Middle School Science

Best Practices for Your Classroom

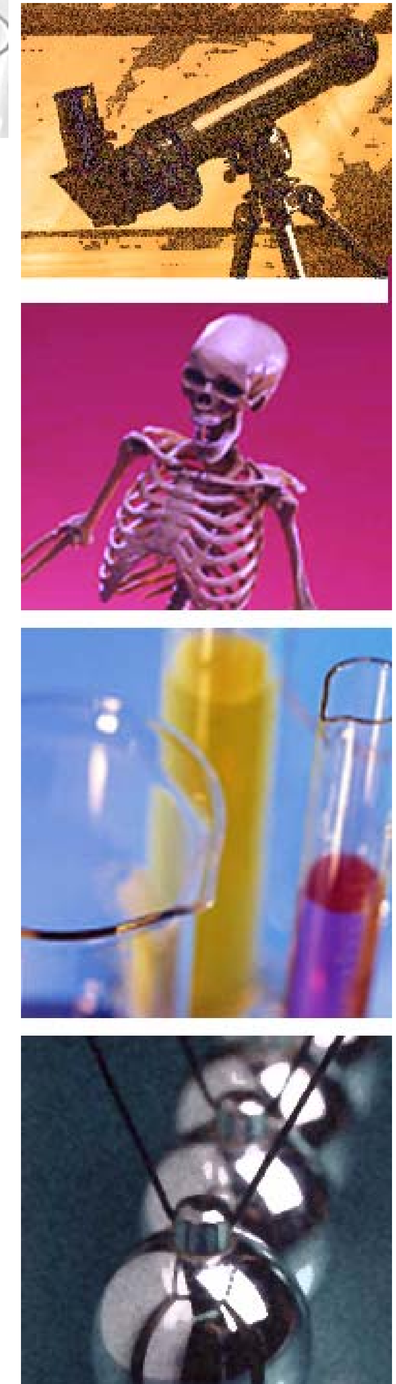
Dr. Sandra Davis
The University of West Florida

Importance of Science Education

In a world filled with the products of scientific inquiry, students need to be able to use scientific information to make choices that arise everyday.

Importance of Science Education

Good science education can help students intellectually engage in important issues that involve science and technology.



Importance of Science Education

All students deserve to share in the excitement and personal fulfillment that can come from understanding and learning about the natural world.

National Science Education Standards

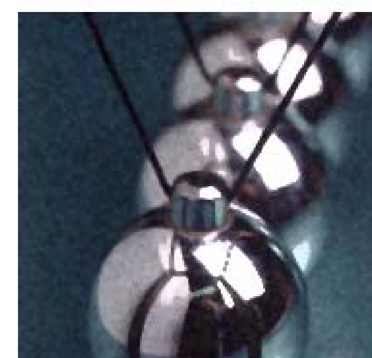
The National Science Education Standards:

"outline what students need to know, understand, and be able to do to be scientifically literate at different grade levels. They describe an educational system in which all students demonstrate high levels of performance, in which teachers are empowered to make the decisions essential for effective learning, in which interlocking communities of teachers and students are focused on learning science, and in which supportive educational programs and systems nurture achievement. The *Standards* point toward a future that is challenging but attainable…"

(*National Science Education Standards,* 1996)

