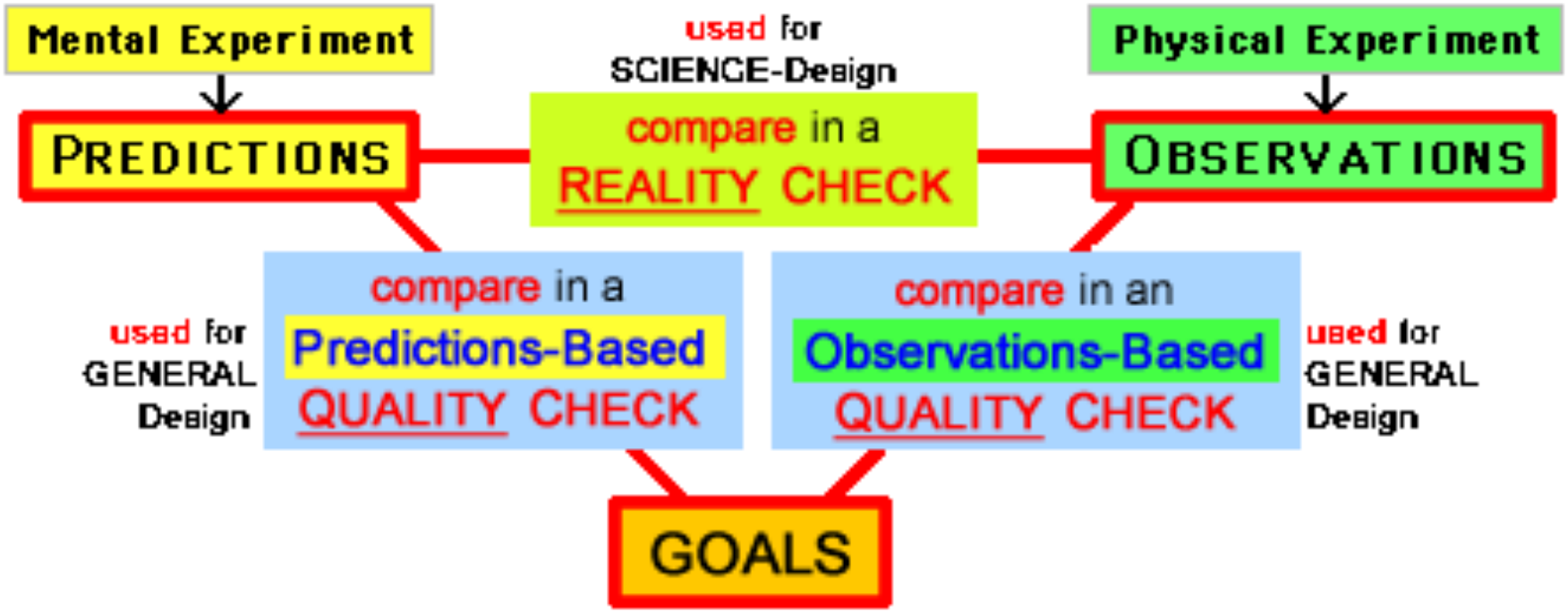
Building Bridges for All Students with Problem-Solving Education

diagrams & links – EducationForProblemSolving.net/eed/

How can we use our ideas for Problem-Solving Education in ways that will **help all students improve** their problem-solving abilities, as part of our efforts to produce **better diversity, equity, and inclusion?**



The next few slides
(before the first "blank slide" that shows a topic-change)
are explanatory comments that I'm making after the seminar.

My purpose for the first slide (above) was
giving people in the seminar room (or on Zoom)
something interesting to **look at** and **think about**
while they were waiting, before I began talking.

