

# BEST PRACTICES IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) IN CAMBODIAN HIGHER EDUCATION INSTITUTIONS

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# Summary of today's agenda

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- Thursday, 17 October
  - Utilizing learner-centered approaches
  - Presentations of new syllabi
  - Problems with implementation and overcoming barriers
  - Motivational variables and interventions
  - Question and answer session
  - Conclusion

# UTILIZING LEARNER- CENTERED APPROACHES

# A quick review

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## Learner-centered pedagogies:

- Small group work: Think Pair Share
- Problem-based learning
- Clickers
- Learner classroom assessments
  - ▣ 1-minute paper
  - ▣ Just in time teaching

# Examples of learner-centered pedagogical techniques

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## □ THINK – PAIR – SHARE:

- ✓ Announce a discussion topic or problem to solve
- ✓ Give students a few minutes to think of their own answer individually
- ✓ Ask them to turn to their neighbor and discuss the topic or solution
- ✓ Randomly ask some of the pairs to share their ideas with the class



Think



Pair



Share

# Examples of learner-centered pedagogical techniques

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## □ PROBLEM-BASED LEARNING:

- ✓ Students explore real-world, hands-on problems and challenges
- ✓ Students work in small groups
- ✓ Instructors serve as guides and facilitators



# Examples of learner-centered pedagogical techniques

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## □ CLICKERS:

- ✓ Teachers have students vote on answers using hand held electronic devices
- ✓ Results are shown instantly, showing the instructor the percentage who understand the concept
- ✓ Can be done without the technology



# Examples of learner-centered pedagogical techniques

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## □ **LEARNER CLASSROOM ASSESSMENTS:**

### ✓ 1 Minute Papers:

- ✓ Students are given open-ended questions and 1 minute to respond (e.g. “What was the most important concept you learned today?” or “What still remains unclear?”)

### ✓ Just In Time Teaching:

- ✓ Students respond to a question, and the teacher reviews responses and adjusts the lesson “just in time” before next lesson



# Activity

(continued from yesterday)

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- **FIRST:** Reflect on the learning objectives for your class that you wrote yesterday
  - ▣ Are they “big picture” enough?
  - ▣ Are they realistic and assessable?
  
- **SECOND:** Determine what you believe would be acceptable evidence that your students met those objectives
  
- **THIRD:** Create assignments, tasks, and activities that will provide you the evidence that your students met the objectives?
  - ▣ Looking for inspiration? Remember the learner-centered pedagogies!

# SHARING YOUR REVISED SYLLABUS

# Questions about course content

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- Explain how to create a syllabus correctly
- Need more help on developing effective rubrics
- Explain how to use think-pair-share while teaching
- Help me understand backward design better

# PROBLEMS WITH IMPLEMENTATION AND OVERCOMING BARRIERS



# In the event of challenges:

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- Assess the goals
- Assess the attained outcome
- Investigate potential causes of the gap
- Develop appropriate interventions
- Reassess the outcomes

