



# **Evaluation of Education Development Projects**

**Russ Pimmel**

**National Science Foundation**

**SENCEER Symposium**

**April 14, 2008**



# Caution

**The information in these slides represents the opinions of the individual program directors and not an official NSF position.**



# Session Goals

**The session will enable you to collaborate more effectively with evaluation experts in preparing and performing effective project evaluation plans**

***It will **NOT** make you an evaluation expert***



# Session Outcomes

**Participants should be able to discuss:**

- **The importance of goals, outcomes, and questions in evaluation process**
- **Factors involved in selecting a tool**
- **Data interpretation issues**
- **An evaluation plan with an evaluator**



# Connectionist Learning

- **Learning situations involve**
  - **Prior knowledge**
    - **Some correct & some incorrect (i. e., misconceptions)**
  - **New Knowledge**
- **Learning is**
  - **Connecting new knowledge to prior knowledge**
  - **Correcting misconception**
  - **Updating long-term memory**



# Active & Collaborative Learning

- **Effective learning activities**
  - Recall prior knowledge -- actively, explicitly
  - Connect new concepts to existing ones
  - Challenge and alter misconception
- **Active & collaborative processes effective**
  - **TSRL Process**
    - Think individually
    - Share in small groups
    - Report to large group
    - Learn from program director's views



# Evaluation and Assessment

- **Evaluation (assessment) has many meanings**
  - Individual's performance (grading)
  - Program's effectiveness (ABET & regional accreditation)
  - Project's progress & accomplishments (monitoring & validating)
- **Session addresses project evaluation**
  - May involve evaluating individual and group performance – but in the context of the project
- **Project evaluation**
  - **Formative** – monitoring progress
  - **Summative** – characterizing final accomplishments



# Evaluation and Project Goals & Outcomes

- Evaluation starts with carefully defined project goals & outcomes
- Goals & outcomes related to:
  - Project management
    - Initiating or completing an activity
    - Finishing a “product”
  - Student behavior
    - Modifying a learning outcome
    - Modifying an attitude or a perception
- Workshop focuses on student behavior



# **Evaluation and Project Goals/Outcomes/Questions**



# Developing Student Behavior Goals & Outcomes

- Start with one or more overarching statements of project intention

- Each statement is a **GOAL**

*What is your overall ambition? What do you hope to achieve?*

- Convert each goal into one or more specific expected measurable results

- Each result is an **EXPECTED OUTCOME**

*How will achieving your “intention” reflect in student behavior?*



# Goals – Objectives – Outcomes -- Questions

- Converting goals to outcomes may involve intermediate steps
  - Intermediate steps maybe called *objectives*
    - More specific, more measurable than goals
    - Less specific, less measurable than outcomes
- Outcomes lead to **questions**
  - These form the basis of the evaluation
  - Evaluation process **collects and interprets data** to answer evaluation questions



# Definition of Goals, Objectives, and Outcomes

**Goal** – Broad, overarching statement of intention or ambition

- A goal typically leads to several objectives

**Objective** – Specific statement of intention

- More focused and specific than goal
- A objective may lead to one or more outcomes

**Outcome** – Statement of expected result

- Measurable with criteria for success

***NOTE: No consistent definition of these terms***



# Exercise #1: Identification of Goals/Outcomes

- **Read the abstract**
  - **Note - Goal statement removed**
- **Suggest two plausible goals**
  - **One focused on a change in learning**
  - **One focused on a change in some other aspect of student behavior**



# Abstract

The goal of the project is ..... The project is developing computer-based instructional modules for statics and mechanics of materials. The project uses 3D rendering and animation software, in which the user manipulates virtual 3D objects in much the same manner as they would physical objects. Tools being developed enable instructors to realistically include external forces and internal reactions on 3D objects as topics are being explained during lectures. Exercises are being developed for students to be able to communicate with peers and instructors through real-time voice and text interactions. The project is being evaluated by ... The project is being disseminated through ... The broader impacts of the project are ...

