SCIENCE

Adolescence and Young Adulthood ♦ Ages 14–18+

Entry 1:

Teaching a Major Idea Over Time

Entry 2:

Active Scientific Inquiry

Entry 3:

Whole Class Discussions about Science

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Entry 1: Teaching a Major Idea Over Time

a. Knowledge of Students (KOS)

- Identify special needs. Gather information from IEPs, snapshot, paraeducators, special education staff/case managers, parents. Explain effect on decisions about activities, assessments, pacing of instruction.
- Know your students' learning styles. Use a simple personality (Myers-Briggs) or learning style survey. Relate to need for activities that engage hands-on or visual learners. Google search "Learning Styles Surveys"
- Have students complete "introduction cards." Survey for previous science/math classes, preconceptions about your class (What word comes to mind when you hear "Physics?"), reason for taking your class, favorite class, college/career plans.
- Gather information on parents/guardians and resources for class (careers, rationale).
- Assign students to lab groups using KOS.
- Understand larger issues (e.g., enrollment trends, graduation requirements, college entrance; relevance to course structure, pace, math level).
- Consider extracurricular activities, family/home issues, other courses.

b. Major Idea/Goals/Connections (MI/G/C)

- Identify major idea. Check National Science education Standards or Major Ideas in Science appendix to Portfolio Instructions. Use one of these. DO NOT use any concepts not explicitly in the Standards.
- Rationale should be based on KOS.
- Make holistic considerations. Connect to history, society, technology, mathematics, culture, entertainment.
- Goals must be measurable.
- Learning objectives must be measurable and observable, so you can prove growth using evidence from student work.
- Connect specific content objectives to other science content. (E.g., show evidence of students learning how understanding of forces from physics applies to movement of tectonic plates in Earth science or chemical bonding in chemistry.)

c. Instruction (INS)

- Explain learning cycle (exploration, concept development, application, 5E).
- Implement discrepant events and/or exploration. Use to engage students; can be a demonstration (more effective if a student-led demonstration).

- ♦ Consider safety in demonstrations. Refer to Flinn Scientific catalog or website; NSTA website is another good resource.
- ♦ Explain misconceptions. Identify from pre-test; look at science education research for lists of misconceptions; check the FLAG website http://www.flaguide.org/index.php for ideas.
- ♦ USE INQUIRY. Student questions determine sequence; focus on data collection/evidence.

d. Assessment (ASMT)

- ♦ Be diagnostic (Force Concept Inventory, DIRECT.) Use the FLAG website http://www.flaguide.org/index.php for resources.
- ♦ Use formative assessments.
  - Minute paper—students have one minute at the end of the class to answer an understanding-measuring question
  - Interactive response system (PRS, CPS, Qwizdom)
  - Detailed observation
  - Just-in-time teaching—use feedback from students (emails, minute papers, end-of-class quizzes, prompted journal entries) to determine reteaching, more lab activities, (more concept development)
  - Concept maps
- ♦ Use summative assessments.
  - Traditional tests
  - Authentic (portfolios, projects, writing, concept maps, webquest)
  - Relate alternative assessment projects to individual student interests from KOS
  - Post-test—calculate gain scores
  - Rubrics, grading checklists—establish quantitative grading for authentic tasks
- ♦ Correlate assessment questions/activities/exercises to learning objectives.
- ♦ Identify opportunities that promote fairness/equity.

e. Analysis (ANA)

- ♦ Collect lots of student work! Not just quizzes, but constructed response work—essays, lab writeups, experimental procedures, data analyses (graphs, tables, diagrams).
- ♦ The commentary and the evidence should be completely linked. (There are no

surprises in the evidence that weren't in the commentary.)

- ♦ Explain, don't describe, what is shown.
- ♦ Did students achieve goals? What evidence shows this achievement? What evidence shows areas to be improved?
- ♦ What modifications were made during the sequence and what evidence from student responses/work was used to determine those modifications?
- ♦ This entry should show your strength in content and pedagogy.
- ♦ Using evidence from student work, explain how growth over time has occurred, not just an improved score but transfer of learning.
- ♦ Using evidence from student work, explain how technology impacts learning. Why was technology necessary to reach this level of learning that couldn't have been reached without it? One of the work samples must have a technology connection.
- ♦ Identify using evidence from student work what specific misconceptions were present before the unit (and identified in the planning commentary) and are now conceptually correct.

f. Feedback (F)

- ♦ Feedback must connect specific learning objectives and specific level of performance from student evidence (formative assessments).
- ♦ Feedback should address specific misconceptions present in the student's work.
- ♦ A score on a quiz is not feedback.
- ♦ Verbal feedback is okay, but written is better evidence.
- ♦ Restructuring the instructional sequence based on student performance on formative assessment can be effective, but needs to be communicated to students.
- ♦ Feedback is a loop from objective to instruction to assessment to performance to teacher to student.

g. Content Knowledge (CK)

- ♦ Provide evidence for CK through use of resources (ASMT, INST).
- ♦ Connect INST to current science education research.
- ♦ Does not mean teacher must always know the answer; teacher can demonstrate science inquiry with an authentic investigation.
- ♦ Address ALL student misconceptions; do not allow to perpetuate (e.g., students equating velocity with acceleration, mass with weight).