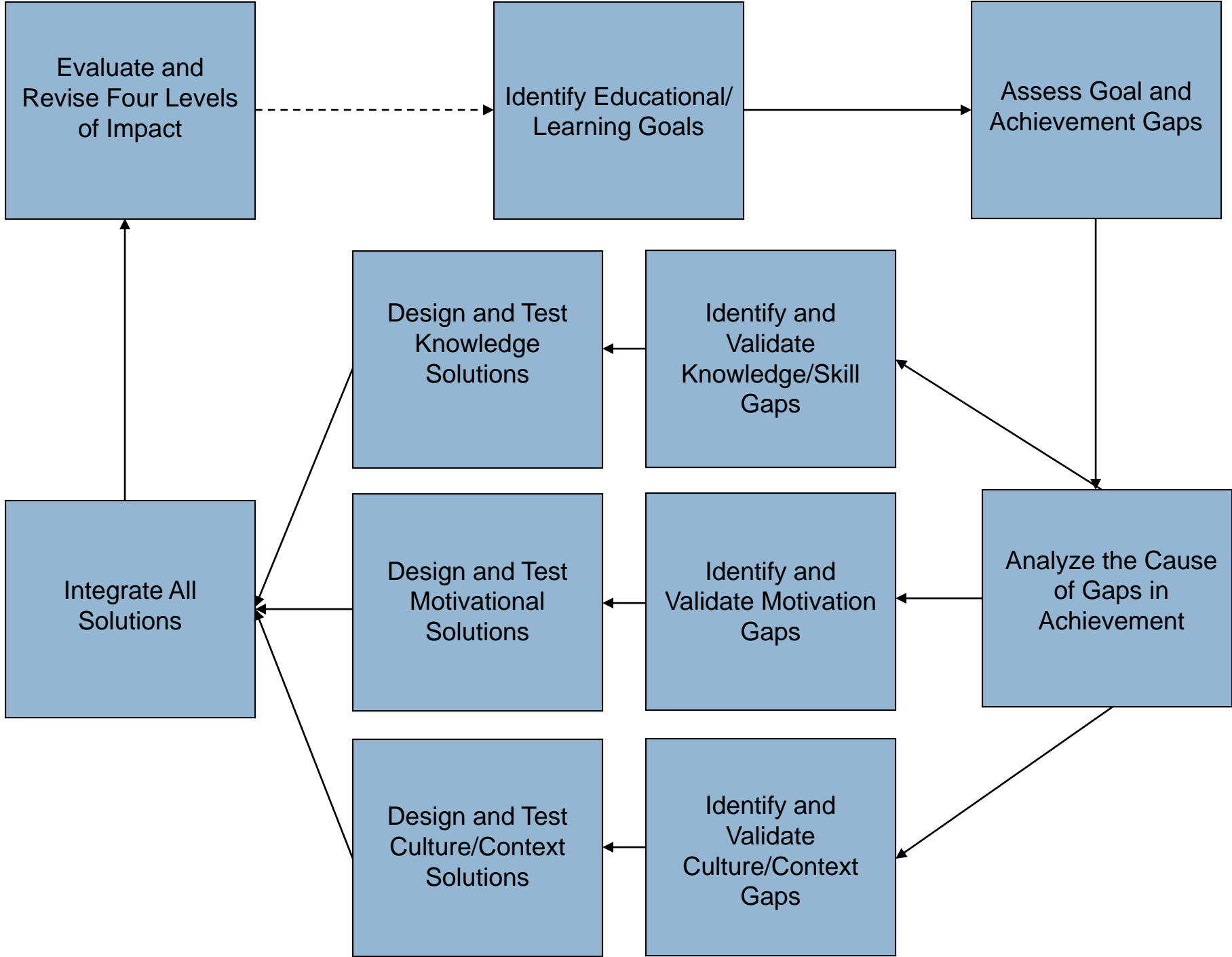
# Analyzing Gaps



- The four causes of gaps
  - Knowledge
  - Motivation
  - Culture
  - Context

# Four Types of Gaps

- Knowledge – Skills, concepts, knowledge
  - ▣ Motivated participants without the necessary knowledge
- Motivation – Start, persist, invest mental effort
  - ▣ Participants unwilling to use or acquire relevant knowledge
- Culture – Cultural values and beliefs
  - ▣ Participants becoming angry or ashamed regarding goals or process
- Context – Policies, bureaucratic practices or structures
  - ▣ Participants unable to act as intended due to logistics





# Four-Level Evaluation Framework

<b>Levels of Evaluation</b>	<b>Kirkpatrick (1994)</b>	<b>Measures</b>
<b>Level 1</b>	Reactions	Liking, approval
<b>Level 2</b>	Learning	Academic performance (tasks)
<b>Level 3</b>	Transfer	Use of knowledge and skills in other contexts (i.e., lab)
<b>Level 4</b>	Results (bottom line)	Degrees earned, impact on national STEM capacity

# Why Measure All Four Levels?

We must conduct all four levels because:

- Level 1 success is unrelated to Level 2 success
  - ▣ Liking is only weakly correlated with learning
  - ▣ Level 2 is not only learning, it is “performance”
- Level 2 success can be unrelated to Level 3 success
  - ▣ Only about 30% of learning transfers
  - ▣ Level 1 is not strongly correlated with level 3