## ***Substitute***

***“organic chemistry” for “statics and mechanics of materials”***

***“Interactions” for “external forces and internal reactions”***

***“molecules” for “objects”***



# PD's Response -- Goals

- **Goals may focus on**
  - **Cognitive behavior**
    - Conceptual understanding
    - Processing skills
  - **Affective behavior**
  - **Success rates**
  - **Diversity**
    - Cognitive, affective, or success in targeted subgroups



# PD's Response – Goals on Cognitive Behavior

## **GOAL: Improve ability**

- **Application in course**
  - Solve textbook problems
  - Describe verbally the effect of external forces on a solid object
- **Application beyond course**
  - Solve out-of-context problems
  - Visualize 3-D problems
  - Communicate technical problems orally



# PD's Response – Goals on Affective Behavior

## **GOAL: Improve**

- **Interest in the course**
- **Attitude about**
  - **Profession**
  - **Curriculum**
  - **Department**
- **Self- confidence**
- **Intellectual development**



# PD's Response – Goals on Success Rates

- **Goals: Improve**
  - **Recruitment rates**
  - **Retention or persistence rates**
  - **Graduation rates**



# PD's Response – Goals on Diversity

**GOAL:** To increase a target group's

- Understanding of concepts
- Achievement rate
- Attitude about profession
- Self-confidence

■ *“Broaden the participation of underrepresented groups”*



# Exercise #2: Transforming Goals into Outcomes

**Write one expected measurable outcome for each of the following goals:**

- 1. Increase the students' understanding of the concepts in statics**
- 2. Improve the students' attitude about engineering as a career**



# PD's Response -- Outcomes

## ***Conceptual understanding***

- ***Students will be better able to solve simple conceptual problems that do not require the use of formulas or calculations***
- ***Students will be better able to solve out-of-context problems.***

## ***Attitude***

- ***Students will be more likely to describe engineering as an exciting career***
- ***The percentage of students who transfer out of engineering after the statics course will decrease.***



# **Exercise #3: Transforming Outcomes into Questions**

**Write a question for these expected measurable outcomes:**

- 1. Students will be better able to solve simple conceptual problems that do not require the use of formulas or calculations**
- 2. In informal discussions, students will be more likely to describe engineering as an exciting career**



# PD's Response -- Questions

## ***Conceptual understanding***

- **Did the students' ability to solve simple conceptual problems increase ?**
- **Did the students' ability to solve simple conceptual problems increase *because of the use of the 3D rendering and animation software?***



# PD's Response -- Questions

## ***Attitude***

- Did the students discussions indicate more excitement about engineering as a career?
- Did the students discussions indicate more excitement, about engineering as a career *because of the use of the 3D rendering and animation software?*



# Reflection

**What is the most surprising idea you heard in this session?**



# Evaluation Tools



# Examples of Tools for Evaluating Learning Outcomes

- **Surveys**
  - Forced choice or open-ended responses
- **Interviews**
  - Structured (fixed questions) or in-depth (free flowing)
- **Focus groups**
  - Like interviews but with group interaction
- **Observations**
  - Actually monitor and evaluate behavior



# Concept Inventories (CIs)



# Introduction to CIs

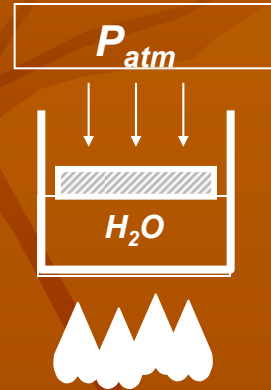
- Measures conceptual understanding
- Series of multiple choice questions
  - Questions involve **single concept**
    - Formulas, calculations, or problem solving not required
  - Possible answers include “**detractors**”
    - Common errors
    - Reflect common “***misconceptions***”

***Force Concept Inventory (FCI) is the prototype***



# Sample CI Questions

$\text{H}_2\text{O}$  is heated in a sealed, frictionless, piston- cylinder arrangement, where the piston mass and the atmospheric pressure above the piston remain constant. Select the best answers.



