Project Evaluation

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Most of the information presented in this workshop represents the presenter's opinion and not an official NSF position

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Activity
Reflection

▸ What are the three most important pieces of advice for a colleague on dealing with evaluation in an engineering education-focused proposal (i. e., a TUES proposal)?

▸ *Write your ideas on your advice*
  ◦ *No discussion*
▸ Put aside and save

Preliminary Comments
Active & Collaborative Learning

▸ **Effective learning activities**
  ◦ Recall prior knowledge -- actively, explicitly
  ◦ Connect new concepts to existing ones
  ◦ Challenge and alter misconceptions
  ◦ Reflect on new knowledge

▸ **Active & collaborative processes**
  ◦ Think individually
  ◦ Share with partner
  ◦ Report to local and virtual groups
  ◦ Learn from Program Directors' responses

Goal for Project Evaluation Session

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

It will not make you an evaluation expert

Session Outcomes

After the session, participants should be able to:
▸ **Discuss the importance of goals, outcomes, and questions in evaluation process**
  ◦ Cognitive and affective outcomes
▸ **Describe several types of evaluation tools**
  ◦ Advantages, limitations, and appropriateness
▸ **Discuss data interpretation issues**
  ◦ Variability, alternate explanations
▸ **Develop an evaluation plan with an evaluator**
  ◦ Outline a first draft of an evaluation plan

Evaluation and Assessment

- Evaluation and assessment have many meanings
  - One definition
    - Assessment is gathering evidence
    - Evaluation is interpreting data and making value judgments
- Examples of evaluations and assessment
  - Individual's performance (grading)
  - Program's effectiveness (ABET and regional accreditation)
  - Project's progress and success (monitoring and validating)
- Session addresses *project evaluation*
  - May involve evaluating individual and group performance – but in the context of the project
- Project evaluation
  - Formative – monitoring progress to improve approach
  - Summative – characterizing final accomplishments

Project Goals, Expected Outcomes, and Evaluation Questions

Evaluation and Project Goals/Outcomes

- **Effective evaluation starts with carefully defined project goals and expected outcomes**

- **Goals and expected 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

Learning Goals and Outcomes

- **Goals provide overarching statements of project intention**
  What is your overall ambition?
  What do you hope to achieve?

- **Expected outcomes identify specific observable results for each goal**
  How will achieving your "intention" reflect changes in student behavior?
  How will it change their learning and their attitudes?

Goals, Expected Outcomes, and Evaluation Questions

- **Goals --> Expected outcomes ––> Evaluation questions**

- **Questions form the basis of the evaluation process**

- **Evaluation process collects and interprets data to answer evaluation questions**

Activity:
Identification of Goals/Outcomes

- **Read the abstract –Write expected measurable outcomes for these two goals:**

  - **Improve the students' understanding of the fundamentals in course material**
  - **Improve the students' self-confidence is solving engineering problems**

- **Individually identify several guidelines**
- **Share these with a neighbor or two**
- **Report to the group**

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 …

PD's Response: Expected Outcomes

Understanding of the fundamentals
- *Students will be better able to*
  - *Describe all parameters, variable, and elemental relationships*
  - *Describe the governing laws*
  - *Describe the effects of changing some feature in a simple problem*
    - *Changes in the frictional force on a block when the angle of an inclined plane changes*
    - *Changes in the forces in a simple three element truss when the connecting angles change*

Self-Confidence
- **Students will do more of the homework**
- **Student will have less test anxiety**
- **Students will express more confidence in their solutions**
- **Students will be more willing to discuss their solutions**

Exercise: Transforming Outcomes into Questions

▸ **Write an evaluation question for these expected measurable outcome:**

Understanding of the fundamentals
- *Students will be better able to describe the effects of changing some feature in a simple problem*

Self-Confidence
- **Students will express more confidence in their solutions**

▸ Individually identify a question for each
▸ Report to the group

PD's Response
Evaluation Questions

Understanding of the fundamentals
- *Are the students better able to describe the effects of changing some feature in a simple problem*
- *Are the students better able to describe the effects of changing some feature in a simple problem as a result of the intervention*

Self-Confidence
- **Do the students express more confidence in their solutions**
- **Do the students express more confidence in their solutions *as a result of the intervention***

Tools for Evaluating Learning Outcomes

Examples of Tools for Evaluating Learning Outcomes

▸ **Surveys**
  - Forced choice or open-ended responses
▸ **Concept Inventories**
  - Multiple-choice questions to measure conceptual understanding
▸ **Rubrics for analyzing student products**
  - Guides for scoring student reports, test, etc.
▸ **Interviews**
  - Structured (fixed questions) or in-depth (free flowing)
▸ **Focus groups**
  - Like interviews but with group interaction
▸ **Observations**
  - Actually monitor and evaluate behavior

Comparing Surveys and Observations

Surveys
- Efficient
- Accuracy depends on subject's honesty
- Difficult to develop reliable and valid survey
- Low response rate threatens reliability, validity, & interpretation

Observations
- Time & labor intensive
- Inter-rater reliability must be established
- Captures behavior that subjects unlikely to report
- Useful for observable behavior

Olds et al, *JEE* 94:13, 2005

Example – Appropriateness of Interviews

- **Use interviews to answer these questions:**
  - What does program look and feel like?
  - What do stakeholders know about the project?
  - What are stakeholders' and participants' expectations?
  - What features are most salient?
  - What changes do participants perceive in themselves?