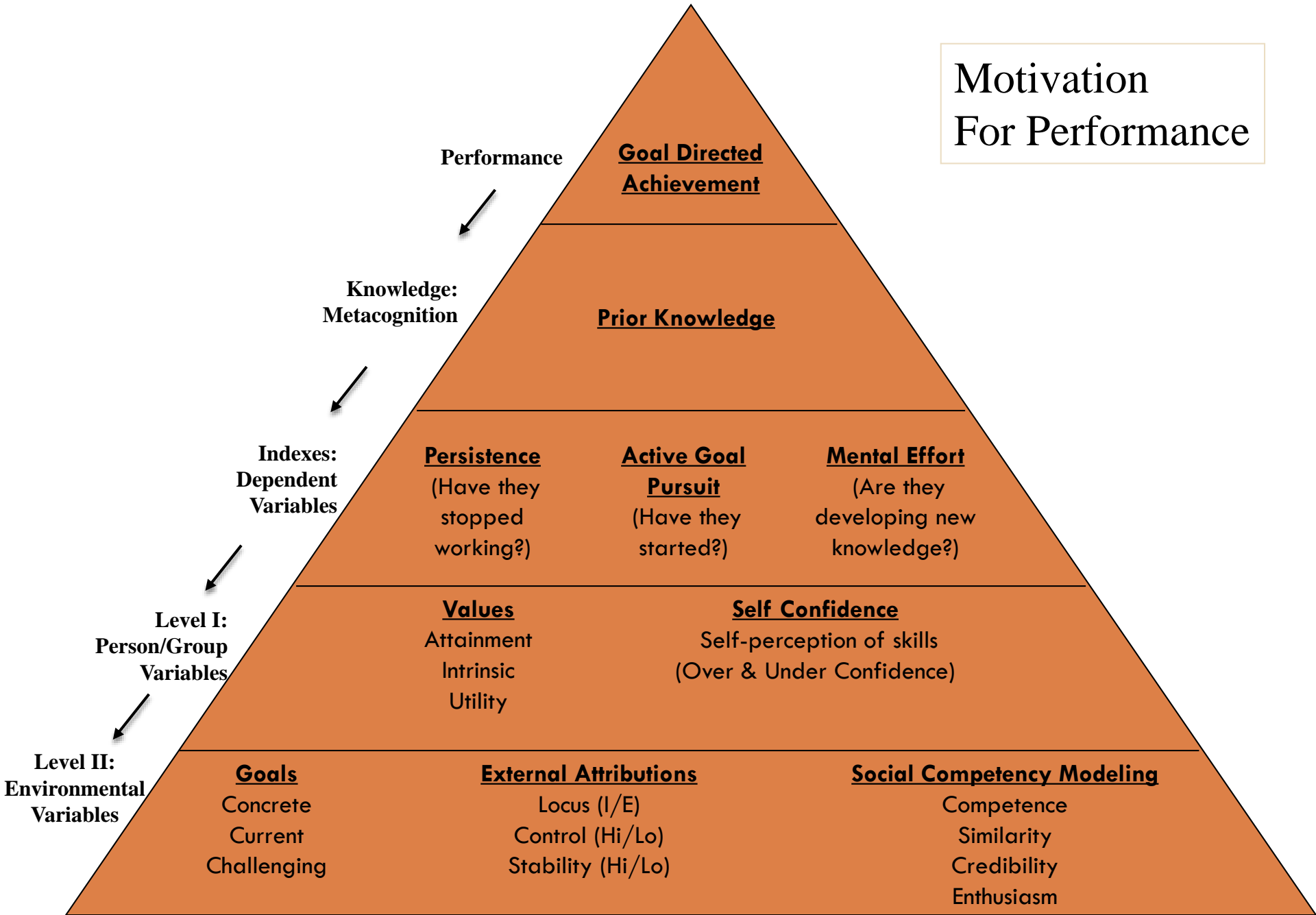
# Why Measure All Four Levels?

