Elements Contributing to High Quality Inquiry Science Programs

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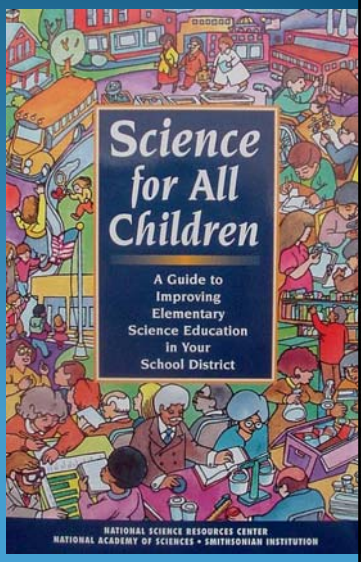
Assumptions

- We have identified what goals and objectives we want from a quality inquiry-based program
- We have identified elements that will contribute to systematically meeting those goals
- We anticipate what the end result should look like if we were to assess results
- We design programs and activities with the intent of reaching those goals

Five Critical Elements for Reform

- High Quality Curriculum
- Sustained Professional Development
- Materials Support
- Administrative and Community Support
- Assessment and Evaluation



Curriculum that is inquiry-based

EVIDENCE:

- Quality of Curriculum
  - Inquiry-based
  - Provides in-depth experiences
  - Hands on
  - Minds on - Intellectually challenging
- Availability of curriculum to all teachers

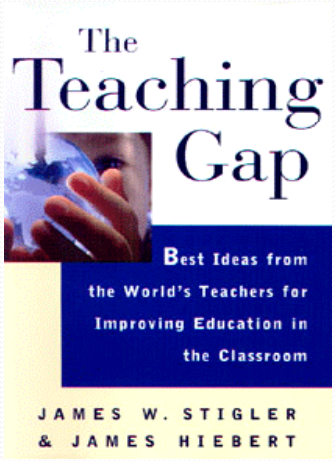
Program Capacity and Implementation

- **Professional Development to prepare teachers and leaders**
- **Materials to support the program are available**

Professional Development

- Explicit instructional components: content and pedagogy.
- Models effective practices.
- Demonstrations where teachers practice with real lessons and discuss or debrief (such as the use of Lesson Study or videotaped lessons).
- Consistent support by experienced resource teachers where and when possible

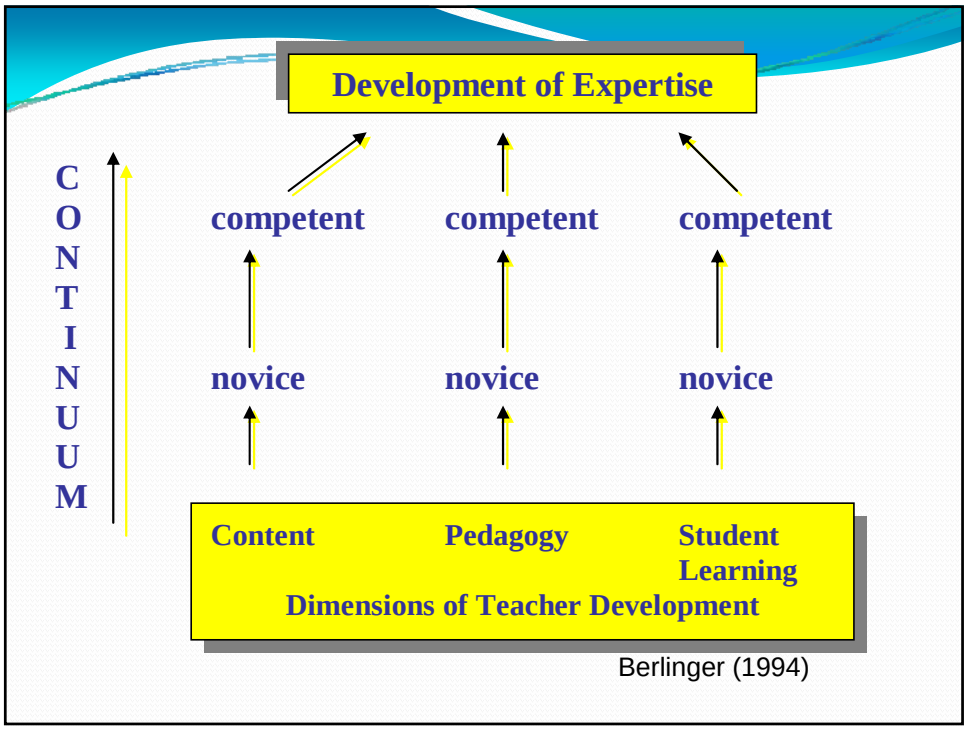
Professional Development



For more than a century, American schools have been caught in a weary cycle of trying to improve but staying the same. The reason, according to Stigler and Hiebert, is that most reforms fail to affect the most critical cause of student learning--processes of teaching and learning in classrooms.

