIENCE

• Inquiry and Process

* Engaging in inquiry
* Using relevant strategies
* Solving real-world problems
Scientific Inquiry in the Classroom

**Confirmation** – results known in advance. Example, pouring 1000 mL of H₂O into 1000 cm³ container.

**Structured** – prescribed procedures. Example, Dracula’s Dilemma – follow procedures, get results as expected, “Cookbook recipe style.”

**Guided** – student designed/selected procedures. Example, finding the mass of salt: a mixture lab, Giant Hand activity.

**Open** – questions are student formulated and procedures are student designed. “I wonder ... What if we tried ...”
Components of Science Learning

• TALKING SCIENCE

Discourse and Communication

• Participating in social and academic discourse
• Using multiple representational formats
• Using the appropriate academic discourse

Houtz 2014
Components of Science Learning

• SCIENTIFIC ATTITUDES AND VALUES
  – Manifesting generic values & attitudes
  – Appropriating culturally mediated values & attitudes

• SCIENTIFIC WORLD VIEW
  – Recognizing ways of knowing
Why Science continued ...

- Science knowledge will increase the possibility of students’ successful inclusion in the general classroom.
- Science provides activity-oriented and content oriented approaches.

(Mastropieri & Scruggs, 1992; Westby, 1997)
Establish a Successful Learning Environment

• Make all students feel welcome, have a sense of belonging.
• Observe individual students to evaluate their cognitive, psychomotor and affective abilities and socio-cultural approaches.
• Confer with Special Ed consultants and specialists.
• Familiarize yourself with the student’s Individualized Educational Plan (IEP).
• Provide the proper structure to overcome handicaps and experience success.
Predictable Environment

- Establish structure and periodically review class rules and procedures.
- Continually reinforce safety expectations.
- Have and communicate an explicit agenda.
- Catch the students “being good” and let them know it.
- Be visible, be helpful, and be encouraging.
Well-planned modifications to science instruction are essential to achieving success for all students in inclusive classrooms.

(Watson & Houtz, 1998)
Students with Disabilities

• Be sure all appropriate people in the education setting are aware of the specific accommodations and modifications outlined in students’ IEPs.

• Differentiate instruction.
Students with Limited English Proficiency

The research literature indicates 5 areas where teachers can support both science and language learning:

1. Literacy strategies for all students;
2. Language support strategies with ELLs,
3. Discourse strategies with ELLs;
4. Home language support;
5. Home culture connections.

Houtz 2014
Strategies to support students from major racial and ethnic groups

• Culturally relevant pedagogy;
• Community involvement and social activism;
• Multiple representation and multimodal experiences;
• School support systems, including role models and mentors of similar racial or ethnic backgrounds.
ADDRESSING THE CHALLENGES

- Activate students’ prior knowledge.
- Give students a purpose for learning the skill by connecting it to their lives.
- Provide a list of high frequency vocabulary words.
Best Practices that Match the Needs of 2nd Language Learners and Students with LD

Classwide:
• Predictable environment
• Activation of prior knowledge
• Thematic Units
• Planning Pyramid
• Explicit instruction
• Modeling of skills/ behaviors

Houtz 2014
• Thematic Units

Our Changing World

Geography
- Climates
- Growing crops in different areas of the world

Math
- Weigh precious minerals
- Story problems: buying and selling precious minerals
- # population in other countries

Physical Education
- Students move like planets - relate how body changes as does the earth

Technology
- Websites
- CD - Magic School Bus
- Word Processing

Language Arts
- Volcano-shaped word search
- Writing stories

Music
- We are the World

Art
- Make volcano
- Create pet rock

Reading
- Magic School Bus
- Keepers of the Earth
- Multicultural literature

Houtz 2014
CURRENT UNIT
Ecology

is about

Ecosystems
can be affected by

human activity

include

biotic factors

undergo

changes

include

abiotic factors

involve

interactions
Why Thematic Units?

Thematic units, webs and related literature provide background knowledge and reinforce vocabulary in context.

A means to:

• Develop semantic networks
• Expand schema knowledge
• Organize information
• Recognize relationships
• Engage in deductive and inductive thought.

