NSF Goals

- Develop the STEM/STEM-related workforce
- Advance science
- Broaden participation in STEM
- Educate a STEM-literate populace
- Build capacity in higher education
- Improve K-12 STEM education
- Encourage life-long learning

NSF Investments

Research-based and research-generating approaches to:

- Understand/advance STEM learning
- Design, test, and study curricular change
- Widely disseminate and implement best practices
- Broaden participation of individuals and institutions in STEM fields

IUSE Objectives

NSF is seeking projects that:

- Increase student retention in STEM
- Prepare students to participate in science for tomorrow
- Improve students' STEM learning outcomes
- Generate knowledge on how students learn and on effective practice in undergraduate classrooms
- Broaden participation
NSF STEM Workforce Priorities

- Prepare students to be leaders, teachers, and innovators in emerging and rapidly changing STEM fields
- Develop a scientifically literate populace

Both depend on the nature and quality of the undergraduate education experience

What are the Common Guidelines for Educational Research and where can I find them?

- The Guidelines were developed to "establish cross-agency guidelines for improving the quality, coherence, and pace of knowledge development in science, technology, engineering and mathematics (STEM) education" (NSF 13-126)

Intro: ACTIVITY 1 (group think/share)

1st:
Organize yourselves into groups of FOUR.

2nd:
As a group, write down 3 things that make a BAD lecture & 3 things that make a GOOD lecture. (2 min)
Remember your audience: Never forget how you felt as a student!

Know thyself: Capitalize on your strengths; admit to your weaknesses.

Work at it: It takes forethought & effort to consistently prepare good lectures.

I. Practical Considerations

ACTIVITY 2 (group think/share)

As a group, write down 3 practical considerations to bear in mind when preparing a lecture. (2 min)

I. Practical Considerations (cont.)

Learning goals & outcomes *more on this


Delivery: practice! timing, voice quality, eye contact slide design

Active learning/engagement activities *more on this
## II. Learning Goals & Outcomes

**GOAL:** “What do I want students to know?”

- This is the knowledge or skills you will teach.
- *e.g.,* DNA is a double helix composed of a sugar-phosphate backbone with complementary base-pairing.

**OUTCOME:** “How will students demonstrate learning?”

- What observable behavior do you want from the student? (not merely, “The student will understand DNA structure.”)
- *e.g.,* Shown 1 strand of DNA, the student will draw the complementary strand with perfect accuracy.

### ACTIVITY 3 (group think/share)

1st:
As a group, select a lecture topic:
- mitotic cell division
- Central Dogma/gene expression
- evidence for evolution
- species interactions

2nd: write down 2 learning goals & 2 outcomes for your topic. (5 min)
III. The Lecture Outline

(Always recall your learning goals & outcomes.)

ACTIVITY 4 (group think/share)
As a group, draft a brief general outline of the info you will cover in your topic. (5 min)

III. The Lecture Outline (cont.)

As a group, draft a brief general outline of the info you will cover in your topic. (5 min)

e.g., I. Stages in Animal Development
   A. fertilization
      1. basic definitions
      2. steps
      3. exceptions
   B. cleavage
      1. steps
      2. egg type & effect on cleavage
         a. sea urchin
         b. frog
         c. chick

III. The Lecture Outline (cont.)

Take-home msg:
- provides needed structure
- post for students
- reproduce outline hierarchy on your slides
IV. Active Learning
Research has shown that students learn and retain more:
- in an active-learning environment.
- from peer-instruction (working in small groups).

(REFER TO PNAS & NSTA ARTICLES...)

e.g., questioning (with/without clickers)
  case study/scenario
  problem-solving
  brainstorm
  arguing from evidence
  generate hypotheses/experimental design
  strip sequence
  concept map
  2-min. essay
  etc.

Fertilization strip sequence
Working in your group, please place the following in the correct sequence – try it without notes!