We must conduct all four levels because:

- Level 3 (transfer) does not guarantee Level 4 (gap closing and/or cost-benefit)
- Level 4 is a check on your cause analysis.
  - ▣ You can succeed at levels 1, 2, and 3 but fail at 4 because you misdiagnosed the cause
  - ▣ This is the reason for cause validation

# MOTIVATIONAL VARIABLES AND INTERVENTIONS

# Motivation For Performance



# Designing Motivational Solutions

- Look for patterns:
  - ▣ Persistence problems are most common
  - ▣ Are certain types of confidence and/or value causes common in setting?

# Designing Motivational Interventions

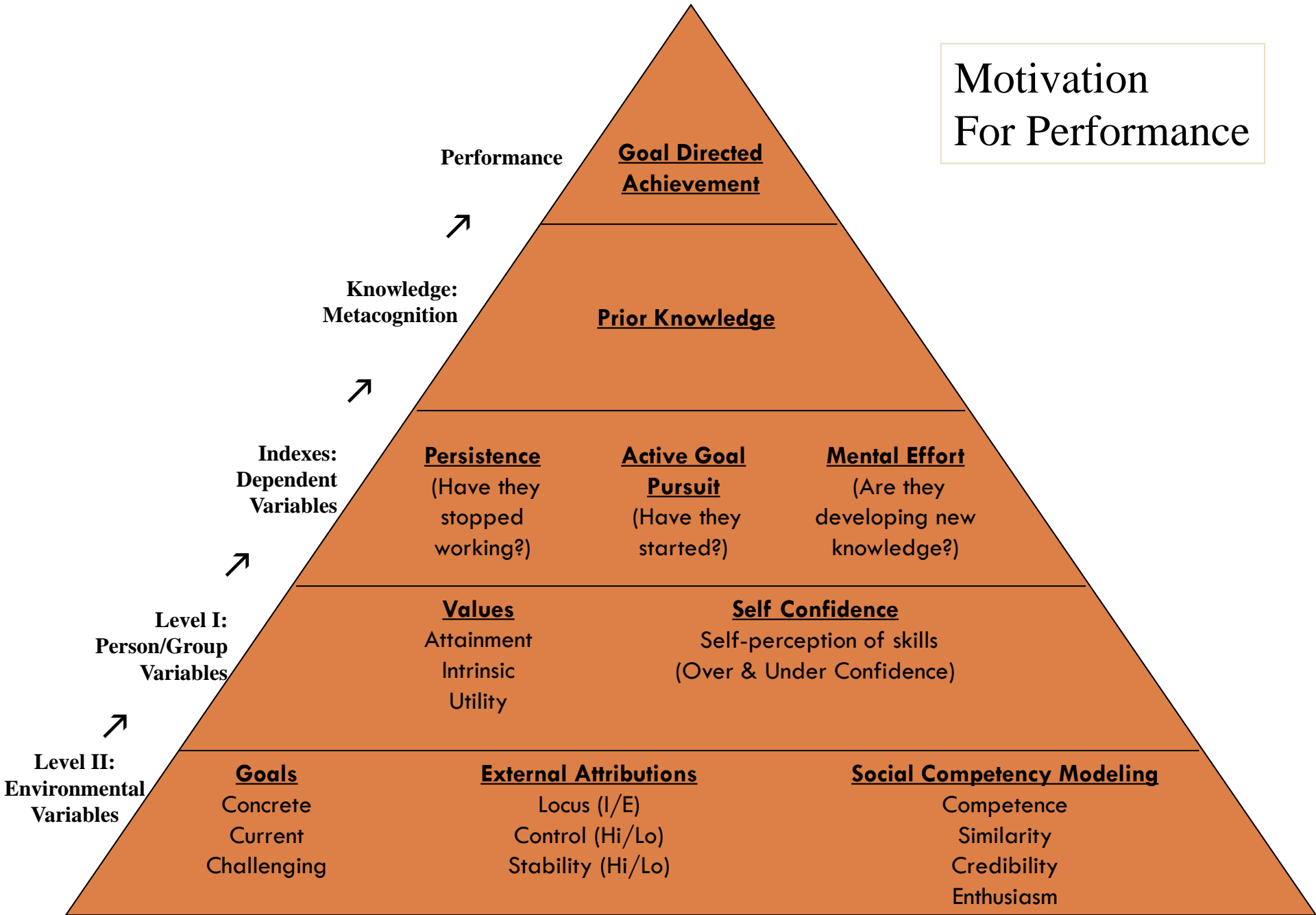
- Are certain interaction sequences common?
  - Is instructor feedback leading to uncontrollable attributions by students, followed by lowered confidence and persistence?
  - Do instructors fail to raise performance because they are too confident in their own abilities, so they do not update their techniques?