The Role of the Teacher



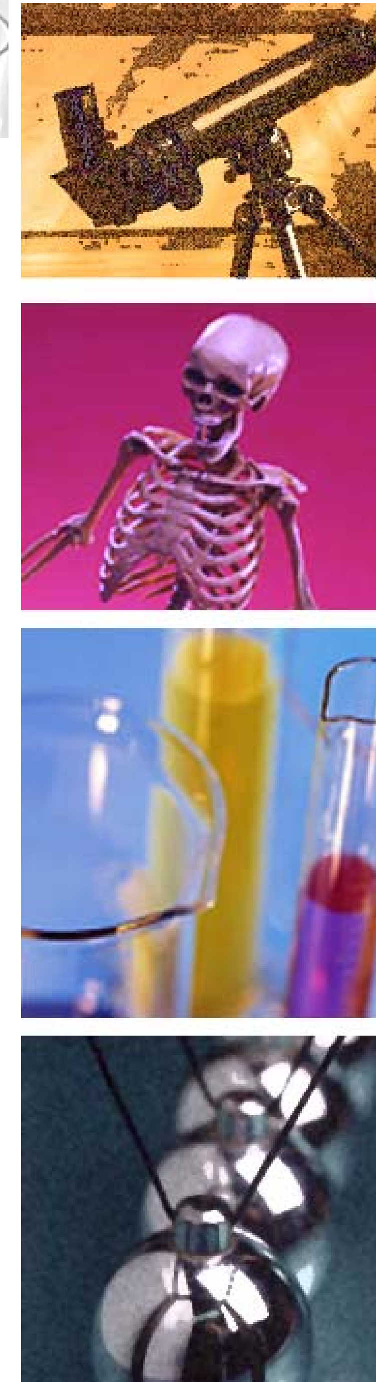



We all know that it can become laborious to constantly teach to the standards set for science education.

How can we reach students by teaching the standards while engaging them in exciting and rewarding science inquiry?

Literature Review: Best Practices in Middle Level Science

1. Inquiry Based and Cooperative Learning
2. Learning Centers
3. Using Technology
4. Learning Resources
5. Authentic Assessment



Science Best Practices

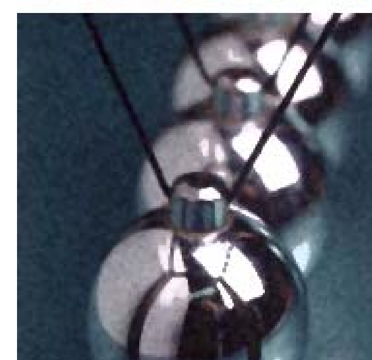
1. Inquiry Based and Cooperative Learning
   - Allows students to learn together
   - Employs active learning strategies
   - Calls for individual accountability, social skills, face-to-face processing, and positive interdependence
   - Requires Hands-on Minds-on learning and exploration

(*Best Practices of Science Teaching, 2006*)

Science Best Practices

- Inquiry Based and Cooperative learning
  - Hands-on Minds-on
  - Social skills
  - Physical activity
  - Authentic experiences

(Wenglinsky, H., & Silverstein, S.C., 2007)



Science Best Practices

2. Learning Centers

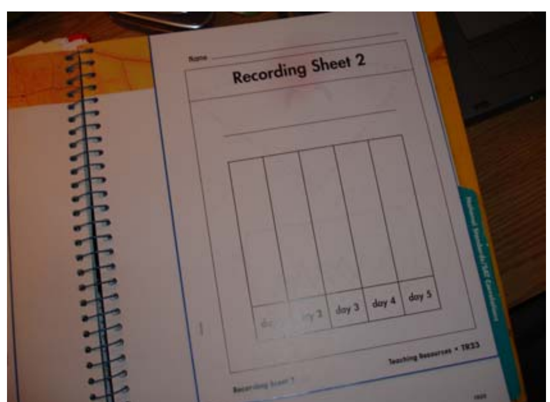
- Teaches strategies to help students take control of their learning
- Organizes knowledge around core concepts
- Provides use of physical materials to use and manipulate

* Activity cards, instructional investigation cards, recording sheets and materials.

(Peters, J.M., & Stout, D.L., 2006).

Science Best Practices

- Learning Centers
  - Activity Cards and Pictures
  - Recording Sheets
  - Materials



Science Best Practices

3. Teaching with Technology
   - Allows students to explore the world of science without leaving the classroom

     (Wenglinsky,H., & Silverstein, S.C., 2007)
   - Inquiry based and self-guided exploration encourages students to look in places they might not normally be able to look for information (Hapgood, S., & Palincsar, A.S., 2007)
   - Provides visual stimulation and a safe environment for students to explore

Science Best Practices

- Teaching with technology
  - Computer and software use
  - Tutorials and games
  - Simulations and virtual tours