6. fusion of gamete cell membranes
5. egg & sperm nuclei fuse
3. fertilization envelope forms
10. Ca++ wave
1. egg membrane depolarization
2. slow block to polyspermy
4. gamete recognition proteins bind
8. cortical granules released
9. acrosomal reaction
7. fast block to polyspermy
Concept map of transcription:

RNA Polymerase

Transcription Factors

Transcription

Promoter

Regulatory elements

Concept map of transcription:

RNA Polymerase

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2-Minute Essay

Examples:

- Why might the average gape size of a fish in one lake be larger (or smaller) than the gape size for the same species in a different lake?

- Select & define two different species concepts, then justify why you think one concept is preferred over the other.

- What was the most important thing you learned in class today?
IV. Active Learning

**ACTIVITY 5** (group think/share)

As a group, briefly describe TWO different types of engagement activities to implement for your topic; one of these must be either a strip sequence or a concept map. (6 min)

- e.g., questioning (with/without clickers)
- case study/scenario
- problem-solving
- brainstorm; arguing from evidence
- generate hypotheses/experimental design
- strip sequence
- concept map
- 2-min. essay
- etc.

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IV. Active Learning

**Take-home msg:**

- engagement activities promote learning & retention
- they change the atmosphere of your classroom
- plan ahead to insert activities into your lecture outline
- you will have less time to cover lecture material

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V. Info Processing & Retention (I.P.R.)

“What can I do to help students remember info from lecture today?”
V. Info Processing & Retention (I.P.R.)

“What can I do to help students remember info from lecture today?”

- Simple mnemonic devices:
  e.g., King Phillip came over for good SOUP

V. Info Processing & Retention (I.P.R.)

Components of effective I.P.R.:

- you must maintain students’ attention
- you must facilitate interpretation/provide context
- provide further elaboration/examples
- have students generate new info (apply what they learn)
- have students practice info retrieval on classwork & homework

e.g., use repetition/mnemonics/visuals, videos
provide diverse “real world” examples
discuss relevance
have structure to your lecture (1 idea leads to another)
encourage student input
V. Info Processing & Retention (I.P.R.)

“What can I do to help students remember info from lecture today?”

**ACTIVITY 6** (group think/share)

As a group, list 2 things you can do to improve I.P.R. for info conveyed in your specific topic. (4 min)

VI. Evaluation

“Did I do good job?”

**ACTIVITY 7** (group think/share)

As a group, list 2 aspects of your lecture you would want to evaluate afterwards and how you would achieve this. (3 min)

VI. Evaluation (cont.)

12-point checklist:
- venue
- content
- structure
- level
- clarity
- use of examples
- handouts/other materials
- audio/visual aids
- audibility
- pace & timing
- enthusiasm & interest
- interaction
VII. The Role of Questioning in Lectures

Bloom’s Taxonomy:
create, compile, device, design, revise, rearrange
compare, contrast, distinguish, diagram
construct, solve, compute, demonstrate
interpret, explain, predict, give an example, infer
define, describe, label, match, list

Higher Order Thinking Skills
Evaluation
Synthesis
Analysis
Application
Comprehension
Knowledge

Lower Order Thinking Skills

>clicker:
In analyzing the number of different bases in a DNA sample, which result would be consistent with the base-pairing rules?

A) \#A = \#G
B) \#A + \#G = \#C + \#T
C) \#A + \#T = \#C + \#G
D) \#A = \#C
E) \#G = \#T

RECALL:
* purines hydrogen-bond with pyrimidines
  \( (A=T; \ G \neq C) \)
VII. The Role of Questioning in Lectures

**ACTIVITY 8** (group think/share)

As a group, list 2 benefits & 2 drawbacks to using questioning in a lecture. (2 min)

IV. The Role of Questioning in Lectures

*Take-home msg:*

- plan ahead & insert questions into your lecture outline
- when possible: “ask it, don’t say it”
- leave time for answers/repeat question/have a backup
- repeat response
- use to learn names of students
- praise/encourage responders
- you will have less time to cover lecture material