After my seminar (September 22, 2022) I revised this page by rearranging MANY slides and adding links and in other ways, like **adding a "blank slide" between major changes-of-topic.**

This PowerPoint summarizes many of my main edu-ideas, and why I'm so excited about them. But for a deeper understanding you can study the **Introductory Overview** in my comprehensive website about **Education for Problem Solving**. During the last week of September I'll be making a **Short Overview** that is a "bigger picture" view of ideas in the website. And **my seminar-page** has abstracts (short and longer) for ideas in the seminar and website, plus an informal bio.

In this PowerPoint,
the LINKS are gold.

Of course, **during the seminar**
I didn't cover all of the ideas in this PowerPoint
(nobody could talk that fast or listen that fast !)
but you can digest the ideas more slowly now.

And, as described in the previous slide,
I recommend studying the **Introductory Overview**
(that includes the **Short Overview**)
where the ideas are explained more thoroughly.

For using **my edu-website** (**Education For Problem Solving**),

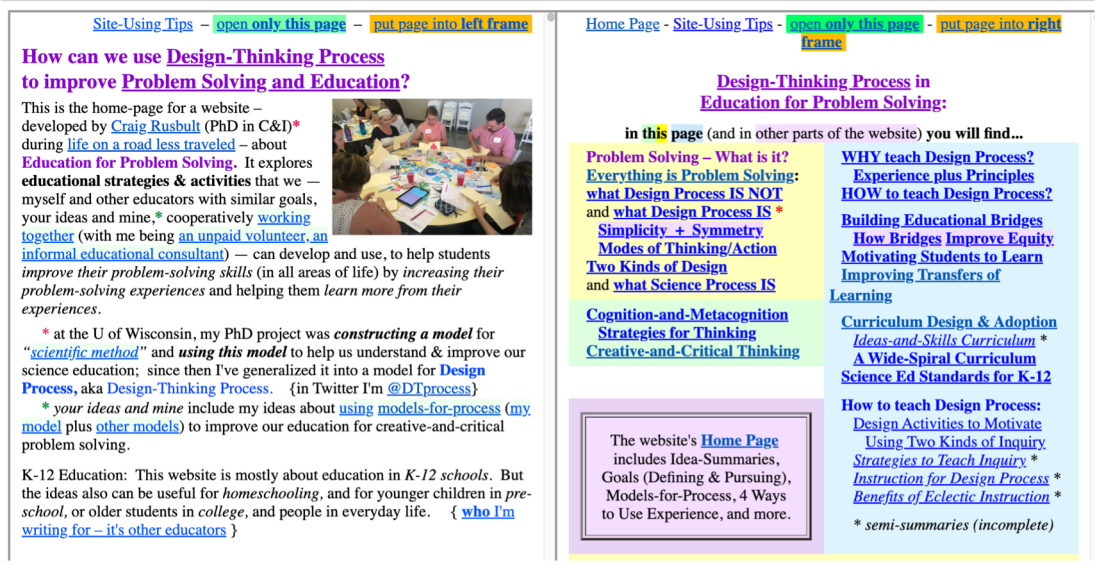
3 tips: use a **BIG Screen** – open **LEFT+RIGHT** and **click links**

because a link usually will open in the "other side" frame so you can continue reading in the frame where the link was.

And you can "open only this page" with a top-of-page link.

LEFT SIDE is homepage with Intro-Overview.

RIGHT SIDE has in-depth examination of topics.



Site-Using Tips – open only this page – put page into left frame

How can we use Design-Thinking Process to improve Problem Solving and Education?

This is the home-page for a website – developed by Craig Rusbult (PhD in C&I)* during life on a road less traveled – about **Education for Problem Solving.** It explores **educational strategies & activities** that we — myself and other educators with similar goals, your ideas and mine,* cooperatively working together (with me being an unpaid volunteer, an informal educational consultant) — can develop and use, to help students *improve their problem-solving skills* (in all areas of life) by *increasing their problem-solving experiences* and helping them *learn more from their experiences*.

* at the U of Wisconsin, my PhD project was ***constructing a model*** for "*scientific method*" and ***using this model*** to help us understand & improve our science education; since then I've generalized it into a model for **Design Process,** aka Design-Thinking Process. {in Twitter I'm @DTprocess}

* *your ideas and mine* include my ideas about using models-for-process (my model plus other models) to improve our education for creative-and-critical problem solving.