" Along with Stigler and Hiebert , I think it is high time we stop spinning our wheels about education reform and dig in and change things"
Paul Macfarlane

http://www.tdl.com/~schaffer/teachgap.htm



Berlinger (1994)

Professional Development

- How well was it delivered?
- Did it meet teachers' needs and expectations?

Professional Development Delivery Quality - Questions

- Did the professional development:
  - Use inquiry-based instruction?
  - Engage all participants?
  - Show evidence of planning and management?
  - Target the audience appropriately?
  - Provide information instructionally useful to teachers?
  - Cover both content and pedagogical knowledge?

Professional Development
Delivery Quality - Measures

- Formal observational protocol
- Checklist of desired components/activities
- Informal notes of PD activities
- Combination of above measures

Professional Development

http://www.horizon-research.com/instruments/lsc/pdop.pdf

HORIZON RESEARCH PD PROTOCOL

1. Design
2. Implementation
3. Content
4. Instructional materials
5. Leadership
6. Culture of the professional development

Professional Development
Teacher Satisfaction - Questions

- Did the PD:
  - Meet teachers' expectations?
  - Provide useful information?
  - Prepare them to change their instructional practice?
  - Change and adapt as needed from session to session?

What teachers want may not be what they need

Professional Development
Teacher Satisfaction - Measures

- Structured in-depth interviews
- Informal discussions with teachers
- Surveys
- Teacher reflections

Teacher Survey

http://cehd.umn.edu/CAREI/CETP/SpanishVersions/K-12Teachers.rtf

8. Diferentes maestros han compartido con los investigadores filosofías de enseñanza muy diferentes. En cada uno de las siguientes pares de aseveraciones, oscurezca el círculo que mejor indique cuánto se parecen sus propias opiniones con cada una de las aseveraciones de cada par. Mientras más se parezca su opinión a una de las aseveraciones, más cercano debe ser el círculo que oscurezca. *Por favor oscurezca un solo círculo en cada par.*

i.	"Veo mi función principalmente como la de un facilitador. Trato de ofrecerles a mis estudiantes las oportunidades y los recursos para que descubran o elaboren los conceptos por sí mismos."	○	○	○	○	○	○	"La investigación es muy buena, pero los estudiantes no aprenderán una materia realmente a menos que yo vaya sobre el material de manera estructurada. Mi trabajo es explicar, enseñarles a los estudiantes cómo hacer el trabajo y asignarles prácticas específicas."
.	"La parte más importantes de la instrucción es el contenido del currículo. Ese contenido es el estándar de la disciplina sobre lo que los estudiantes tienen que saber y hacer."	○	○	○	○	○	○	"La parte más importante de la instrucción es que estimule a los estudiantes a analizar o a pensar. El contenido es secundario."

Program Capacity and Implementation

- **Curriculum that is inquiry-based**
- **Professional development to prepare teachers and leaders**
- **Materials to support the program are available**

Materials

- Inventory – Were materials available?
- Distribution – Did they reach teachers in a timely fashion?
- Refurbishment – Was there an efficient mechanism to refurbish units?

Teacher Performance

- **Teachers**
  - **What do they know? - Content knowledge**
  - What do they do? – Classroom performance

Teachers' Performance - Questions

- Do teachers have sufficient knowledge of science content to teach the units?
- How effectively do teachers employ inquiry-based instruction?
- How do teachers use student assessment to guide instruction?