(Westby & Costlow, 1991)
Components of Lessons

Lesson Structure

- Academic Task Structure
- Social Participation Structures

Factors Influencing lesson structure

Intrapersonal Frames
- (What students bring to the lesson)
  - Cultural experiences
  - Individual preferences

Interpersonal Frames
- (What is constructed during lesson)
  - Local meaning frame
  - Materials frame
  - Academic content frame
  - Social interactional frame
  - Instructional/Pedagogical frame

Houtz 2014
## Preassessment

<table>
<thead>
<tr>
<th>What we already <strong>Know</strong></th>
<th>What we <strong>Want</strong> to know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>How we can find out</strong></td>
<td>**What we <strong>Learned</strong></td>
</tr>
</tbody>
</table>
Pre Reading Plan (PREP)

Teacher
• Tell me everything you think of when you hear...
• What made you think of...
• Do you want to add to or change your first response?

Students
• Free associate/access prior knowledge
• Reflect on thought processes, organization of knowledge
• Reformulate and refine responses

Houtz 2014
PreReading Plan (PREP) Helps teacher to:

• Determine prior knowledge student possesses about topic and how this topic is organized.
• Know language student uses to express knowledge about a topic.
• Judge how much additional background information must be taught.
Techniques for Instruction of Students with Language Challenges

- Increase wait time for internal translations and connections and for processing and practice.
- Respond to the message, not to the correctness of the pronunciation or grammar.
- Simplify your language.
- Don’t force reluctant students to speak.
- Demonstrate the concept; use cues, gestures, and manipulatives.
- Make use of all senses.
- Pair or group native speakers together.
- Adapt the materials, don’t “water down” the content.
- Learn as much as you can about the language and culture of your students.
- Bring students’ home language and culture into the classroom and curriculum.

(Chamot, 1998; Gersten, Marks, Keating, & Baker 1998; Reyes & Bos, 1998; Sullivan, 1992; Towell & Wink, 1993; Vaughn, Bos, Schumm, 2000, p. 303)
Strategies for Linguistically Diverse Students

• Provide bilingual and multilingual signs.
• Recruit people who can tutor or assist students in their first language.
• Contextualize language with photo, manipulatives, multisensory experiences.
• Check frequently for understanding. Be aware of cultural respectful responses.
• Have varied ways to assess your students.
Teach paraphrasing skills:

- Read a selection (or participate in a discussion or complete an activity)
- Ask yourself what are the main ideas or concepts or results.
- Put the main ideas and supporting details into your own words.

Be sure students internalize and can articulate the main points/ideas of discussion, reading, lesson or activity.

As appropriate, discreetly ask the student questions you know the student can answer.
There are different types of blood.

Some blood types cannot be mixed.

There are 4 basic types of blood. Type O is a universal donor. Type AB is a universal recipient.

Type O is the most sought-after blood type for transfusion.

What ALL students should learn.

What MOST students will learn.

What SOME students will learn.
All students will learn:

- To identify the cerebrum, the cerebellum, brainstem, and the spinal cord on a model or diagram.
- The cerebrum has 2 cerebral hemispheres.

Most students will learn:

- To name and locate all parts of the central nervous system (CNS) learned in class.
- To describe the functions of all parts of the brain.
- Identify problems related to lesion on (learned) brain areas.

Some students will learn:

- To identify the limbic lobe and describe its function.
- To differentiate between the CNS and the peripheral nervous system (PNS).
- Discuss the neurology of reading and writing.

- To identify the 4 primary lobes and one of their main functions.
Lesson Plan for Teaching Culturally Linguistically Diverse Students

Thematic Unit:
Subject Area:
Title of Lesson:
Grade Level:
Lesson Outcomes:
State Standards:
Planning Pyramid:
What some students will learn:
What most students will learn:
What ALL students should learn:

Materials/Resources:
Instructional Strategies:

Houtz 2014
Explicit Instruction

• Give students a purpose for learning the skill by connecting it to their lives.
• Clearly teach the concept you want students to learn.
• Provide examples and non examples.

Houtz 2014
CONCEPT DIAGRAM

Name Concept:

Definition

List characteristics:
ALWAYS present  SOMETIMES present  NEVER present

Examples

Nonexamples

Houtz 2014
Materials

- 1 Pencil
- 9 Labels
- 4 Beakers
- Red Food Coloring
- Blue Food Coloring
- 5 Test Tubes

• PICTURE CUES & CHECK OFF SPACES

Houtz 2014
• Use of Linguistic Connectives

*When* Dracula drank some types of blood, he became sick. (evidence)

*If* Dracula became sick with some types of blood, *then* Dracula is not Type AB, the universal recipient. (conclusion)

*When* Dracula consumed the bride of Frankenstien’s blood, he became ill (evidence). *Therefore*, Bridie does not have Type O blood, the universal donor. (conclusion)
Provide Outlines

Provide visual organizers

Give small segments of information
TECHNIQUE:
Learning Groups

MODIFICATIONS:
- Explain the procedures the group will follow.
- Give group members different assignments.

