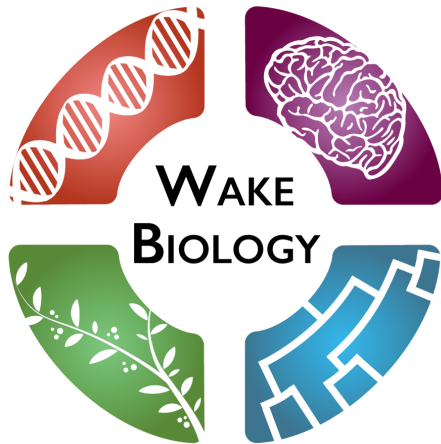# From Cookbook to Guidebook:
Turning Traditional Biology
Labs into Active Inquiries

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Co-Founder, The Adapa Project

Overview of Workshop

- Set the stage
- Old "Diffusion" lab
- "5 of 7" General Design Model
  - Live, hybrid or online
- New "Diffusion" lab
- Logistics, Q&A
- Feedback – Help!

What Experience Levels Are Here Today?

How many use:

- >50% cookbook
- >50% "active" labs

How many use:

- >50% 1-week units
- >50% 2+-week units

Setting the Stage

What are your challenges for adding, teaching "active / inquiry labs"?

<u>Take</u>:

- 1 min to think

- 5 min. to discuss

- Summarize, compile in ≤3-word phrases

What Are Your Implementation Challenges? (AM)

- Students uncomfortable
- Fair grading
- Req prof. devel.
- Loss of control
- Time to convert
- Multiple cooks
- Time, anxiety mgmt
- Students avoid thinking
- Storage b/w weeks
- Students keeping track
- Coming outside hours
- Do you meet learning outcomes?
- Failure IS an OPTION

- Setting boundaries
- Providing materials
- Topic diversity limited
- Coverage breadth v depth
- Setup
- Staff support
- Lab instructor buy-in
- TA training
- The RIGHT answer
- Damage control
- Manuals available
- Course alignment

What Are Your Implementation Challenges? (PM)

- Exp. design ability
- Consistency b/w groups within a section
- How much bkgnd students have
- TA marking accuracy
- Rejection by faculty
- Time, supply resources
- Managing different outcomes in 1 lab section

- Training TAs
- Course alignment
- Low vs. high process skills
- Guiding vs directing
- Scared students – C & free, A &away
- How to develop skills like writing
- Formative assessment
- Do WE know enough to do this effectively?

Common Challenges

- Lack of personal experience with model
- Coverage requirements vs. process skills
- Student & instructor resistance
- Lack of any LAB-oriented design guidelines
    - General:
        - Backwards design (Wiggins & McTighe)
        - Universal design for learning
    - For lecture:
   - PrBL, PjPBL, POGIL, TBL, etc.
    - Lab?

WFU's Top Three Challenges

- Training lab GTAs, faculty to:
  - Adopt a new mindset about learning
  - Be comfortable in an unfamiliar lab course structure
  - Manage labs differently from their own past experiences

- Building labs that OTHERS execute correctly!
  - GTAs want to make changes to fit their needs, not curriculum goals

- UG and GTA resistance (not today)