K-12 Education: This website is mostly about education in *K-12 schools*. But the ideas also can be useful for *homeschooling*, and for younger children in *pre-school*, or older students in *college*, and people in everyday life. { who I'm writing for – it's other educators }

Home Page - Site-Using Tips - open only this page - put page into right frame

Design-Thinking Process in Education for Problem Solving:

in this page (and in other parts of the website) **you will find...**

Problem Solving – What is it?
Everything is Problem Solving:
what Design Process IS NOT
and **what Design Process IS** *
Simplicity + Symmetry
Modes of Thinking/Action
Two Kinds of Design
and **what Science Process IS**

Cognition-and-Metacognition
Strategies for Thinking
Creative-and-Critical Thinking

The website's **Home Page** includes Idea-Summaries, Goals (Defining & Pursuing), Models-for-Process, 4 Ways to Use Experience, and more.

WHY teach Design Process?
Experience plus Principles
HOW to teach Design Process?

Building Educational Bridges
How Bridges Improve Equity
Motivating Students to Learn
Improving Transfers of Learning

Curriculum Design & Adoption
Ideas-and-Skills Curriculum *
A Wide-Spiral Curriculum
Science Ed Standards for K-12

How to teach Design Process:
Design Activities to Motivate
Using Two Kinds of Inquiry
Strategies to Teach Inquiry *
Instruction for Design Process *
Benefits of Eclectic Instruction *

* *semi-summaries (incomplete)*

Building Bridges for All Students with Problem-Solving Education

by Craig Rusbult, PhD – September 22, 2022
(a seminar for OSU's Dept of Engineering Education)

WHY should we Build Bridges? What are the **benefits?**
When we Build Bridges, we can help students improve their
TRANSFERS of Learning (for their **Skillful Uses of Knowledge**)
Across Areas (between **School-Life** & **NonSchool-Life**), and
TRANSITIONS of Attitudes (**Confidence** & **Motivations**) with
"**transfers**" **Through Time** (**Past → PRESENT → Future**).

my claims about Objectives and Process:

I think **people use a similar Process of Problem Solving** for **almost everything we do in life,** in most areas of life.

This claim is based on **logically combining two sub-claims:**

A) our **Problem-Solving OBJECTIVES** include **almost all we do,**

B) our **Problem-Solving PROCESS** is similar for **almost all we do.**

For awhile, these two claims will be our focus, beginning with

A) why **PS-OBJECTIVES** include **almost everything we do.**

the scope of **PS-Objectives** is wider
when we choose **broad definitions:**

EDUCATION is
learning from life-experiences.

PROBLEM is
an opportunity to **make something better.**
(better in any way, in any area of life)

PROBLEM SOLVING is
whenever you do **make something better.**

A) With these **broad definitions,**
your Problem-Solving **OBJECTIVES**
(**what you choose to make better**)
can include **almost everything in your life.**

because **your** **OBJECTIVE** can be (with my categorizing) a

product - activity - relationship - strategy - theory

(often there are overlaps, so it's product **and/or** activity **and/or**...)

For many reasons, it's educationally useful to split these kinds of **OBJECTIVES** into **two kinds of Design:**

product - activity - relationship - strategy – theory

can be categorized into two kinds of design:

product - activity - relationship - strategy

in **GENERAL Design** (in **Engineering** & other Areas)

theory

in **SCIENCE-Design** (in Science, **Engineering**,...)

HOW can Educational Bridges **increase Transfers Across Areas?**

A) By using **broad definitions** for **Problems** & **Problem Solving,** Problem-Solving **OBJECTIVES** include almost everything we do.

And in a second wide scope,

B) my model for **Design Process** shows how we use a similar Problem-Solving **PROCESS** for almost everything we do.

