Theory and Practice of Teaching and Learning: Outcomes, Objectives, and Goals

Bryan Scott | LSST-DA Data Science Fellowship Program Session 24

“Learning is not the product of teaching. Learning is the product of the activity of learners.”

- John Dewey

Philosopher, Psychologist, and Educational Reformer

"The only [person] who is educated is the [person] who has learned how to learn; the [person] who has learned how to adapt and change; the [person] who has realized that no knowledge is secure, that only the process of seeking knowledge gives a basis for security."

- Carl Rogers

Cogntiive and Educational Psychologist

What does it mean to teach? What is it that we teach?

Learning (noun):
Adaptive reorganization in a complex system.

*The essence of learning is **meaning**.*

Big Idea: Significant learning is a fundamental human need. It is personal, self-initiated, pervasive, and triggers reflection.

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Big Idea: Significant learning is a fundamental human need. It is personal, self-initiated, pervasive, and triggers reflection.

As teachers, we **facilitate** and **support** learning, but it is learners who do the learning.

Questions in Formal Learning

1. *What do we want students to know and be able to do?*
2. *How will we know if we've been successful?*
3. *What is known about the process of learning?*

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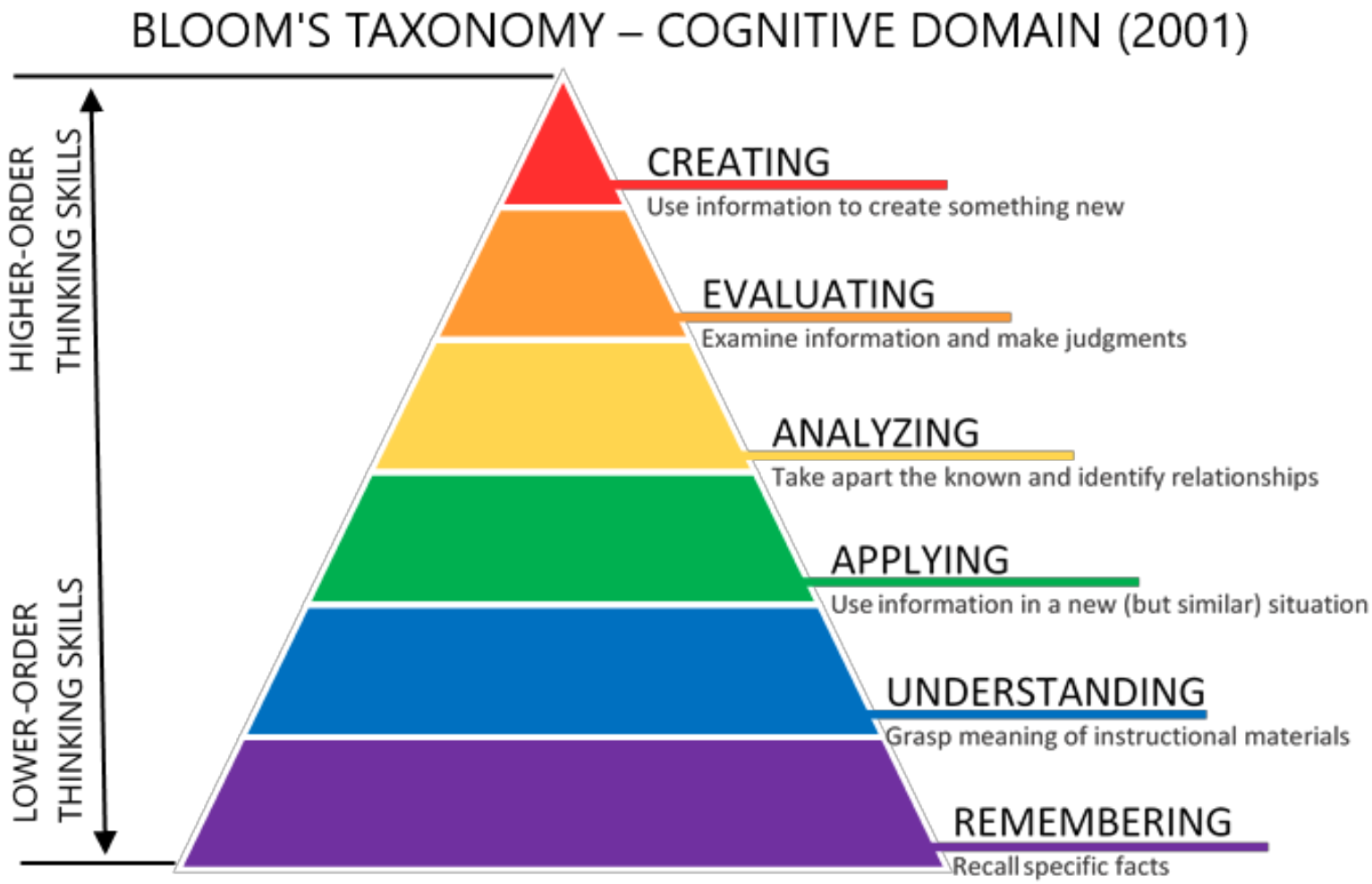
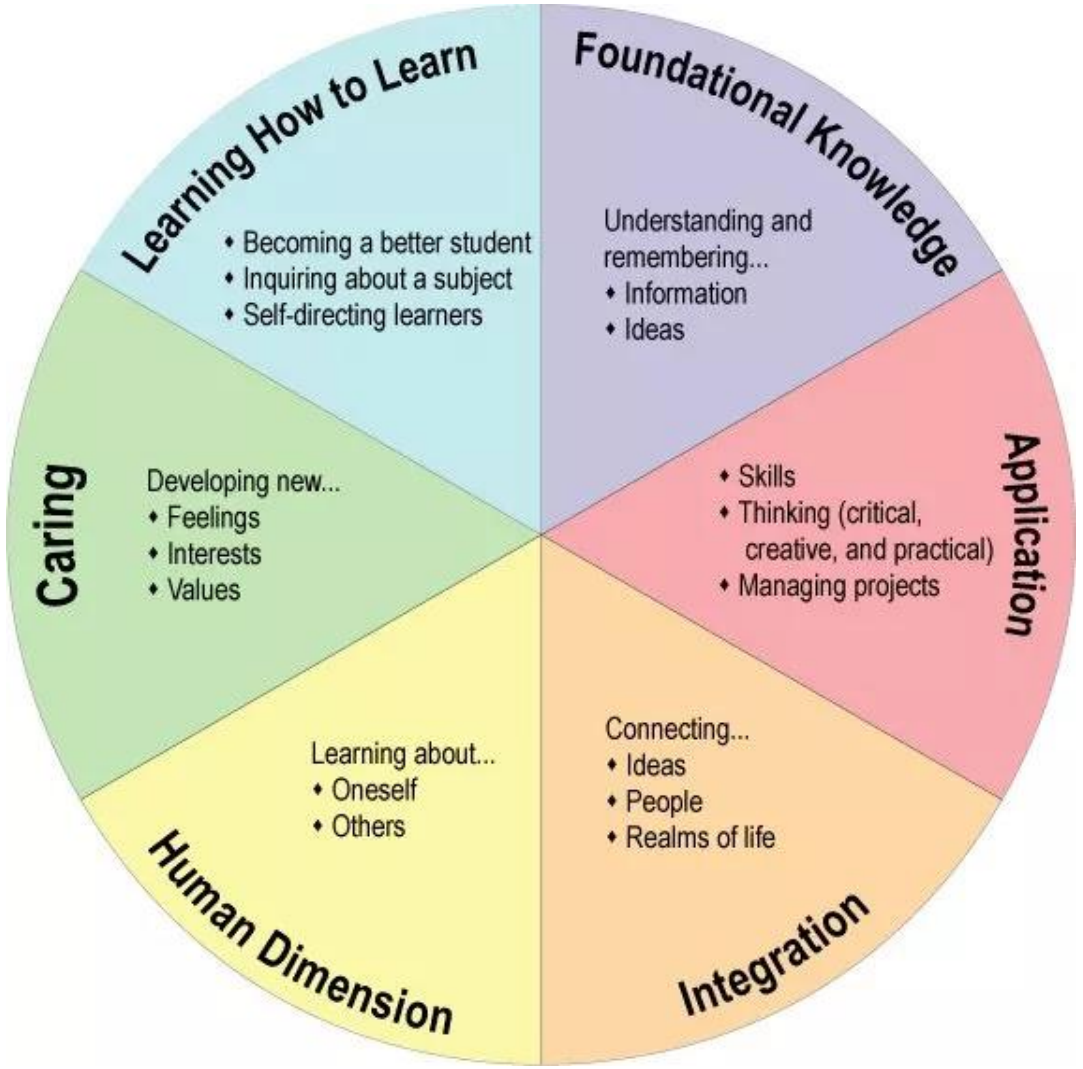
The taxonomy of learning