# What is Inquiry "Mindset?"

Meta-Goals

- Prime, coach students
- Most time, effort DOING:
  - Process of science
  - Autonomous exploration
  - Authentic activities
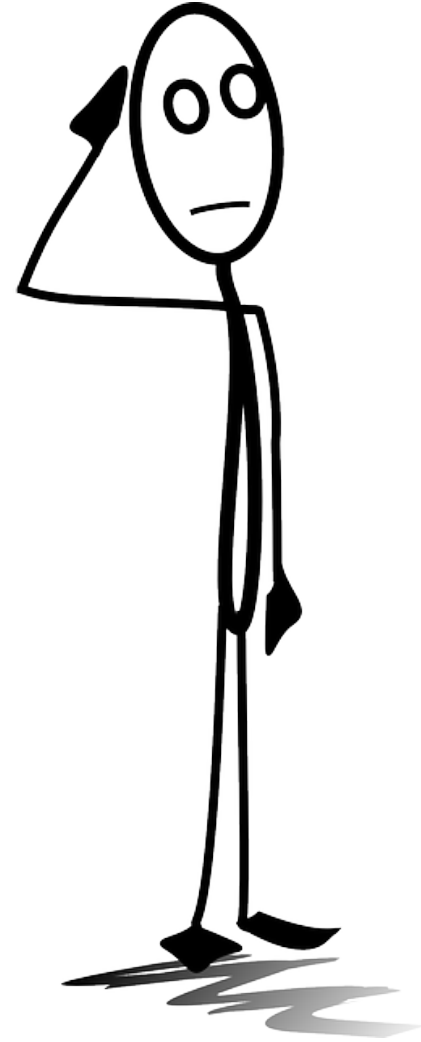
Mindset: Authentic Activities

- Picture a mentored research lab:

  New lab members

  – <u>How</u> do students learn important questions?

  – What <u>skills</u> do they need?

  – <u>How</u> do students get those skills?

  – What do students <u>**DO**</u> to show progress?
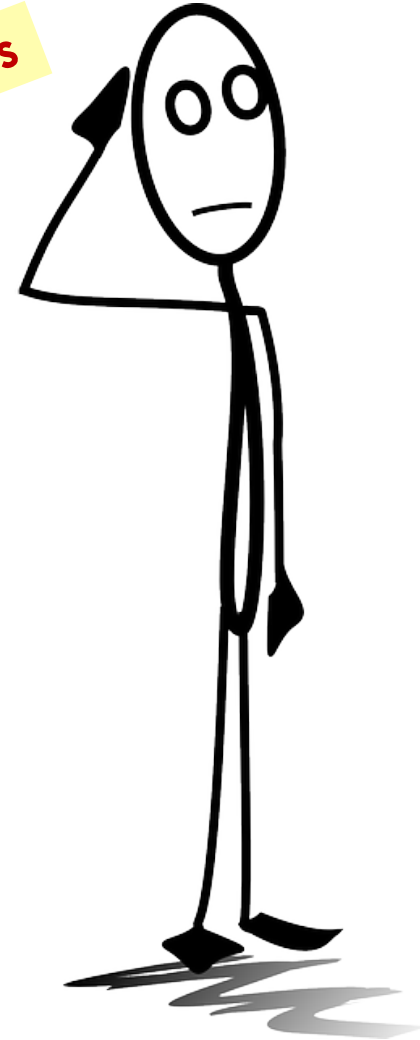
How is <u>Course Structure</u> Different?

- Outcome goals
  - Process, skills centered
  - Ex.: ID 10 organisms *vs.* form clades
- Assessment
  - Open-ended, authentic, **often**
- Class structure, flow
  - Messy, loud, less predictable
- Management
  - Coaching, not content delivery
  - Instructors adapt *in situ*
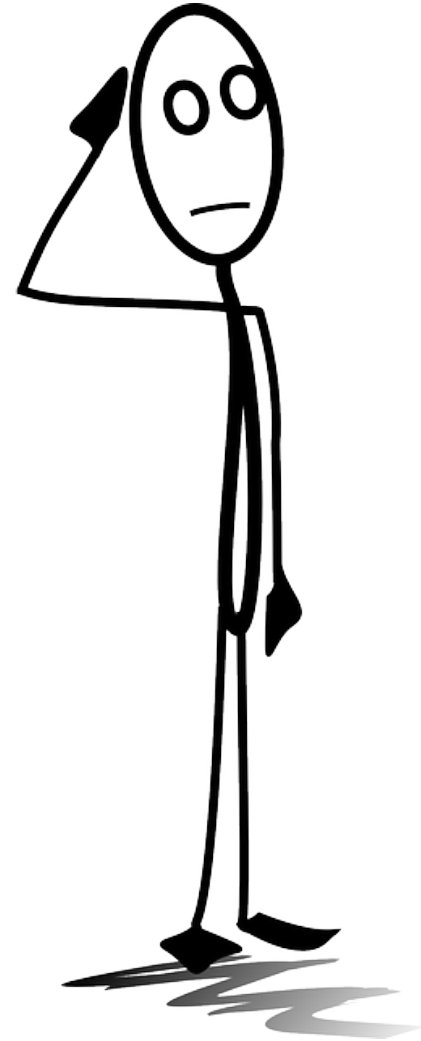
How is <u>Assessment</u> Different?