Science Best Practices

4. Learning Resources

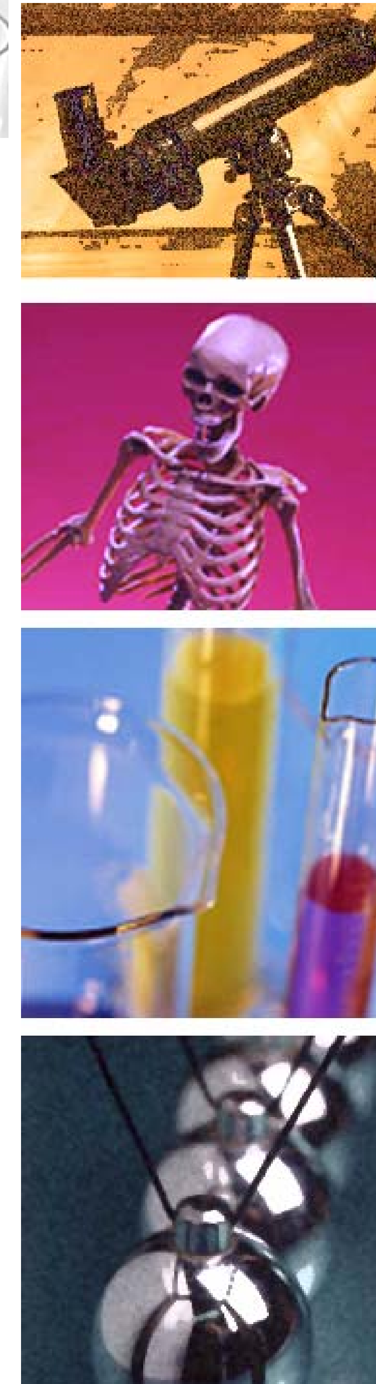
- Students use a wide range of resources to develop effective science lessons
- Provide active learning experiences and keep students involved in discussions
- Provide an opportunity for students to visit a site or location within their realm of exploration

(Hammer, M., & Polnick, B., 2007)

Science Best Practices

- Learning Resources
  - Community members and speakers
  - Class trips (museums, science centers, zoos, science fairs, etc.)

Science Best Practices



5. Authentic Assessment
   – Can serve as two-way communication between student and teacher
   – Determines student’s previous knowledge and post knowledge

(Longfield, J., 2007)

   – Provides opportunity for students to raise issues requiring a response

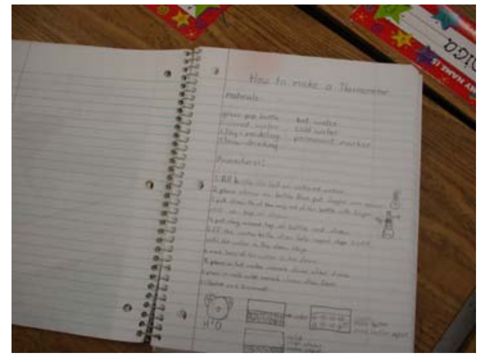
(Enfield, M., 2007)

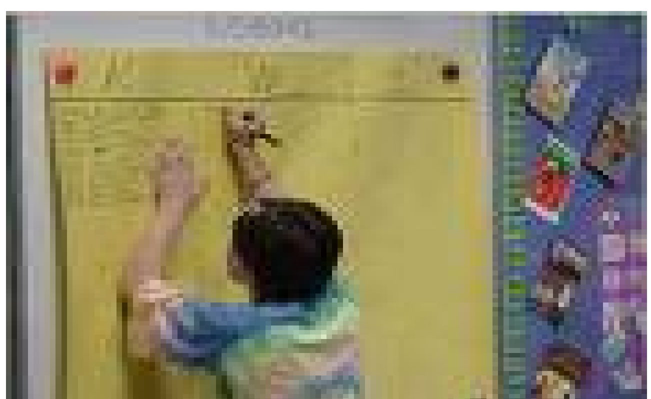
   – Allows for long term observations

(Hammer, M., & Polnick, B., 2007)