Taxonomies of Learning



Taxonomies of Learning



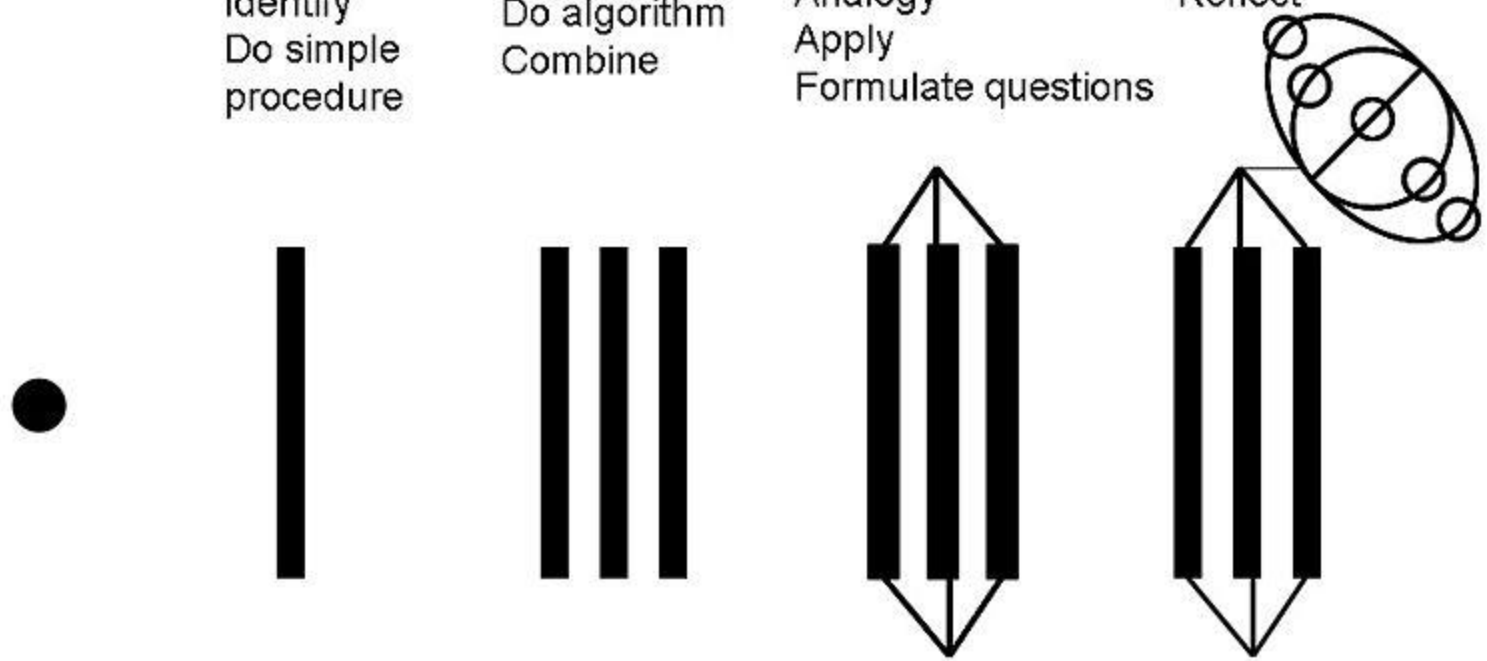
SOLO TAXONOMY
(after Biggs and Collis 1982)