- How will activities, assessments…
  - Create <u>positive</u> challenges?
  - Identify gaps, weaknesses <u>**early**</u>?
  - Provide opportunities to correct gaps?
  - Accommodate a <u>range</u> of abilities?
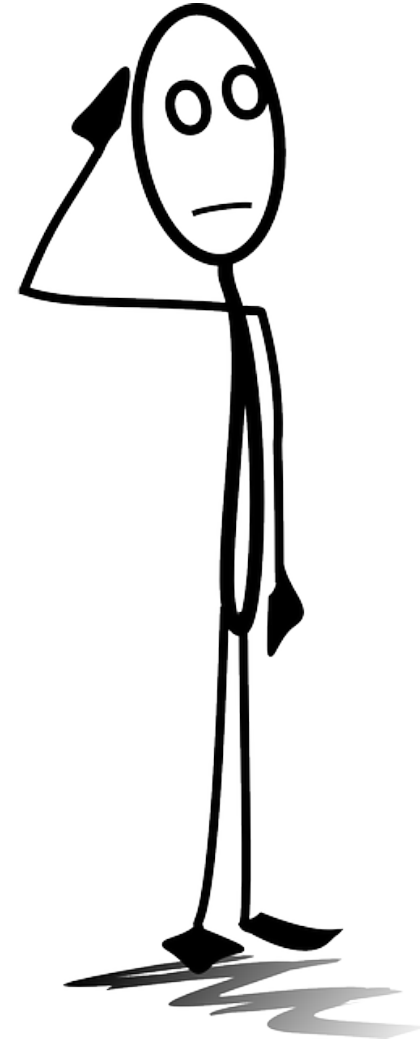
Classic Exercise: "Diffusion Through a Membrane"

1. Fill dialysis tubing "cell" with glucose, starch, or combined sol'n

2. Float in Lugol's starch indicator

3. After 20+ minutes record:
   - Water inside "cell" is black (starch "+")
   - Water outside "cell" is "+" w/glucose indicator

4. Report results (w'sheet, lab rept., n-book)

Is This Lab A Good Inquiry?

5 minutes:
Break down exercise

– Where are authentic activities?

– Where is autonomous exploration?

– What is "positive challenge"?

– What skills do students develop? How do they demonstrate them?

– Where is assessment?

– Is reporting memorable, useful? Why/not?

– What are logistics issues?

Concerns w/Original Diffusion Lab

1. Dialysis tubing
   - Unfamiliar, less engaging
   - Cannot vary properties
2. Assays show diffusion <u>indirectly</u>;
   do not directly observe
   (Iodine sol'n – hazardous)
3. Students report <u>known</u> outcomes
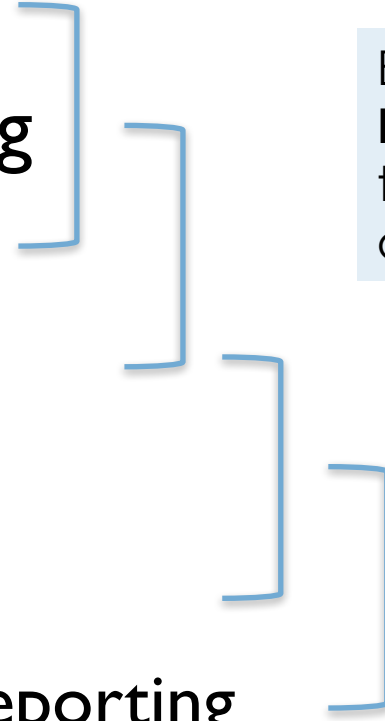4. Online - mat'ls access

Concerns w/Original Version, cont.