# Designing Motivational Interventions

- When you focus on a central “cause” then design a culturally and contextually appropriate motivation solution
  - ▣ Start with solutions to causes at pyramid base (goals, attributions, models)
  - ▣ New goals, reattribution training, more appropriate models that will influence next level of causes (values, confidence)
  - ▣ Check to see if values and confidence influence performance goals
  - ▣ Focus ALL motivational solutions on conditions and goals



# Motivation For Performance



# Enhancing Self-Efficacy

- Focus feedback about mistakes and failure on their effort and on improving strategies for lower confidence students
  - ▣ NO: “you made a mistake” or “you are stupid”
  - ▣ YES: “Let’s try to improve the strategy you used” or “You can do it if you try harder with a better strategy”
- Focus feedback about mistakes on the novelty of the goal and the fact that their strategy was not appropriate for students who are too confident
  - ▣ NO: “You are not as good as you think you are”
  - ▣ YES: “The strategy you used will not achieve this new goal. Can you think of another strategy that will work better?”

# Reattribution Interventions: College Students

- Students watch videotaped interviews of upperclass students stating:
  - ▣ Their grades were low the first year but they improved thereafter
  - ▣ Reasons for initial problems were due to unstable, controllable reasons
  - ▣ Instructors can emphasize that problems can be overcome through persistence

# Discussion

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- Discussion of common barriers identified by faculty and brainstorm of learning activities to address barriers
- Sharing of new elements incorporated into syllabi

# QUESTIONS AND ANSWERS

Audience questions:

# Challenges working with students:

## Student Motivation:

- If students don't like the subject we teach or are not committed to studying STEM, how do we get them interested in it?
- Students don't like to move beyond their comfort zone
- Students only care about their scores (or grades), and don't really care about what they are learning. How can we get them to care more about learning?
- What do we say to students who want to change their major from STEM to something else?
- How can we help reduce students' anxiety?

Audience questions:

## Challenges working with students:

- How do we use learner-centered approaches with students in a class where they don't have good background knowledge?
- How do we develop a syllabus for a class in which there are students at different levels of prior knowledge?
  - ▣ Use a pre-test so you can know the range of students' skill levels

Audience questions:

## Classroom management issues:

### Class size:

- How do we use learner-centered strategies with large courses (e.g., over 100 students?)
- In the U.S. what is the typical size of a class in order to be more effective in teaching STEM?
- How do we use learner-centered approaches for a class in which we have a certain amount of information to cover?
- Most students prefer working alone because working in terms causes the process to slow down. How do we get them to work in groups?



Audience questions:

## Other learner-based strategies

- What are other examples of learner-based strategies (other than Think-Pair-Share, Problem-based learning, Clickers, and Learner Classroom Assessments)?
  - ▣ Flipped classrooms
  - ▣ Partially worked-out examples
  - ▣ Peer teaching

Audience questions:

# Teaching in STEM:

## Applicability of learner-centered strategies for STEM:

- Couldn't learner-centered strategies be used in any discipline?
- Learner-centered approaches are not applicable to STEM
- Learner-centered approaches are not applicable for Cambodia
- What is the difference between CTA-based instruction vs. traditional instruction?
- What do Cambodian instructors need to do to make their lectures more effective?
- In order to develop a STEM-based Cambodian economy and successfully integrate into the ASEAN community in 2015, what are your recommendations?