The 2002 User Friendly Handbook for Project Evaluation, NSF publication REC 99-12175

Tool for Measuring Conceptual Understanding – Concept Inventory

- **Originated in physics -- Force Concept Inventory (FCI)**
- **Several are being developed in engineering fields**
- **Series of multiple choice questions**
  - Questions involve single concept
    - Formulas, calculations, or problem solving skills not required
  - Possible answers include *detractors*
    - Common errors -- *misconceptions*
- **Developing CI is involved**
  - Identify misconceptions and detractors
  - Develop, test, and refine questions
  - Establish validity and reliability of tool
  - Language is a major issue

Tool for Assessing Attitude

- **Pittsburgh Freshman Engineering Survey**
  - Questions about perception
    - Confidence in their skills in chemistry, communications, engineering, etc.
    - Impressions about engineering as a precise science, as a lucrative profession, etc.
- **Validated using alternate approaches:**
  - Item analysis
  - Verbal protocol elicitation
  - Factor analysis
- **Compared students who stayed in engineering to those who left**

Besterfield-Sacre et al , JEE 86:37, 1997

Tools for Characterizing Intellectual Development

- **Levels of Intellectual Development**
  - Students see knowledge, beliefs, and authority in different ways
    - " Knowledge is absolute" versus "Knowledge is contextual"
- **Tools**
  - Measure of Intellectual Development (MID)
  - Measure of Epistemological Reflection (MER)
  - Learning Environment Preferences (LEP)

Felder et al, JEE 94:57, 2005

Activity
Considering an Existing Tool

- **Suppose you where considering an existing tool (e. g., a concept inventory) for use in your project's evaluation**

- **What questions would you consider in deciding if the tool is appropriate?**

- **Individually identify several questions**
- **Share these with a neighbor or two**
- **Report to the group**

PD's Response: Evaluating a Existing 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 or 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?

Interpreting Evaluation Data

Interpreting Evaluation Data

Question or Concept	No. of Students		Percent with Correct Answer	
	Comparision Group	Experimantal Group	Comparision Group	Experimantal Group
1	25	30	29%	23%
2	24	32	34%	65%
3	25	31	74%	85%
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Activity: 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**

- Individually identify several explanations
- Share these with a neighbor or two
- Report to the group

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 distorted pretest data**
- **Instrument was unreliable**
- **Other changes in course and not the intervention caused improvement**
- **Characteristics of groups were not similar**

Activity: Alternate Explanation for Lack of Change

- **Data suggests that the understanding of the concept tested by Q1 did not improve**
- **One interpretation is that the intervention did cause a change that was masked by other factors**
- **Think about alternative explanations**
- **How would these alternative explanations (confounding factors) differ from the previous list?**

- **Individually identify several explanations**
- **Report to the group**

Evaluation Plan

Activity
Evaluation Plan

- **List the topics that need to be addressed in the evaluation plan**

- Individually identify all the topics
- Share these with a neighbor or two
- Report to the group

PD's Response: Evaluation Plan

- **Name & qualifications of the evaluation expert**
  - *Get the evaluator involved early in the proposal development phase*
- **Goals, outcomes, and evaluation questions**
- **Instruments for evaluating each outcome**
- **Protocols defining when and how data will be collected**
- **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

- *NSF's User Friendly Handbook for Project Evaluation*
  - http://www.nsf.gov/pubs/2002/nsf02057/start.htm

- **Online Evaluation Resource Library (OERL)**
  - http://oerl.sri.com/

- **Field-Tested Learning Assessment Guide (FLAG)**
  - http://www.wcer.wisc.edu/archive/cl1/flag/default.asp

- **Student Assessment of Their Learning Gains (SALG)**
  - http://www.salgsite.org/

Reflection on Project Evaluation

- What are the three most important pieces of advice for a colleague on dealing with evaluation in an engineering education-focused proposal (i. e., a TUES proposal)?

- *Write your ideas on your advice*
  - *No discussion*

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Activity
Final Reflection

Review your reflective statements
  - How have they changed?
  - What have you learned?

- Individually review your statements
- Share these with a neighbor or two
- Report to the group

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Questions