4. <u>Reinforces misconception</u> - exercise = experiment

5. Where do students:

   - Experience "positive challenge"?

   - Exercise critical thinking?

   - Make their own decisions?

   - Discover "personally novel" knowledge?

General Revision & Design Strategy

Modules have 5-7 linked stages:

- Initial assessment

- Structured inquiry/training
  – Reconvene, debrief

- Open exploration phase
  – Initial group reporting

- Guided inquiry phase
  – Final group or individual reporting

Each stage **EXPLICITLY** tied to prior one(s)

Version A of Design Strategy

Five Stages *(WFU uses, but is retiring)*:

- Initial assessment

- Structured inquiry/training

- Reconvene & debrief

- Open exploration phase

  - Initial group reporting

  - Guided inquiry phase

- Final individual or group reporting

Version B of Design Strategy

Five Stages (*modeled today*):

- Initial assessment

  - Structured inquiry/training
  - Reconvene & debrief

- Open exploration phase

- Initial group reporting

- Guided inquiry phase

- Final group or individual reporting

Version C of Design Strategy

Seven Stages (*Project courses; WFU's target*)

- Initial assessment (pre-lab quiz)

- Structured inquiry/training

  – Reconvene & debrief (informal, oral)

- Open exploration phase

  – Initial <u>group</u> reporting (informal, oral)

- Guided inquiry phase

  – Final group or individual reporting (formal written/oral)

Time to Think Like a Student...

Diffusion 2.0: Initial Assessment

Three Lead-In Questions

- What do you know about diffusion?

- How do you know it?

- Is _(ex.)_ an example of diffusion? What about _(counter-ex.)_? What is your evidence?

What Initial Assessment Accomplishes

Instructor's Three Lead-In Questions

- What do you know about diffusion?
  (Assessing prior knowledge)

- How do you know it?
  (Sets expectation for evidence)

- Is _____ an example of diffusion?
  What about _____?
  (Example vs. counter-example, rationale)

FYI: Questions are Based in Stephen Toulmin's Reasoning Model

- **What do you know about diffusion?**
  - Claim

- **How do you know it?**
  - Evidence/data/backing
  - Reasoning/warrant/assumptions
  - Accuracy, relevance, credibility

- **Is _(ex.)_ an example of diffusion?**
  - *Transfer*

- **What about _(counter-ex.)_?**
  - Rebuttal/limitations
  - *Boundaries for transfer*

* Not part of Toulmin model but good pedagogical practices

Diffusion 2.0: Open Exploration

<u>Student Directions</u>

Your 1st challenge–

- Create a <u>visual</u> demo of diffusion across membrane
- Use any materials here in lab
  - Hand materials list
- You have until ____ to finish, report
  - Hold back optional hints; students need "struggle time"

Diffusion 2.0: Available Materials

Diffusible Mat'ls

- *Particulate*: pigment based paints
- *Soluble*: food or pond dye, red soda/wine, coffee

Absorb, Carry Color

- *Liquid*: water, veg. oil
- *Solid*: marshmallows, balsa wood, styrofoam, banana or other food "cubes"

Membranes, Containers, Etc.

- Latex, nitrile gloves
- Cling wrap, plastic bags
- Newspaper (1-10 layers)
- Paper towels, coffee filters
- Canning jars
- Plastic beakers
- Tape
- Parafilm

Optional Hints to Guide Students

- What will be diffusing?

- What will carry diffusing substance?

- What will absorb color for observations?

- What containers will you use?

- What will you need to quantify, and how will you do it?