Define
Identify
Do simple procedure

Define
Describe
List
Do algorithm
Combine

Compare/contrast
Explain causes
Sequence
Classify
Analyse
Part/whole
Relate
Analogy
Apply
Formulate questions

Evaluate
Theorise
Generalise
Predict
Create
Imagine
Hypothesise
Reflect



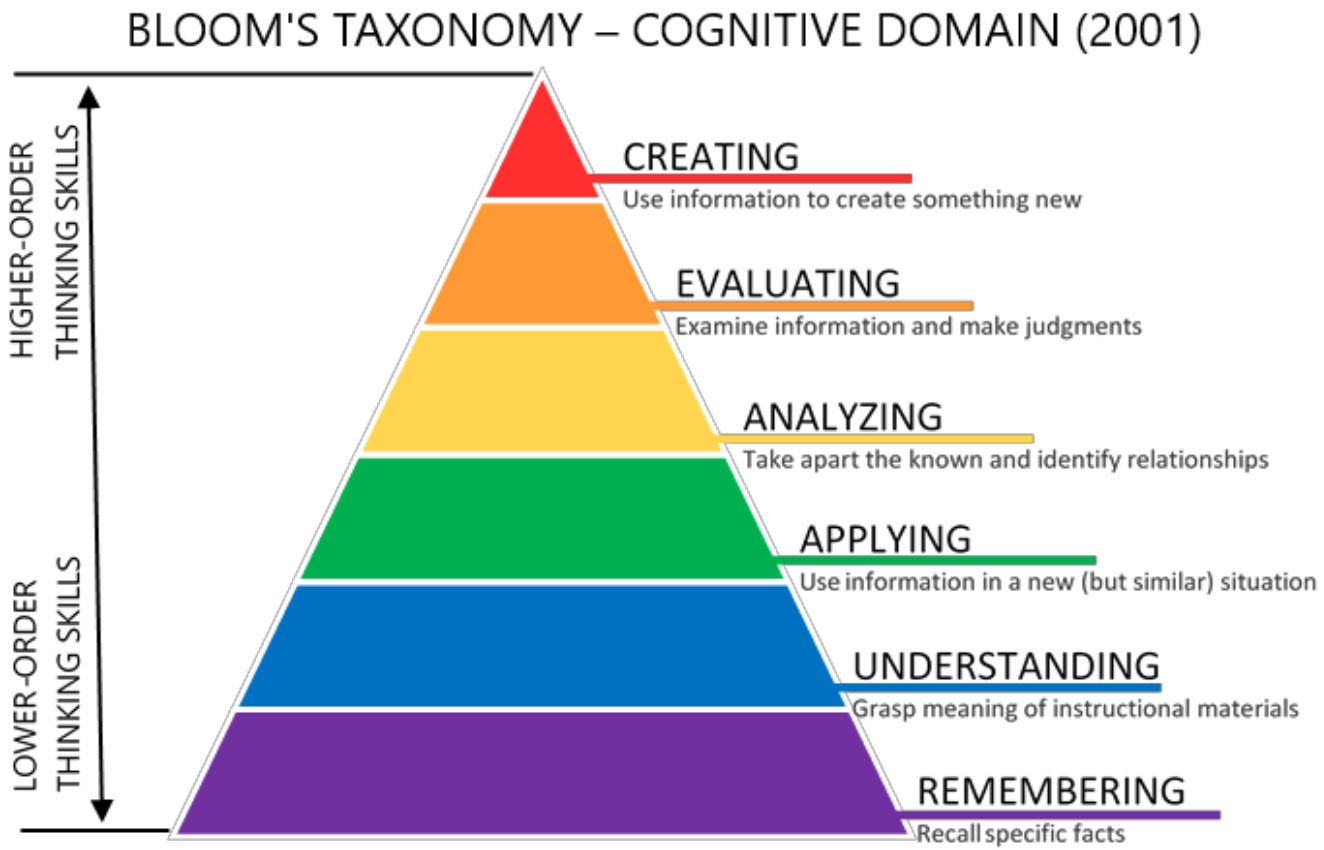
Prestructural **Unistructural** **Multistructural** **Relational** **Extended abstract**