Teachers' Class Performance - Measures

- Self report
- Teacher portfolios
- Classroom observations (live or video)
  - Checklist
  - Scales
  - Rubrics

Teachers' Class Performance - Measures

- Self Report

- Teacher portfolios
- Classroom observations (live or video)
  - Checklist
  - Scales
  - Rubrics

Teacher Performance Self Report

Strategy	New to me*	Less than monthly	Monthly-weekly	More than weekly
INSTRUCTIONAL STRATEGIES				
Require students to demonstrate reasoning				
Preview vocabulary used in a lesson				
Use open-ended problems and questions				
Require alternative solution strategies				
Sequence instruction from easy to difficult				

Teachers' Class Performance - Measures

- Self report
- Teacher portfolios
- Classroom observations (live or video)
  - Checklist
  - Scales
  - Rubrics

Teacher Performance Portfolios

1. Lesson plans
2. Samples of student work
3. Sample assessments with feedback
4. Reflections about lessons delivered
5. Changes to plans for next time they teach the unit
6. Questions they have about aspects of the lessons

Teachers' Class Performance - Measures

- Self report
- Teacher portfolios
- Classroom observations (live or video)
  - Checklist
  - Scales
  - Rubrics

Teacher Performance Observation Checklist

Strategy	**1: Not yet** **2: Developing** **3: Doing well** **4: Mastered**
INSTRUCTIONAL STRATEGIES	
Teacher gives students the opportunity to become familiar with materials before proceeding with lesson	
Questions are often of an open-ended nature and require explanations	
Teacher asks students many questions	
Asks students to demonstrate reasoning	
Review homework and worksheet assignments	

Teachers' Class Performance - Measures

- Self report
- Teacher portfolios
- Classroom observations (live or video)
  - Checklist
  - Scales
  - Rubrics

Protocolo para observacion en el salon de clases

1. Esta lección estimuló a los estudiantes a buscar y valorar modos alternos para la investigación o para la solución de problemas
2. Se estimularon elementos de la abstracción (es decir, representaciones simbólicas, construcción de teoría) cuando fue importante hacerlo
3. Los estudiantes reflexionaron acerca de su aprendizaje
4. Las estrategias y actividades *de enseñanza respetaron el conocimiento previo de los estudiantes y las preconcepciones inherentes al mismo*

Teachers' Class Performance - Measures

- Self report
- Teacher portfolios
- Classroom observations (live or video)
  - Checklist
  - Scales
  - Rubrics

Teacher Performance Observation - Rubric

STRAND	I	II	III	IV	V
Lesson Focus	Tasks, intent and purpose of the lesson are unclear.	Tasks made clear but not the intent or purpose of the lesson.	Lesson tasks and intent are clear but not set within a larger frame.	Some linkages are made between the current activity and the key concepts of the unit.	Lesson tasks and intent are clearly evident within the key concepts of the unit.
Student Engagement	Many students not actively engaged in the lesson.	Most of the students engaged and participate in the lesson.	Nearly all students engaged and participate at various points in the lesson.	Most students engaged physically and intellectually in the lesson.	Nearly all students engaged physically and intellectually to contribute consistently throughout the lesson.
Data, Claims & Evidence	Teacher doesn't require and/or provide direction for data collection.	Teacher requires data collection but without sufficient student support.	Teacher monitors and guides students to clearly and accurately record data from the lesson.	Teacher ensures that students record data clearly and accurately and can interpret data.	Teacher ensures students record data clearly and accurately, can interpret data, and relate findings to the key concepts.
Discourse Discussion	Teacher talks, students listen.	Teacher engages students in procedural and management discussions.	Teacher asks students fact based questions about what they did and found in the lesson.	Teacher poses questions to develop student thinking that begin to link the lesson to the key concepts.	Teacher poses questions that connect lesson to key concepts and requires students to explain their responses with clear lines of evidence.
Closure Conclusion	Lesson ends without closing activity.	Procedures reviewed to handle and put away materials.	Lesson's activities and findings were reviewed. Teacher directed all students to the same conclusion.	Lesson's activities and findings were reviewed with some reference to the key concepts.	Lesson's activities and findings were reviewed and tied to lesson intent, purpose, and key concepts.