- ♦ Focus content instruction on the BIG IDEA.
- ♦ Demonstrate CK through historical references (e.g., discovery of DNA molecule, development of atomic structure).

h. Instructional Resources (IR)

- ♦ Technology can be a pedagogical tool and is weighted heavily in this entry.
    - Interactive Response System
    - Multimedia projector
    - World Wide Web—class web pages, webquests, resource pages
    - Simulations, animations, applets
    - SmartBoard, Schoolpad
    - Emphasis on teacher-student and student-student communication
    - Videos (*Nova, Mechanical Universe, Bill Nye*; better use is short clips from popular films—*Star Wars, Apollo 13*)
    - Textbook ancillary materials—CD-ROMS, websites
- ♦ Technology can be a data collection/analysis tool.
    - LoggerPro (Interface & sensors)
    - Graphical Analysis
    - Excel
    - Mathematics connections
    - Graphing calculators
    - Digital imaging—video analysis of motion
- ♦ Technology is not an add-on, used for technology's sake. It must be integrated into the activity.
- ♦ Consider community resources.
- ♦ Consider career connections.
- ♦ Decisions on use of resources should always consider
    - Rationale, KOS
    - Relevance to major idea in science
    - Correlation to learning objectives
    - Developmentally appropriate
    - Safety
    - Furthering equity, fairness, access (access may be an issue with use of

computers, internet)

i. Reflection (R)

- ♦ Identify using evidence from student work that shows learning of the major idea and measurable.
- ♦ Identify using evidence from student work specific learning objectives that were learned or not learned. Identify reasons why.
- ♦ Identify and provide evidence from the student work/growth that dictates the next step(s) in this instructional sequence.
  - Reteach specific information
  - Extension activity based on student interests/needs
  - Fill in gaps/provide clarification of concepts
  - Modify pacing – accelerate or slow down instruction
- ♦ Identify possible modifications to instruction.
  - Peer evaluation
  - Graphic organizers
  - Cooperative learning
  - Kinesthetic activities
  - Visual activities
  - Technology (e.g., was more time spent training students to use the technology than them using the technology to learn?)
  - Context of questions/activities (e.g., not every student is equally comfortable studying projectile motion using the context of kicking a football.)
  - Pacing of instruction/activities.
- ♦ JUSTIFY THE REASONS FOR THE USE/MODIFICATION/ABANDONING OF THE IDENTIFIED STRATEGIES.
- ♦ Identify what activities/practices had NO IMPACT on student learning; explain using evidence from student work.
- ♦ Identify other resources that could be used more effectively; identify resources that were not effective. (Use evidence from student work.)
- ♦ If the unit was effective, what could make it more effective for every student?
- ♦ Identify aspects of the instructional sequence that enhances your understanding of accomplished teaching.

Entry 2: Active Science Inquiry

a. Knowledge of Students (KOS)

- Refer to suggestions provided in Entry 1.
- Explain why students are grouped the way they are, and cite evidence from the video that demonstrated impact on learning

b. Goals/Connections (G/C)

- Refer to suggestions provided in Entry 1.
- Learning objectives must be observable, so you can prove growth using evidence from the video.
- Connect specific content objectives to other science content. (E.g., show evidence of student learning of heat transfer in physics applies to weather patterns in Earth science or global warming in ecology.)

c. Instruction (INS)

- Refer to Suggestions provided in Entry 1.
- Use a constructivist approach (prior knowledge, discrepant event, conceptual change). Identify where and when these discrete events occur in the video.
- Explain the learning cycle (exploration, concept development, application, 5E). Identify what stage(s) of the learning cycle occur where and when in the video.

d. Science Inquiry (INQ)

- When and where in the video is evidence of student use of prior knowledge?
- When and where in the video is evidence of student development of investigation questions?
  - Student design of investigation
  - Student identification of dependent and independent variables and controls
  - Student decisions about data collection (type and amount)
  - Student collection of data, use of equipment
  - Student use of measurement and mathematics
  - Student analysis of data collected
  - Student communication of results
  - Student representation of major concept in multiple modes (verbal, graphical, mathematical, visual)
  - Student collaboration
  - Teacher use of open-ended questions to guide/focus/direct student inquiry

- Student familiarity with all of the above (cannot be the first time—students know how to do all of these; minimal questions, answered by each other, not the teacher)

e. Instructional Resources (IR)

- ♦ Refer to suggestions provided in Entry 1.
- ♦ Explain how classroom layout maximizes opportunities for inquiry. Students' design of experiment allows as much room as needed.
- ♦ Explain how use of time maximizes inquiry. Do not need to contain all three segments in the same class period.
- ♦ Use teacher-designed materials or processes to support the inquiry activity.

f. Learning Environment (LE)