# DEMONSTRATION



# Objectives

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1. Students will be able to evaluate a business strategy using cost-benefit analysis to help businesses choose the most effective strategy.
2. Students will be able to create a report that explains a cost-benefit analysis to a business client.

Objective 2

**CREATE**

Synthesis

To create something, to integrate ideas into a solution, to propose an action plan, to formulate a new classification scheme

Objective 1

**EVALUATE**

Evaluation

To judge the quality of something based on its adequacy, value, logic, or use

**ANALYZE**

Analysis

To identify the organization structure; to pull meaning from parts, relations, and organizing principles

**APPLY**

Application

To apply knowledge to new situations, to solve problems

**EXPLAIN**

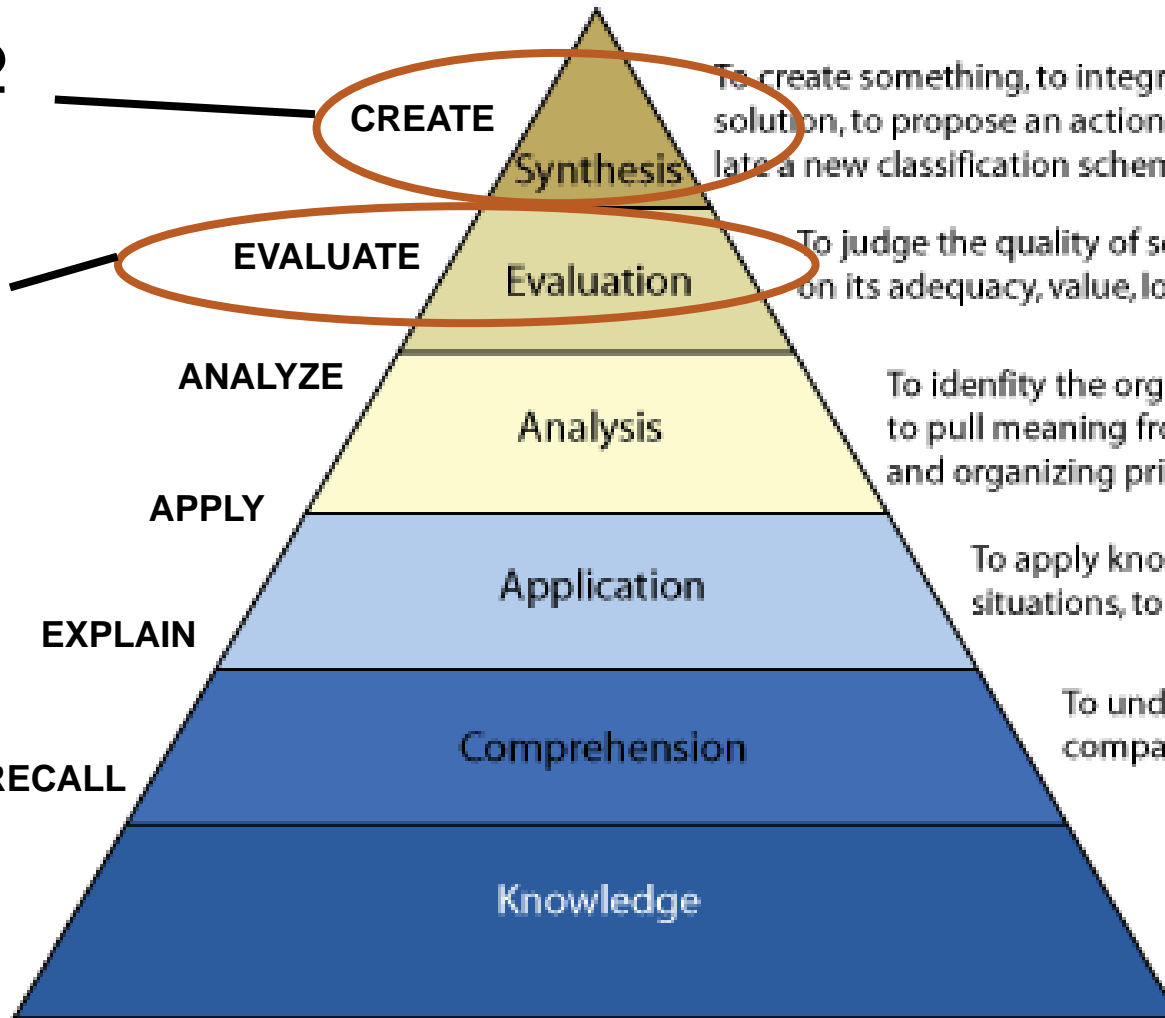
Comprehension

To understand, interpret, compare, contrast, or explain

**RECALL**

Knowledge

To know specific facts, terms, concepts, principles, or theories



# Assessments

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- Conduct a cost-benefit analysis
- Explain the results in a report

# Rubric for report

← EVALUATION LEVELS →

CRITERIA	0 Unsatisfactory	1 Developing	2 Proficient	3 Accomplished
Identify costs				
Identify benefits				
Monetize costs				
Monetize benefits				

# Rubric for report

← EVALUATION LEVELS →

CRITERIA	0 Unsatisfactory	1 Developing	2 Proficient	3 Accomplished
Compute cost-benefit ratio				
Compare ratios from different strategies				
Select optimal strategy				
Explain how costs were identified				



# Rubric for report

← EVALUATION LEVELS →

CRITERIA	0 Unsatisfactory	1 Developing	2 Proficient	3 Accomplished
Explain how benefits were identified				
Explain assumptions of monetization				
Create a graph to show comparison of strategies				
Explain cost-benefit ratio for selected strategy				

# Rubric for report+

## EVALUATION LEVELS

CRITERIA	0 Unsatisfactory	1 Developing	2 Proficient	3 Accomplished
Identify costs	Costs not identified or incorrect identification of costs	Most costs identified correctly	All direct costs identified correctly	Direct and indirect costs correctly identified
Identify benefits	Benefits not identified or incorrect identification of benefits	Most benefits identified correctly	All direct benefits identified correctly	Direct and indirect benefits correctly identified