Student Achievement

The ultimate goal

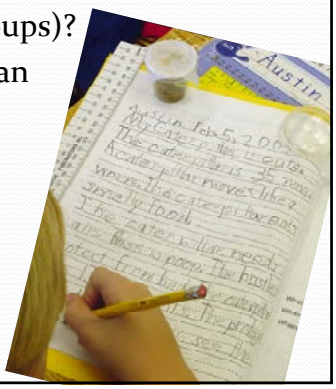
- **What did they learn?**
  - **Content Knowledge**
- What can they do?
  - Classroom performance

Big Ideas in Science

- Goal is to get students to understand **big ideas** in science
- Purpose is to make it a cumulative scaffolded effort so students can **grow** in science **over time** (rather than focusing on facts or readiness solely for a test)
- Teaching for understanding/make **meaning** vs. teaching for coverage

Student Performance
Content Knowledge - Questions

- As a result of the program:
  - Do students know more science content?
  - Do students know more science content than non-program students (use of control groups)?
  - Did program students learn more than non-program students?



Student Performance
Content Knowledge - Comparisons

- As a result of the program:
  - Do students know more science content?
    - Pre-post tests of program students
    - Teacher/parent reports – perhaps grades as well
  - Do students know more science content than non-program students?
    - Post tests of matched groups (program vs non-program)
  - Did program students learn more than non-program students?
    - Gain scores (post – pre) of program students vs. gain scores of non-program students.

Student Performance
Content Knowledge -Measures

Standardized Measures

- Nationally normed assessments
  - Sub-test scores
- Unit Specific Measures (pre-post, post-post)
  - Publisher developed measures
  - Locally developed

Student Achievement

- **What did they learn?**
  - **Content knowledge**
- **What can they do?**
  - **Classroom performance**

Student Performance
Classroom Work- Questions

Do student notebooks demonstrate:

- A clear understanding of the purpose of the lesson?
- Original student thinking?
- Ability to record and interpret findings?
- Clear lines of evidence to defend findings?
- Conclusions founded in the data and related to the larger concepts?

Student science notebooks used to gauge individual student progress and thinking about science

Student Performance
Classroom Work- Rubrics

STRAND	I	II	III	IV	V
Lesson Focus	Tasks, intent and purpose of the lesson are unclear	Tasks made clear but not the intent or purpose of the lesson	Lesson tasks and intent are clear but not set within a larger frame.	Some linkages are made between the current activity and the Big Ideas of the unit.	Lesson tasks and intent is clearly evident within the Big Ideas of the unit.
Student Engagement	Many of the notebook components are missing or incomplete	Some of the notebook components are missing or incomplete	All parts of the notebook are present and complete	Notebook entries complete with some examples of original student thinking or work.	Most of the notebook entries reflect original student thinking and work
Data, Claims & Evidence	Students don't gather or report data.	Data is not clear or is inaccurate.	Students clearly and accurately record data from the lesson	Students record data clearly and accurately and interpret the findings.	Students record data clearly and accurately, interpret data, and relate findings to the Big Idea
Discourse Discussion	Notebook does not contain evidence student thinking.	Student thinking is limited to procedural information.	Students relate facts about what they did and found in the lesson.	Student links findings to the Big Idea	Student connect findings to the Big Idea and explain reasoning with clear lines of evidence.
Closure Conclusion	No conclusion recorded	Conclusion is not supported by the findings	Conclusion is supported by the findings	Conclusion is supported by the findings with some connections made to the Big Idea.	Conclusion well founded in the data and strongly tied to the Big Idea. Includes ideas/questions for further investigation.

Notebook Rubric

Big Idea: Matter is made up of elements that are arranged according to their characteristics properties in the periodic table of elements. When these elements are combined chemical reactions occur and their characteristic properties change.

	1	2	3	4	5
	Standard not addressed	Student attempts activities and reports findings which were inaccurate, incomplete, or not original work.	Student completes activities related to the standard, correctly reports results.	Student completes activities and links findings to the standard.	Student shows deep understanding of the standard by generalizing results beyond activities in the lesson.

Lessons covered: 1, 2, 3, 4, 5, 6, 7, 8, 20, 21, 22, 23, 25

	Properties of a **SOLID** – shape, mass, volume	Properties of a **LIQUID** – shape, mass, volume	Properties of **GAS** – shape, mass, volume	Properties of a **DENSITY** – 2.1, 2.2, 2.3, 3.1 ,4.1 mass/volume, predict float or sink, buoyant force	Changes of state – solid – liquid - gas	Elements arranged by characteristics on **Periodic Table**	Overall concept – concept maps
Students							
Jamie	2	2	2	2	2	1	2
Pricilla	2	2	2	4	3	1	2
Kathryn	2	2	2	3	2	1	2
Dan	1	1	1	2	1	1	2

Classroom Work- Rubrics

Data and Observations

3	Student drawings are accurate and contain sufficient detail (e.g. critical contact points are clearly identified). Most lessons show sufficient detail to support claims and evidence.
2	Accuracy and/or detail is inconsistent.
1	Student drawings are inaccurate or incomplete/sloppy so that critical aspects of drawing are missing and/or not labeled.
0	No evidence.