Notice that, in my model ,
Problem-Solving Process
is **Design Process**

Why should you accept these two claims?

A) A wide scope for Problem-Solving **OBJECTIVES** is easy to show — IF you think **my broad definitions** are reasonable — and the wide scope of PS-**Objectives** lets us design PS-**Activities** that are **FUN** and (as **perceived by students**) are **USEFUL.**

B) **Later** I'll show how my model for **Design Process** – for the Problem-Solving **PROCESS** that people use for most things we do in life — is an accurate description of how we actually use **creative-and-critical thinking** while we solve problems. **If students believe** that PS-Process (used by them in **School**) will be **Personally Useful** (in **Life**), they will be motivated to invest in their own **Personal Education.**

HOW? using **Design Process** leads to **wide scopes** for...

A) Problem-Solving OBJECTIVES,

B) Problem-Solving PROCESS.

PLUS – How People Learn: Brain, Mind, Experience, and School

How People Learn (**from National Research Council**) says **transfer** is "the ultimate goal of learning" so it's "a major goal of schooling," and recommend (based on **research about learning**) that **to increase transfer, we should:**

A) teach knowledge in multiple contexts;

this is encouraged by the wide scope of **PS-Objectives;**

B) teach knowledge in a form that's easy to generalize;

Design Process does this by using a **similar PS-Process** across the wide range of **PS-Objectives** and **PS-Activities.**

How People Learn

says that – to **increase transfer** – we should

"teach knowledge in a form that's **easy to generalize**"

and

easy-to-generalize occurs with my model

for Design PROCESS,

for Problem-Solving PROCESS.

Why should you accept my bold claims?

Is there "**PROOF** beyond a reasonable doubt"? – **NO.**
Are there **logical REASONS** for "**a good way to bet**"? – **YES.**

We have **logical reasons** to predict that **using Design Process** is **a good way to bet,** can be **useful in educational projects, is worth developing** with investments of time, money,...

The logical reasons are analogous to logic in my PhD project,

when my two sub-projects were ...

1. **developing a model** for Scientific Method,
2. then **using this model to analyze instruction.**

During that time the logic was:

Scientific Method(s) → **scientists do Science-Actions.**

IF students do these Actions during the instruction,

probably they will improve their Science-**Actions**.

But this is a **logic-based PREDICTION** (re: a good way to bet), not an **OBSERVATION** that using D-Process improves Actions.

And now these logical reasons are analogous to my claims:

How People Learn (with its basis in educational research) provides logical support — because **HPL claims** that transfer can be increased by **A) teaching in multiple contexts,** and **B) teaching generalized principles,**

similar to my claims that we can use Design Process to make wide scopes for **A) PS-Objectives,** and **B) PS-Process,** and that **together** (with **their A+B and my A+B**) this provides a logical reason to think Design Process may increase transfer.

I want to work cooperatively with other educators
to develop our ideas for improving education,
by creatively-and-synergistically combining
MY experiences-understandings-skills
with
YOUR experiences-understandings-skills.

I've been thinking mainly about education for K-12,
but most ideas also can be used for college education.

If you find my ideas interesting – even if (maybe especially if)
you're thinking "**yes, but...**" because you **agree partially** (yes)
but **not totally.** Of course that's ok, and it could help both
of us learn if we discuss your reasons for "yes" and also "but".

Building Bridges for All Students,
with Problem-Solving Education

Building Bridges with Problem-Solving Education,
for All Students

The two **title-colors** show two fairly-independent ideas (and I think both ways-to-arrange have similar meanings?) because **we could improve Problem-Solving Education** but **do it in ways that don't help "all students" and instead lead to LESS diversity-equity-inclusion.**

The colors also show **areas where I feel competent,** and **areas where I think people in OSU's Engineering Education know much more about "how to do it" compared with me.**

We want to build
effective Edu-Bridges
so students will be motivated to
pursue their own Personal Education,
therefore we should
develop Activities
that are
FUN and USEFUL

The wide scope of **Problem-Solving Objectives** (and thus of possible **Problem-Solving Activities**) makes it easier for educators to creatively design a variety of Activities that are **FUN and USEFUL.**

Designing Activities that are FUN and USEFUL:

FUN (with intrinsic experience) happens when activity has
fun TOPIC that (for a student) is interesting,
fun ACTIONS (by a student) that are interesting.