Science Best Practices

- Authentic Assessment
  - Science journals
  - Interviews
  - KWL charts
  - Concept maps
  - Project or performance-based assessment





Summary

- Best practices for teaching middle level science include:

  1. Inquiry Based and Cooperative Learning

  2. Learning Centers

  3. Using Technology

  4. Learning Resources

  5. Authentic Assessment

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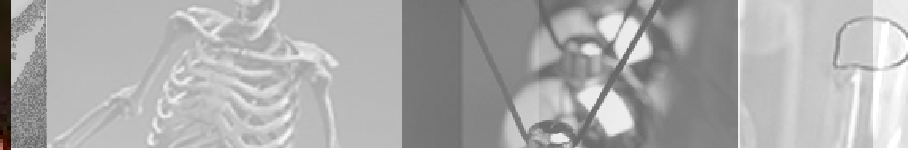


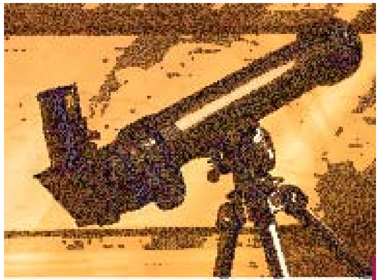


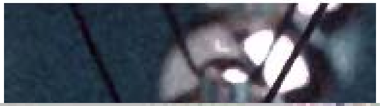
Best Practices in AP Chemistry

Dr. Sandra Davis

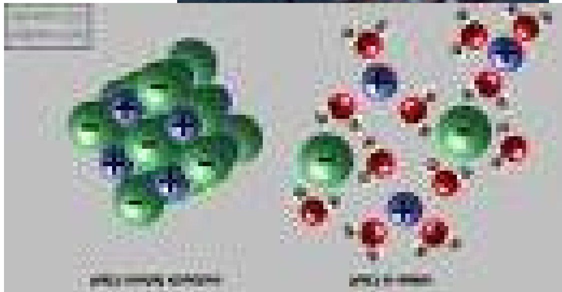
The University of West Florida

What is AP Chemistry?



- AP Chemistry is an Advance Placement class in Chemistry.
- It is a program that allows students to take colleges level classes in Chemistry to earn college credits while still in High School.
- Most colleges and Universities grant a full year of college credit if students pass the AP exam at the end of the year.



Best Practices in AP Chemistry

- Qualitatively: Research based textbook, topics, and the type of experiments done in the course are extended performance tasks.

- Quantitatively: Time spent on topics and in laboratory add depth and richness to concepts.

Best Practices in AP Chemistry




- AP courses need to meet at least 290 minutes per week.
- All AP classes need to take at least 90 minutes in each lab.
- Schools need to provide a laboratory equivalent to a college chemistry setting.
- Emphasis is placed on course structure, content and assessment techniques.

Best Practices in AP Chemistry

- Experiments should enhance students chemistry knowledge of laboratory materials and chemical reactions.

- Varied Exams should be administrated often to check for student learning process.

- Lab reports should have a scientific method format.




Emphasis in Topics

- Atomic Structure
- Periodicity
- Equilibrium
- Thermodynamics
- Acid-Base Chemistry
- Chemical Reactions
- Gas laws

Conclusion

- Best Practices in AP Chemistry are different than those in high school chemistry.
- NCLB or FCAT does not take a part in the instruction.
- College institutions set the requirements for the course.
- Sufficient time and preparation are necessary for the teacher and students.

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BEST PRACTICES
ALGEBRA
AND
STUDENTS WITH MATH LEARNING DISABILITIES

Dr. Sandra Davis
The University OF West Florida

WHY ALGEBRA?

- *All* high school students are required to pass an algebra course in order to receive a high school diploma by state and district requirements. Mathematics is the gatekeeper to a number of opportunities for occupational and educational advancement (Maccini, and Gagnon, 2000) so students need high-level math and reasoning skills. Students with learning disabilities or low achiever may not receive a high school diploma or meet the standards because some teachers may not implement strategies needed for the students to understand the concepts of algebra. It is the responsibility of the teacher to provide strategies in these higher-level classes in order to reach *all* students.