Questions to Ponder . . .

1. Which features of the science program have you identified as CENTRAL to its success?
2. What evidence do you already have that will help you understand the level of implementation?
3. What additional evidence (instruments) do you need to evaluate the level of success in the program.
4. If you have the above, what will your Professional Development Plan include?

Some examples from the Imperial Valley

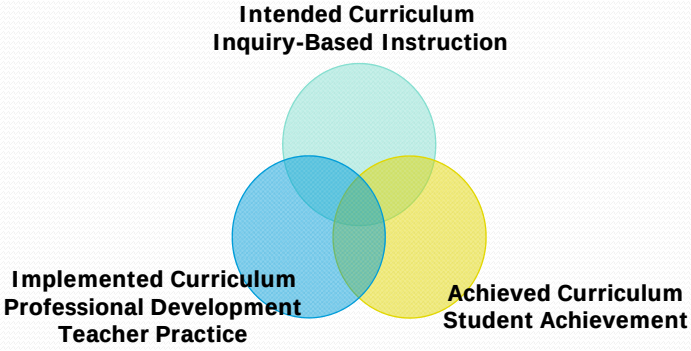
The Work

- Focuses on development of science content knowledge through inquiry and direct experience
- Develops deep knowledge of what is difficult to teach and difficult to learn in science
- Supports the instructional programs and materials used by the teacher participants
- Identifies and develops teacher leaders as instructional leaders

The Work

- Develop and design professional development experiences focused on the effective teaching of science
- Mechanisms include: summer institutes,workshops, short courses, seminars, academic year programs
- Inquiry as the key element of analysis of teacher learning, teacher discourse, teacher practice and student work.

Examining where teacher practice and student achievement intersect



Fidelity of Implementation

Our Beliefs

- All teachers want to and are capable of improving classroom instructional practices to increase student understanding and achievement.
- Content institutes will lead to significant growth in teachers' understanding of content, pedagogy and student learning.

Best Practices in Science

Questioning Strategies

- **Prior knowledge activation (inference strategies)**
- **Exposure to critical vocabulary that is contextualized in pedagogy**
- **Reflection on hands-on experiences**
- **Ensure intellectual rigor of inquiry**
- **Nurture collaboration among students**
- **Share authority for answers**
- **Facilitate student thinking (greater focus on "how" and "why" questions rather than "what and "when")**

Types of Questions

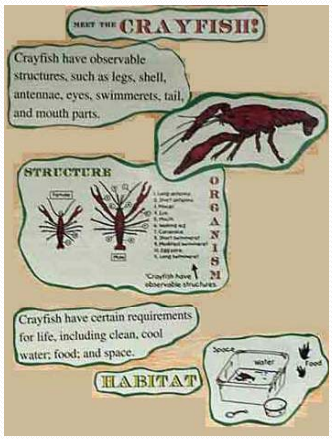
- 60% - recall of facts
- 20% - procedural
- 20% - require student to think

Levels of Questions

- **Input**
  complete; count; define, describe, identify, list, locate, match, name, observe, recite, select, tell
- **Process**
  analogy, analyze, arrange, cause/effect, classify, combine, compare, construct, contrast, distinguish, estimate, experiment, explain, group, infer, invent, organize, plan, produce, relationship, report, separate, sequence, show, summarize, synthesize, use, write
- **Output**
  apply principal, build model, choose, create, decide, discuss, evaluate, expand, extrapolate, forecast, generalize, hypothesize, imagine, judge, predict, project, recommend, speculate

Courtesy of Fresno Unified School District, California

Graphic Organizers used to review and reinforce conceptual understanding of science content



Discourse/Discussion

- Probably the most important for determining students' ability to **make meaning**
- Connection to key concepts
- Must have linkages to what they found in the lesson (i.e. my findings do not support this but the class found….) not supported by their own evidence: Open to their own thinking