- ♦ Room layout allows for students free to make appropriate modifications for the inquiry process.
- ♦ Students have equitable access to resources during the activity.
- ♦ Use hallways, courtyards, parking lots, parks. Science needs a lot of room for experiment and data collection.
- ♦ Other artifacts in the classroom support inquiry.
- ♦ Check for safety. Be attentive to issues of chemical/physical hazards; there should be NONE!
- ♦ Cooperative learning group assignments should be made using KOS as an important vehicle for ensuring equity, fairness, access.

g. Analysis (ANA)

- ♦ Refer to suggestions provided in Entry 1.
- ♦ Identify using evidence from video what specific misconceptions were present before the activity (and identified in the planning commentary) and are now conceptually correct, and the point in the video where conceptual change occurs. (When does the light bulb come on?)
- ♦ Specifically identify examples from the video of student inquiry. (See INQ.)

h. Content Knowledge (CK)

- ♦ Refer to suggestions provided in Entry 1.

i. Reflection (R)

- ♦ Refer to suggestions provided in Entry 1.
- ♦ Explain, using evidence from video, learning of the major idea that is measurable.

- Explain, using evidence from video, specific learning objectives that were learned or not learned. Identify reasons why.
- Explain, using evidence from video, student work/growth that dictates the next step(s) in this instructional sequence.

Entry 3: Whole Class Discussions about Science

a. Knowledge of Students (KOS)

- Refer to suggestions provided in Entry 1.

b. Goals/Connections (G/C)

- Refer to suggestions provided in Entry 1 and Entry 2.
- Goals must be learning goals. The act of discussing is not a goal.
- Learning facts (knowledge level) is not a goal for this type of activity.
- Goal should be at the analysis/evaluation level.
- The goals and objectives must be appropriate to discussion and not better achieved with another mode. (E.g., measuring air resistance with falling coffee filters is a good experiment; examining the different historical models of atomic structure is a good discussion.)
- Topics with some "controversy" seem to work well to stimulate student interaction (science-technology-society issues).
- Debate or trial discussions provide structure for students and enable participation.
- The goal should not be to recap what has already been learned. It is not simply a "reporting-out" on conclusions already made; the discussion itself is the method of reaching a new conclusion.
- Develop a rubric for measuring student performance in preparation and discussion.

c. Analysis (ANA)

- Refer to suggestions provided in Entry 1 and Entry 2.
- Refer specifically to the rubric for evaluating student performance in the discussion
- Specifically identify examples from the video of learning due to the discussion.

d. Learning Environment (LE)

- Room layout of circles seem to work the best.
- Students have equitable access to resources (internet, computers, books, teacher, time, equipment) to prepare for the discussion.
- Identify how the structure of the activity enable access, fairness, and equity
- Identify teacher-to-student, student-to-teacher, and student-to-student interactions that demonstrate equity. Students are comfortable discussing with the teacher and each other as equals.

- The absence of intimidation and anxiety about the discussion is evidence of a safe environment.
- Discussion rules/management procedures should promote fairness, equity, and access without curbing participation.

e. Engagement (ENG)

- Evidence from the video demonstrated student interest in the topic and the activity.
- Identify examples of nonverbal engagement (e.g., body language, eye contact, listening pose, ready to interject pose).
- Avoid “rules of dis-engagement” that suppress participation. (There is no need for students to raise their hands to say something in a discussion.)
- Interruptions can be evidence of engagement.
- Identify examples of student engagement in the complete activity (e.g., preparation for the discussion with organized notes).

f. Feedback (F)

- Teacher feedback to students (verbal or nonverbal) during video must not hamper participation. (Do not say “good” or indicate approval of particular statements or students.)
- Teacher attentiveness to all students is the best feedback during the video.
- Teacher participation in the video should exclusively be to maintain and encourage the discussion; prompt with open-ended questions.
- Feedback at the conclusion of the activity must connect specific learning objectives and specific level of performance from student performance in the video.
- Feedback should address specific misconceptions present in the discussion.
- Feedback is a loop from objective to instruction to assessment to performance to teacher to student.

g. Content Knowledge (CK)

- Provide evidence for CK through the topic for the discussion. (E.g., compare and contrast the phenomenon of wave/particle duality” is a high CK topic, “discuss the names of the elements” is not.)
- A teacher-provided set of resources is evidence of CK (e.g., bibliography, list of reviewed websites, CD-ROMs, journal articles).
- The structure of the activity is evidence of CK. Focus on higher-level learning objectives (analysis/evaluation instead of knowledge).

- ♦ Address ALL student misconceptions in the instructional sequence, but allow students the opportunity to "discuss their way" to the correct concept.

h. Reflection (R)

- ♦ Refer to suggestions provided in Entry 1 and Entry 2.
- ♦ Identify possible modifications to the activity (e.g., more teacher involvement or more student involvement).
  - Structure of the discussion question (too abstract?)
  - Connection to prior knowledge/rationale
  - Resources available to students
  - Student preparation for discussion
  - Structure of the discussion (open or assigned roles—trial/debate/hearing)