NCTM STANDARDS
(National Council of Teachers of Mathematics)

- Learning to value mathematics
- Becoming confident in their ability to do mathematics
- Becoming mathematical problem solvers
- Learning to communicate mathematically
- Learning to reason mathematically

ADVANTAGES OF THE NCTM STANDARDS

- Promote hands-on learning
- Support “equal opportunity” between general and special education students
- Emphasize a more rigorous mathematics program encompassing higher-order reasoning and critical thinking skills

(Maccini and Gagnon, 2000)

STUDENTS WITH LD EXPERIENCE DIFFICULTY WITH:

- Basic Skills / Terminology

  *lack fluency math facts and basic math procedures
- Problem Representation

  *understanding the problem

  *paraphrasing parts of the problem into algebraic symbols
- Problem Solving

  *selecting correct operations and performing calculations can be problematic

  *difficulty in applying basic facts
- Self-monitoring Activities

  *problems in monitoring thinking and strategy use

Best Practices in Lesson Planning

- Identify the concept to teach
- Generate a list of examples
- Determine prior knowledge
- Develop word/story problems
- Prepare a concrete, pictorial, and abstract model to demonstrate the problem
- Generate a visual representation or script of the concept-steps needed
- Develop practice problems for guided instruction-immediate feedback

(Smith and Geller, 2004)

Mathematics Best Practices

- Teach Prerequisite Skills, Definitions, and Strategies
  - review or quizzes
- Direct Instruction in Problem Representation and Problem Solution
  - provide students with questions or prompts on a card or structured worksheets
- Explicit Instruction in Self-Monitoring Procedures
  - thinking aloud / ask questions
- Organizers
  - structured worksheets, prompt cards, or graphic organizers

BEST PRACTICES FOR MATH INSTRUCTION

- Manipulatives
  - items from environment / patterns
  - algebraic blocks and tiles / visualize
- Conceptual Knowledge
  - explanations instead of right answers
- Effective Teaching
  - modeling the task, providing guided and independent practice, frequent reviews, and corrective and positive feedback
  - teaching algebraic reasoning
  - building on prior knowledge
- Teaching through stories that connect math instruction to students' lives

BEST PRACTICES FOR MATH INSTRUCTION

- Mnemonic Strategy (DRAW / STAR)

Discover the sign
Read the problem
Answer or DRAW
Write the answer & check

Search the word problem
Translate the words into equation in picture form
Answer the problem
Review the solution

Instructional Procedures

- Advance organizer - connected to previous knowledge / identified new skill or concept
- Model - two methods (Maccini, P. & Ruhl, K., 2000)

  *"Think-Aloud" the researcher ask and answer questions for one or two problems using cues provided in **STAR**.

  *The researcher used the **STAR** strategy with up to three problems while involving students in the think-aloud process through verbal prompts.
- Guided practice - students are solving problems with assistance while using the **STAR** strategy and eventually the assistance will begin the fading process.

Instructional Procedures

- Independent practice - students solve problems independently without prompts or cues
- Posttest - students had to score 80% or higher to advance to the next phase / score is lower than 80% students are provided with more modeling and guided practice
- Feedback/Rewards - positive and corrective feedback

Assessment
Visual Inspection and Analysis of Results

- Percent of strategy use
- Percent correct on problem representation
- Percent correct on problem solution and answer
- Generalization
- Social validation

Results/Conclusion

- The adolescents in the study using the mnemonic **STAR** for problem solving showed an increase in the use of strategy. They also showed improvements in identifying the correct operations, drawing a picture, writing a correct equation, and solving the problem. The students stated, “That the intervention was positive to their learning and worth the time spent learning.” Even though the results seem very encouraging, I believe that more research should be done on the different strategies for math class. A future study should be conducted on a larger number of students and the timing of the study such as beginning of school or after Christmas break instead of at the end of the school year.