Strategies in Science and Literacy

Science

1. **Predict**
2. **Infer**
3. **Classify**
4. **Compare/Contrast**
5. **Synthesis**
6. **Observation**
7. **Evaluation**
8. **Graphic Organizers**
9. **Questioning Strategies**
10. **Academic language**
11. **Academic discourse**
12. **Text structure**
13. **Key words (technical vocabulary)**

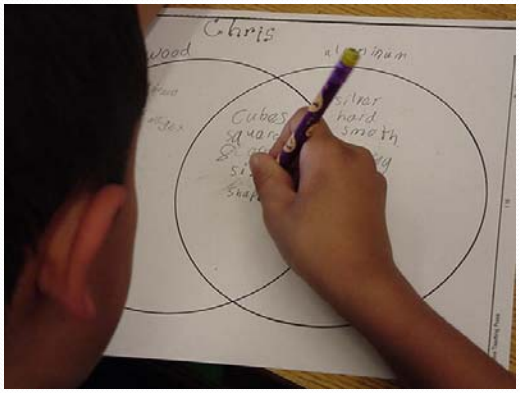
Sorting & Classifying

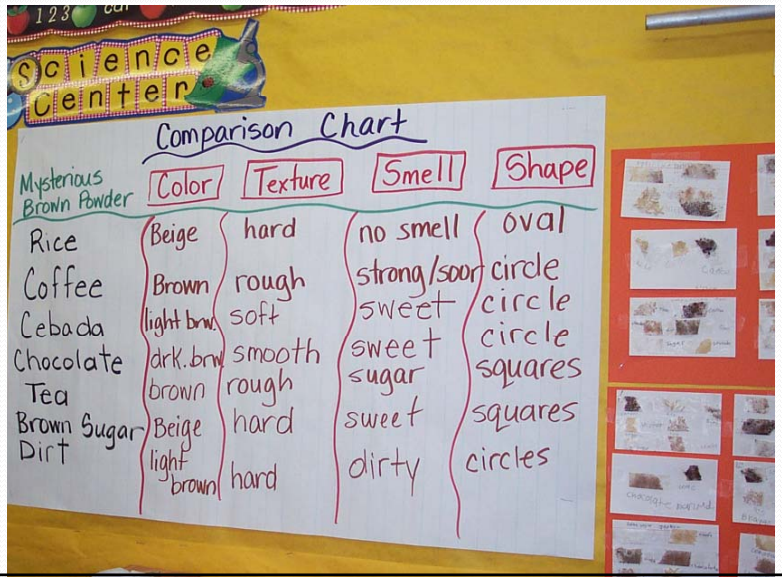
- Sort objects to form groups
- Classify objects using properties
- Share out and/or document characteristics

KWLH Chart

What We Know	What We Want to Find Out	What We Learned	How Can We Learn More
Soil is dirt Soil is all around us Plants grow in soil Soil is wet	What's in soil? Are there different colors of soil? Do all plants grow in soil?	Soil is made of different minerals. There are different types of soil Some seeds can grow in soil and humus Some seeds cannot grow in sand and clay	Research Museums Field Trips Videos Internet computer search

Venn Diagram




Science Center
Comparison Chart
Mysterious Brown Powder
Color
Texture
Smell
Shape
Rice
Beige
hard
no smell
oval
Coffee
Brown
rough
strong/sour
circle
Cebada
light brw.
soft
sweet
circle
Chocolate
drk. brw.
smooth
sweet
circle
Tea
brown
rough
sugar
squares
Brown Sugar
Beige
hard
sweet
squares
Dirt
light brown
hard
dirty
circles

Technology

Coherent Instruction…

"…is teaching that connects. It connects the student's reading skills to writing. It connects reading and writing to content. It links the content of learning to student interests. Coherent teaching makes it easy for students to learn because it combines the ***strange-new with the familiar-old***. When the classroom is coherent, teachers help students make connections among reading, writing and content."

Key Lesson Components

- What are some key lesson components or practices that your professional development program is trying to develop with classroom teachers?
  - Observable
  - Another example: Questioning Strategies

Video Clip

- Teacher: F. Espino
- Grade: 5
- Lesson: Mixtures and Solutions
- Scoring of:
  - Data, Claims, and Evidence
  - Discussion/Discourse

Planning of Summer Institute

- Identifying the Summer Institutes to be offered based on:
  - Teacher Surveys
  - SRT Assessments
  - Test Data

- Institute Design
  - College level courses
  - Institutes' content related to California Science Standards
  - Institutes' content related to California Science Standards AND grade level Curriculum

What is Lesson Study?