Take a moment to reflect on which taxonomy best matches your experience as a learner.

How would you use each taxonomy to design a lesson? What about a course? An academic program?

What makes higher education different? What makes a graduate degree different from an undergraduate one? What is special about a PhD?

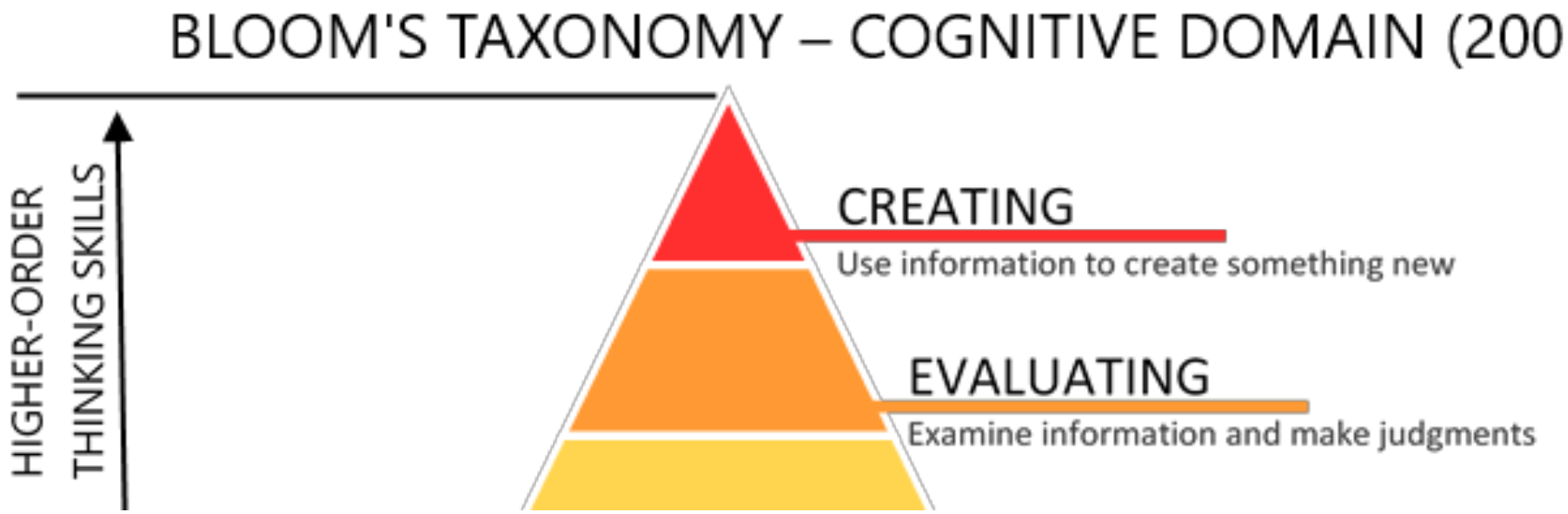
What makes higher and graduate education special?



Graduate and Professional Degrees

Undergraduate

Primary/Secondary education, early Undergraduat



Teaching and Learning at the (intermediate-advanced) undergraduate and graduate level is focused on high order thinking skills/tasks. These require 100s-1000s of hours of learning to successfully perform ***and are difficult for all brains.***

Learning outcomes:

What students will learn and how they will be assessed.