RECOMMENDATIONS

- Continue to instruct math students with LD in basic arithmetic.
- Use think-aloud techniques when modeling steps to solve equations.
- Provide guided practice before independent practice so that students can first understand what to do for each step and then understand why.
- Provide a physical and pictorial model (diagrams, manipulative, and mnemonic) to aid the processes for solving operations.
- Relate algebra problems to real life events that match the students' ages and interests.

(Witzel, Smith, and Brownell, 2001)

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Best Practices in Secondary Mathematics

Teaching Entry-Level Calculus

Dr. Sandra Davis
The University of West Florida

Introduction
The Importance of
Entry-Level Calculus

1. It <u>is</u> the mathematics of Science and Engineering.
2. Establishes the foundation for higher-level mathematics courses.
3. Is necessary to establish exact calculations, instead of average values.

Traditional Calculus Teaching Methods

1. Lecture – chalkboard, white-board, "I write – you write."
2. Work sheets – in class problems, learn by repetition.
3. Homework problems – about a gazillion of them.
4. Written tests – "… excuse me professor, I don't recall doing this type of problem before!"

Best Practices Method #1
The Problem-Solving Method with Handout Material

1. The handouts include:
   a. A review of the pertinent theorems.
   b. A general procedure for solving related calculus problems (see example).
   c. A comprehension guide (example).

BP #1 - Example
A Maximum-Minimum problem

- A metal box (without top) is to be constructed from a square sheet of metal (s = 10”), by first cutting square pieces of the same size from the corners of the sheet and then folding up the sides. Find the dimensions of the box with the largest volume that can be constructed.

The handout

1. General procedure – a guide for solving:
   a. x = length of each side.
   b. The volume of the box is V.
   c. Define the boundaries of x.
   d. The problem reduces to finding the max value of V on [,] to determine the critical points of V in [,].

The handout (cont'd)

2. Comprehension Guide.

I. Check all known / unknown information:

____ A metal box is constructed from a square sheet.

____ Sides of a square sheet of metal equals 10 inches.

____ Squares of the same size are cut from each corner of the sheet.

The handout (cont'd)

II. What is to be found?

- ___ Side length of the square sheet of metal.
- ___ Side length of the metal box.
- ___ Volume of the metal box.
- ___ Maximum value of the box's volume.

How is BP #1 better than traditional lecture methods?

1. The students are not left (solely) to their own devices to figure out the calculus process.
2. A process may make sense in class, but might not appear so when class is over – this provides guidance.
3. This is an excellent method for shaping the "thought process" when working calculus problems.

Best Practices Method #2
"…the real world? Surely you jest!"

1. During a Maximum-Minimum lecture, the professor challenged the students to write some manufacturers' (of canned goods) concerning their methods of calculating max-min issues.
2. The purpose was for the student to find out for themselves how calculus is used in the manufacturing community.
3. Some companies would not answer the questions posed by the students, but sent a bunch of coupons for their products instead, along with a form letter thanking them for the interest.

4. Some companies did genuinely reply with letters, Faxes, or telephone interviews.
5. The information they gave, showed that they were wasting metal, according to the students' calculations.
6. However, the students were not aware of the other aspects of manufacturing that goes in to the design of cans, such as:
   a. The density of the product.
   b. The potential shelf-life of the product.
   c. The anticipated durability with respect to shipping and storage.

How is BP #2 better than traditional lecture methods?

1. Students get a sense of "ownership" for a particular type of problem by them contacting ***real*** companies.
2. Students come away with a better appreciation for how much more they need to know, in order to apply what they have learned.
3. The teacher can field most mathematical questions, and guide the students toward completion and genuine understanding.

Best Practices #3
Integrating Physics into the Calculus Curriculum

1. A noticeable problem is that, in physics, mathematics skills are necessary – but not necessarily sufficient for success in physics.
2. To help eliminate this deficiency, a program was developed to meld the two subjects in to a comprehensive curriculum with the following objectives in mind:

a. Show that variables represent *measurable quantities* instead of just numbers.
b. Correct any misinterpretations and misuses of mathematics in a physical context.
c. Minimize the differences in language and notation while highlighting the common ideas.

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