Houtz 2014
→ Give each student a structured role and a clear list of responsibilities.

→ Vary your criteria for success for each group member.
**TECHNIQUE:**

**Hands-On Experiments**

**MODIFICATIONS:**

- Give purpose and hypothesize outcome of experiment.

- Model procedures and allow student to assist.
Modeling of Skills/ Behaviors

• Show/demonstrate what you want the students to do.

• Model the cognitive and physical process of the task. Think-aloud.

• Provide guided practice before assigning independent practice.
Provide short, simple and sequential directions (with visual models).

Have student check off each completed step.
PROCEDURES

____ Label the beakers:

_______ A (Red Water = Type A Blood)

_______ B (Blue Water = Type B Blood)

_______ AB (Purple Water – Type AB Blood)

_______ O (Clear Water = Type O Blood)

A B AB O

____ Fill each beaker with about 200 mL of water.

____ Put 6 drops of RED food coloring in beaker A.
Other Specific Strategies

• More white space gives impression of ease and provide space for writing for students with fine motor skill difficulties.

• Illustrations and graphics maintain interest and motivation.

• Use a simple font such as Helvetica to avoid having letters with tails or curly-cues, which prove problematic for some students in their reading.

• Font size should be no smaller than 12 point.
• Keep the visual copy clean, crisp, clear.
• Number pages, staple in order, 3-hole punch.
• Have students use erasable pencil instead of ink.
• Instead of simply stating a problem, encourage students to formulate an hypothesis to develop critical thinking and risk-taking.
Assessment

• Be sure that students can appropriately articulate the main concepts, purpose and outcome of the science activity.
  “What did we learn today?”

• Authentically evaluate learning outcomes independent of reading and oral language difficulties.

• Recognize that science requires a report card grade as well as NeSA reporting.
Rhymes With Orange

POP QUIZ

Question 1:
Describe the Periodic Table and provide examples.

Something that’s not a table, but sometimes used like one – like a dashboard. I have a couch you could call a periodic bed, as well as a bed you could call a periodic laundry basket.

For Lydia, passing the science requirement was going to be a challenge.


Lynne E. Houtz, MS, PhD
Brief Bio

Lynne Houtz did undergraduate study at the College of Saint Teresa, University of Nebraska, and earned her B.S. degree in Elementary Education from Kent State University in 1971. Her 23-year public school teaching career includes grades 4, 5, 6, 7, 8 in Ohio, Illinois and Nebraska. She was simultaneously a perpetual student, doing graduate study at Kent State, the Ohio State University, University of Nebraska at Omaha, University of Iowa, and Purdue University. Lynne accumulated additional teaching endorsements in Music, Middle Level, Social Sciences, and Science. In 1985 she earned a Masters in Elementary Science Education from the University of Nebraska at Omaha, and in 1992, her PhD in Administration, Curriculum and Instruction in Science and Math Education from the University of Nebraska - Lincoln. She served as the Science Supervisor for Omaha Public Schools prior to entering academia. Lynne taught science and math education courses at the University of Nebraska-Lincoln, Wayne State College, Nebraska Wesleyan University and is now Professor of Science and Mathematics Education at Creighton University.

Dr. Houtz's research and application works related to improving science education for all have been shared at national and international venues, including Brazil, Prague, Athens, Paris, Italy and Spain. Publication venues include the Journal of Research in Science Teaching, Journal of Elementary Science Education, Journal of Science Education for Students with Disabilities, Science and Children, Science Scope, Science Education Review, Journal of the National Medical Association, Journal of Higher Education Outreach and Engagement, Academic Medicine, and The International Journal of Learning. Lynne has been involved with numerous grant projects, including outreach programs by biomedical sciences funded by AAMC, HHMI, NASA and NAIDA. She is available for consulting to school districts, and for outreach programs by medical schools and health science divisions.

The best way to reach her is by email at lhoutz@creighton.edu.