Learning goals:

What you want students to be able to do or demonstrate at the end of your class.

Example:

"Data Science Fellowship Program alumni will be able to employ state of the art approaches to open questions in large astrophysical surveys."

Learning Objectives:

What you want students to be able to do after completing a single lesson or activity.

Example:

Fellows who attend Session 24 will be able to describe the signal chain from photons to pixels and use this knowledge to perform image processing tasks enabling scientific analyses and inference.

When writing learning outcomes and objectives, consider:

What the big idea of the lesson/course/unit is. What is the one thing learners should understand or be able to do in order to benefit from it?

What are the unique values, perspectives, methodologies, concepts, etc that learners gain from the lesson/course/unit?

What must learners already know or be able to do prior to the lesson (or course)?

Practical Framework

Keep Things Learner Centered

The subject of each sentence should be learners, not instructors, activities, or topics.

Think about who will be attending the lesson. Significant learning happens when the learners are invested in the material they're receiving instruction on.

What values, expectations, background knowledge, or external factors be impacting them?

Outcomes and Objectives Should be Action Focused and Situational

Use active and specific language.

Avoid "understand" and "know" - what behaviors indicate that a learner has understanding?

Consider when/where a task should be done. How will the learners know?

Outcomes and Objectives Should be Measureable

What does proficiency mean?

How will you know that learning has taken place? How will the learner know that they've learned?

More importantly: How will you know if learning hasn't taken place?

Subject:

Fellows who attend Session 24 *will be able to describe the signal chain from photons to pixels impacts measurements and use this knowledge to perform image processing tasks enabling scientific analyses and inference.*

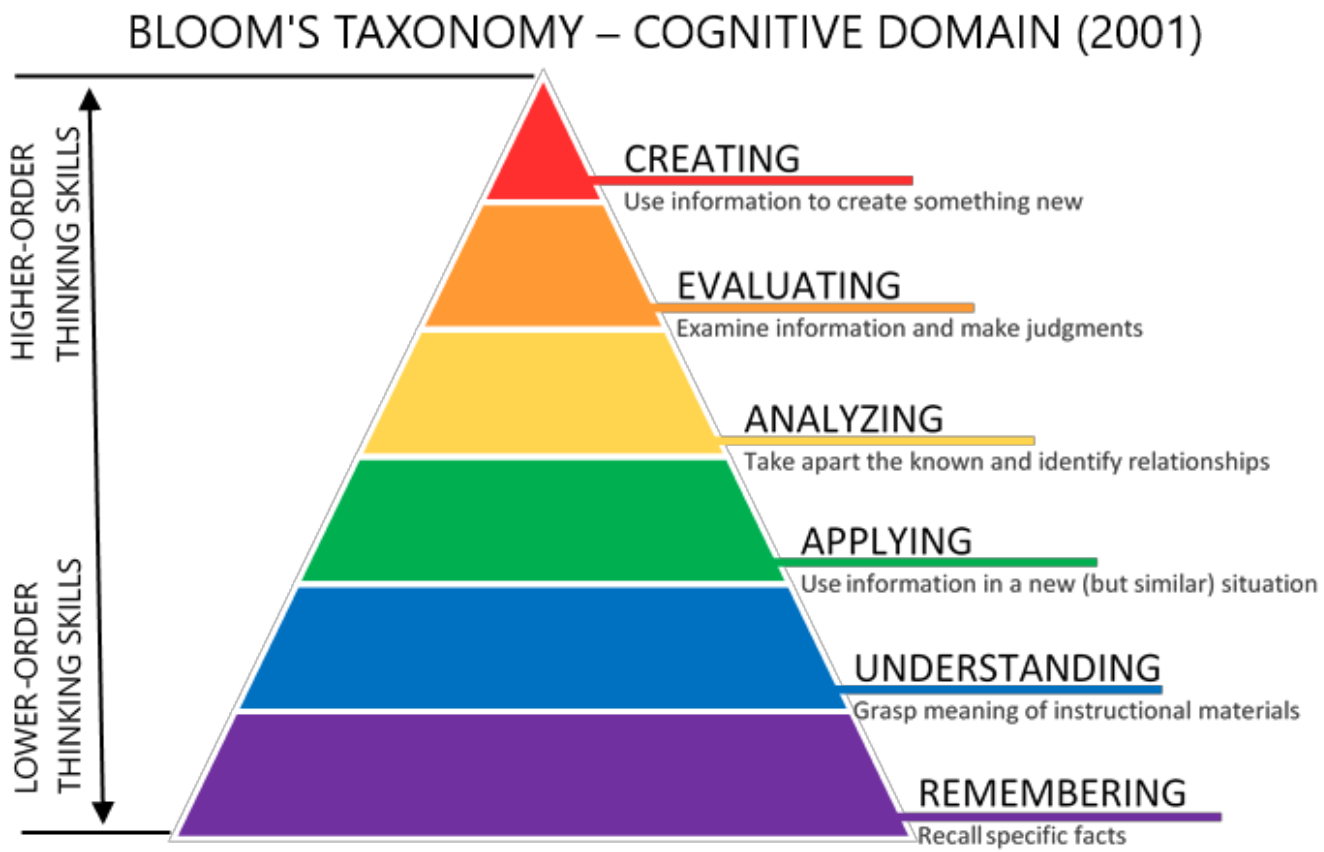
Action:

*Fellows who attend Session 24 will be able to **describe** the signal chain from photons to pixels impacts measurements and use this knowledge to **perform image processing tasks** enabling scientific analyses and inference.*

Measurable

Fellows who attend Session 24 will be able to describe the signal chain from photons to pixels impacts measurements and use this knowledge to perform image processing tasks ***enabling scientific analyses and inference.***

Hierarchical Learning Outcomes



End

Middle

Early

Evaluate

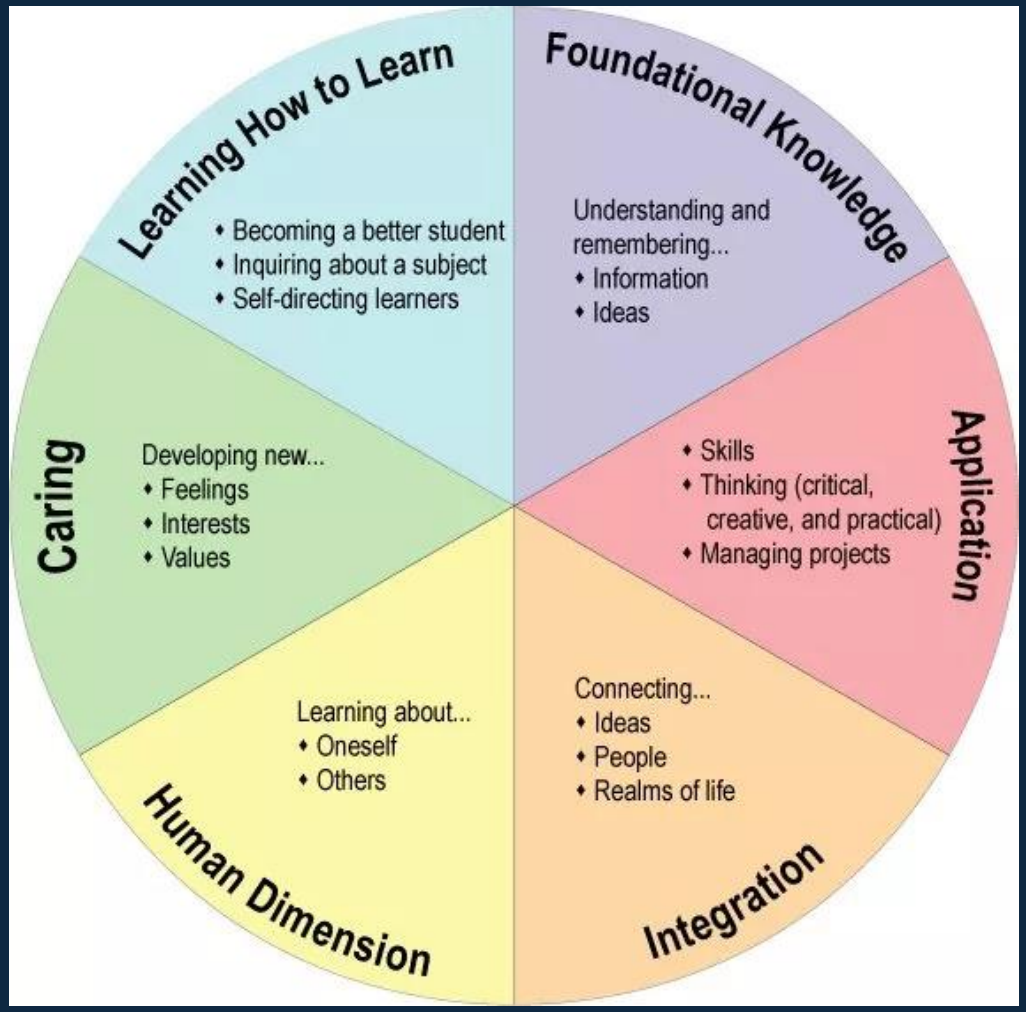
Fellows who attend Session 24 will be able to ***describe how the signal chain from photons to pixels impacts measurements*** *and use this knowledge to perform image processing tasks enabling scientific analyses and inference.*