Monetize costs	Not all direct identified costs monetized	All direct costs monetized, but not all correct	All direct costs monetized correctly	All direct and indirect costs monetized correctly
Monetize benefits	Not all direct identified benefits monetized	All direct benefits monetized, but not all correct	All direct benefits monetized correctly	All direct and indirect benefits monetized correctly

# Lesson to Identify Costs

- Lecture to explain definitions and ways to identify costs
- Demonstration to show how
- Give case for practice
- Think-Pair-Share
- Short lecture to give feedback and clarify information
- 1-minute paper

Audience questions:

## Lack of resources:

Lack of resources makes learner-centered strategies difficult/impossible:

- How can we be more effective teachers when we lack good teaching materials?
- What kinds of teaching methods should we use in a STEM course if we do not have a laboratory?
- Some activities may not be possible in Cambodia
  - ▣ E.g., Biology 101 lab report
- Tuition in Cambodia is very low (\$400 per year). This may make improving the quality of teaching and learning in Cambodia difficult

Audience questions:

## Lack of resources:

- There is a dilemma in Cambodia between the quality and quantity of students at universities. For profit-oriented universities, they admit too many students in order to make a profit
- Which is more costly for universities? Teacher-centered or learner-centered techniques?
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Audience questions:

# Uniqueness of Cambodian Context

- We don't see any national strategy for STEM
- What are other countries similar to Cambodia doing and what strategies are they employing?
- Most lecturers like positive evaluations, so they may not be willing to change their teaching if it is rated positively
- Textbooks mainly come from U.S. and other countries. Examples should be derived from Cambodian context.
- If you were a teacher in Cambodia, would you use teacher-centered approaches or learner-centered approaches (based on the Cambodian economy)

## The definition of insanity:

Doing the same thing over and over again and expecting different results.

– Albert Einstein

# Additional materials

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- Essential readings
- Additional readings
- Examples of backward designed syllabi in STEM courses
- Examples of learner-centered pedagogies
- Examples of evaluation rubrics



# URL for Materials

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- <http://stemworkshop.wordpress.com/>
- Password: SiemReap2013