Diffusion 2.0: Initial Group Report

- Begin w/<u>general</u> question template
  - What are you doing/did you do?
  - Why?
  - What do/did you expect/actually see?
  - What does it mean?

- Add 1-2 specific qus. directed at central topic
  - "How does your example show diffusion?"
  - "Based on the demos & data, is rate of diffusion constant?"

Diffusion 2.0: Guided Inquiry Phase

- *Options A & B:*
  - <u>Background</u>: rate of diffusion depends on factors like -
    - Area available
    - Concentration gradient
    - Properties of diffusing material
    - Distance
    - Temperature

Diffusion 2.0: Guided Inquiry Phase

- *Options A & B* (cont.):
  - Second challenge is to determine:
    - *Option A (basic):* how <u>one</u> factor affects rate of diffusion.
    - *Option B (intermediate):* which factor <u>most</u> affects diffusion.
  - You have until _____ to report to class

Diffusion 2.0: Guided Inquiry Phase

- *Option C* (advanced):
  - Rate of diffusion determined by several factors.
  - Your challenge: create a general model for how different factors control rate of diffusion
  - Work with others in lab to solve challenge
  - You have until _____ to report what you discovered

What am I asking them to devise?

Diffusion 2.0: Final Group Reporting
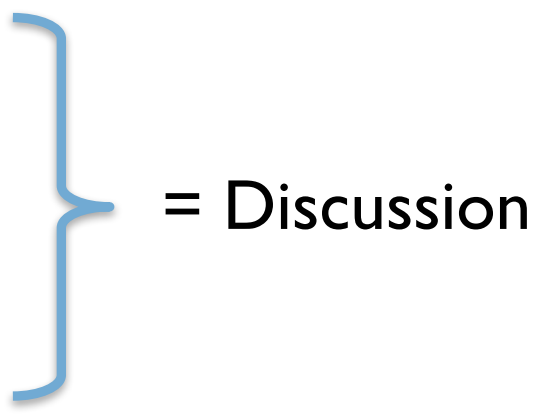
- <u>Repeat</u> general question template:
  - What did you do?
  - Why did you do it?
  - What did you see?
  - What does it mean?
    (Ex.: "how does it show diffusion?")
- <u>Modify</u> the 1-2 specific qus.:
  - Alternate explanations
  - Links to other lab units, topics

Logistics & Practical Tips: Questions

<u>Reusable</u> question templates = scaffold for thinking process

- Ex.: simple directed questions for experimental design
  - What are you doing?
  - Etc.

Logistics & Tips

- General questions map to writing:
  - What did you do? = Methods
  - Why did you do it? = Introduction
  - What did you see? = Results
  - What does it mean?
  - Alternate explanations } = Discussion
  - Links to other lab units, topics

Logistics & Tips: Inviting In Technology

- Use phones to document results
  - Photographs
  - Video or audio files
- Online shared reporting methods
  - LMS
  - Google apps
  - WordPress, Wiki
- Future-proof using OERs, FOSSware

Logistics & Tips

- Common design mistakes
  - Scripting for outcomes, <u>not</u> process
  - Eliminating <u>all</u> confusion, missteps
  - Moving too fast
  - Over-responding to complaints (what do DATA tell you?)

Logistics & Tips

- Your questions, challenges, concerns

Your Final Challenge Today

Break down YOUR Exercise

- What are:
  - Authentic processes?
  - Autonomous exploration?
  - Positive challenge?
  - Skills students develop? How demonstrated?
- Where is assessment?
  - Is reporting memorable, useful?
- What are logistics issues?

Rebuild YOUR Exercise

- Initial assessment
- Structured inquiry/training
  - Reconvene, debrief
- Open exploration phase
  - Initial group reporting
- Guided inquiry phase
  - Final group or individual reporting

Thanks! Chrissy Spencer, Colin Harrison @ GA Tech

Questions, Suggestions, Etc.

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Don't Forget!
Fill out evaluations