Create

Fellows who attend Session 24 will be able to describe how the signal chain from photons to pixels impacts measurements and use this knowledge to perform image processing tasks ***enabling scientific analyses and inference.***

Non-hierarchical learning outcomes

Learners engage in all of these tasks in all parts of a lesson or course.



Non-hierarchical learning outcome Example

Fellows who attend Session 25: Machine Learning will be able to select classical models, apply them to a new dataset, and inquire about alternative approaches.

Summary

Learning is what learners do. Teaching is supporting learning.

*Learning outcomes or objectives describe would **learners** should be able **to do** at the end of an activity. They should be measureable.*

Learning objectives should be based on an understanding of where learners are in a learning taxonomy. Learners should be met where they are.

Theory and Practice of Teaching and Learning: Cognitive Psychology and Learning

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Brains at Work

Educational psychology is the study of when, how, and why learning occurs. Multiple complex, overlapping, and interacting regulatory pathways are involved in learning.

Neural learning proceeds changes in behavior. Similar behaviors may not correspond to the same neural state. What does it mean for the brain to know?

What is knowledge?

Gettier Problems

What if you believe something that is true, but only by coincidence?

Empirical Theories of Knowledge

Educational theory is based on the assumption that knowledge is not **entirely** subjective, but that there is some overarching pattern to **how knowledge is stored and represented** in the brain.

Types of Knowledge

Knowledge is not a single category:

1. Different types of knowledge may be represented differently in memory.
2. Different representation schemes are possible.

Some possible categories of knowledge

Declarative knowledge: facts and concepts, integrated understanding, mental models of the world

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Procedural knowledge: how to carry out tasks

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Declarative knowledge: facts and concepts, integrated understanding, mental models of the world

Procedural knowledge: how to carry out tasks

Self-regulatory: knowledge of the learning process itself (metacognition)

Reminder definition:

"Learning is adaptive reorganization in a complex system."

Learning in context

Learning can take place informally: emergent locations of learning

- meanings for skills, development of culture, formation of personal/professional identity.

The link between formal and informal learning:

Learning which involves a change in self organization - in the perception of oneself - is threatening and tends to be resisted. [...]

Those learnings which are threatening to the self are more easily perceived and assimilated when external threats are at a minimum. [...]

Self-initiated learning which involves the whole person of the learner - feelings as well as intellect - is the most lasting and pervasive.

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