The density of the  $\text{H}_2\text{O}$  will:

- (a) Increase (b) Remain constant (c) Decrease



# Exercise #4: Evaluating a CI Tool

- Suppose you were considering an existing CI for use in your project's evaluation
- What questions would you consider in deciding if the tool is appropriate?



# PD's Response -- Evaluating a CI Tool

- **Nature of the tool**
  - Is the tool relevant to what was taught?
  - Is the tool competency based?
  - Is the tool conceptual or procedural?
- **Prior validation of the tool**
  - Has the tool been tested?
  - Is there information on reliability and validity?
  - Has it been compared to other tools?
  - Is it sensitive? Does it discriminate novice and expert?
- **Experience of others with the tool**
  - Has the tool been used by others besides the developer? At other sites? With other populations?
  - Is there normative data?



# Decision Factors for Other Tools

**Would these questions be different for another tool?**



# Interpreting Evaluation Data



# Hypothetical Concept Inventory Data

Quest	Pre	Post	Pre	Post
1	35	32	29%	23%
2	35	32	34%	65%
3	35	32	74%	85%
-	-	-	-	-



# Exercise #7: Alternate Explanation For Change

- Data suggests that the understanding of Concept #2 increased
- One interpretation is that the intervention caused the change
- List some alternative explanations
  - Confounding factors
  - Other factors that could explain the change



# PD's Response -- Alternate Explanation For Change

- Students learned concept out of class (e. g., in another course or in study groups with students not in the course)
- Students answered with what the instructor wanted rather than what they believed or “knew”
- An external event (big test in previous period or a “bad-hair day”) distorted pre- or post-test data
- Instrument was unreliable
- Other changes in course and not the intervention caused improvement
- Students not representative groups



## Exercise #8: Alternate Explanation for Lack of Change

- Data suggests that the understanding of Concept #1 did not increase
- One interpretation is that the intervention did cause a change but it was masked by other factors
- List some **confounding factors** that could have masked a real change



# PD's Response -- Alternate Explanations for Lack of Effect

- **An external event (big test in previous period or a “bad-hair day”) distorted pre or post-test data**
- **The instrument was unreliable**
- **Implementation of the intervention was poor**
- **Population too small**
- **One or both student groups not representative**
- **Formats were different on pre and post tests**



# Reflection

**What is the most surprising idea you heard in this session so far?**



# Evaluation Plan



# Exercise #9: Evaluation Plan

- **Suppose that a project's goals are to improve:**
  1. **The students' understanding of the concepts in statics**
  2. **The students' attitude about engineering as a career**
  
- **List the topics that you would address in the evaluation plan**



# Evaluation Plan -- PD's Responses

- Name & qualifications of the evaluation expert
- Goals and outcomes and evaluation questions
- Tools & protocols for evaluating each outcome
- Analysis & interpretation procedures
- Confounding factors & approaches for minimizing their impact
- Formative evaluation techniques for monitoring and improving the project as it evolves
- Summative evaluation techniques for characterizing the accomplishments of the completed project.



# Other Sources

- **Workshop on Evaluation of Educational Development Projects**
  - [http://www.nsf.gov/events/event\\_summ.jsp?cntn\\_id=108142&org=NSF](http://www.nsf.gov/events/event_summ.jsp?cntn_id=108142&org=NSF)
- ***NSF's User Friendly Handbook for Project Evaluation***
  - <http://www.nsf.gov/pubs/2002/nsf02057/start.htm>
- **Field-Tested Learning Assessment Guide (FLAG)**
  - <http://www.wcer.wisc.edu/archive/cl1/flag/default.asp>
- **Online Evaluation Resource Library (OERL)**
  - <http://oerl.sri.com/>
- **CCLI Evaluation Planning Webinar**
  - [http://oerl.sri.com/ccli\\_resources.html](http://oerl.sri.com/ccli_resources.html)
- **Evaluation of Educational Development Projects**
  - [http://www.nsf.gov/events/event\\_summ.jsp?cntn\\_id=108142&org=NSF](http://www.nsf.gov/events/event_summ.jsp?cntn_id=108142&org=NSF)



# Question