Lesson Study

- *While it may be a simple idea, lesson study is a complex process, supported by collaborative goal setting, careful data collection on student learning, and protocols that enable productive discussion of difficult issues."*
  (Catherine Lewis, Lesson Study: A Handbook Teacher-Led Instructional Change, 2002)

- *"A lesson is like a swiftly flowing river. When you're teaching, you must make judgments instantly. When you do a research lesson, your colleagues write down your words and the students' words. Your real profile as a teacher is revealed to you for the first time."*

— A Japanese teacher's reflection on lesson study

"Highly Qualified Teachers" Building Capacity

- Chronicles Best Practices
- Becomes Deeper with More Practice
- Peer Collaboration and Feedback
- Promotes Reflection
- Focus on Student Work

Recruiting

- Recruitment Successes
  - One on One
  - Bring a friend
  - Lead Teacher Challenge
  - Be clear on the expectations

Summer Institute Components

- Development of expertise
  - (Content & pedagogical, knowledge)
- Content: physical; earth; life
- Literacy
- ELD

Classroom Implementation – Follow up

- Structured and led by Science Resource Teachers
- Direct connections between intensive summer institutes & follow-up
- Evidence of effectiveness
  - Observation of PD – modeling of strategies
  - Content pre/post measures
  - Videos of classroom practices
  - Student notebooks
  - Student unit pre-post tests

Important Dates

Attendance at follow-up meetings:

- **Topics**
- **Q&A**
- **Notebook Refresher**
- **Follow-Up Requirements**

Checklist

- **18 copies of Notebook Exemplars**
- **Class set of complete notebooks**
- **Video Packet (video personal reflection)**
- **Implementation/Prep Log**
- **SRT Visit & Debriefing**
- **Pre/Post Test Packet**

Notebook Exemplars

- Submit 3 different copies of student examples for each of the 6 components for a total of 18 examples
- Label each exemplar with the Notebook Component it represents
- Spread the examples out over a series of different lessons. Not all 18 from the same notebook or student.
- Place an identification sticker on the back of each example.

Implementation/Prep Log

The purpose of the Implementation & Prep Log is to record significant changes to the existing science unit based on what you learn in your Summer Institute. The focus must be content and pedagogy.

Student Notebooks

- Submit a class set of student notebooks. The unit must be completed and all lessons represented in your notebooks.
- Not all notebook components will be implemented in all lessons, although you should at least have the 3 essential components:
  - Focus Question
  - Claims/Evidence
  - Conclusion
- Place a sticker on the back of each notebook.

SRT Visit & Debriefing

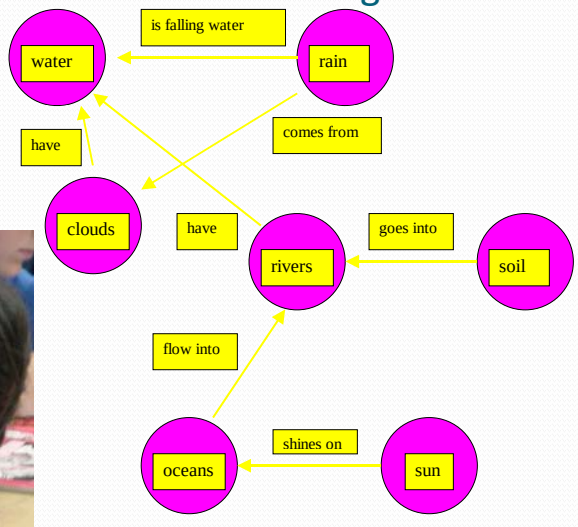
- Schedule a date and time by *Sept. 9th* for SRT to visit your classroom.
- SRT will observe a lesson and meet with you briefly to provide feedback.
- SRT and teacher will look over student notebooks.

Discussion

Taking time to discuss all aspects of programs and their progress and ways of improving it is an important professional development activity for project leadership but also for teachers.

Concept Mapping – Declarative Knowledge

- [illegible]
  - [illegible]
  - [illegible]
  - [illegible]



Muchas Gracias

- Preguntas?
- For more information:
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