FUN (satisfying result-of-success) when student
anticipates success, and **achieves** success.
So this happens more often, design activities with
appropriate **level of difficulty** (not too easy, not too hard)
a well designed **PS-Activity** is similar (re: difficulty) to a
a well designed **mystery story** — so most students are
not bored (if too easy) and **not frustrated** (if too hard).

USEFUL is defined by a student.

During an Activity, a student will **perceive USEFUL-ness** when they **think & feel** (in their **thoughts & emotions**) that the Activity will be **USEFUL** for **their own future life** — their **near** future (after school), **medium** future (next year), and **far** future (as an adult) — because they're deciding that what they are doing-and-learning will be **Personally Useful** in their own lives, and this belief **motivates them** to pursue their own **Personal Education.**

They are being motivated by their imaginings of **TRANSFERS Across Areas** (from **School** into **Life**) and **TRANSFERS Through Time** (from **Present** into **Future**).

Personal Education: **Area**-Transfers & **Time**-Transfers:

When students decide that they want to pursue their own **Personal Education,** they're motivated by imagining **TRANSFERS Across Areas** (from **School** into **Life**) and **TRANSFERS Through Time** (from **Present** into **Future**).

There are logical reasons (e.g. earlier I described the **A**-and-**B** of **OBJECTIVES**-and-**PROCESS** with wide scope) to accept **Transfers Across Areas.**

By contrast, accepting **"transfers" Thru Time** depends more on the thinking of a student: Are they imagining the ways that **their present School-Learning** will improve the quality of **their future Life-Living?**

Personal Education is Problem-Solving Education:

We can ask students to...
think about their goals for life (involving themselves & others)* and **develop a proactive problem-solving approach** for their education, asking "how can I **solve a problem** – by **making my education better** and **making my life better** – and help me achieve my **goals for life**?"

(* and help others have better lives, with win-win goals & results?)

Personal Education is **proactive problem solving.**
A student tries to **make things better**
because they believe that...
improving **School-Life** improves **their Whole Life**
because **better Education** produces a **better Life;**
making **Their Education** better will make **Their Life** better.

Student Expectations: When students think they will get **TRANSFERS of Learning**

Across Areas and Through Time,

this can produce TRANSITIONS in Attitudes:

Past **PRESENT** **Future**

SCHOOL → **LIFE**

↓

MOTIVATIONS:

If I improve my PS-Skills NOW in School,

I can use my improved PS-Skills LATER in Life.

and TRANSFERS (Across Areas & Through Time) can produce TRANSITIONS in Attitudes:

Past **PRESENT** **Future**

LIFE → SCHOOL

↓

CONFIDENCE

I've done PS-Process BEFORE in Life,
so I can do it NOW in School.

A student's perception of **Personal Useful-ness**
provides their motivation for **Personal Education.**

Here are some useful self-education strategies
(that most of you already know) for **Personal Education:**

- developing and using (with consistency) a **Growth Mindset,**
- trying to learn from every experience (good or bad)
with a proactive attitude of **Intentional Learning,**
- believing that **Better Learning NOW**
will lead to **Better Performing LATER,**
- developing-and-using a **Checklist for Problem Solving.**

Growth Mindset: develop-and-use it consistently, so — whenever you ask "how well am I doing in this area?" and honestly answer "not well enough" — you are thinking "not yet" (instead of “not ever”) because you are confident that in this area you can "grow" by improving your skills, when you invest intelligent effort in your Personal Education. An effective growth mindset combines honest accuracy (in self-perception) with reasonable optimism (about being able to grow by improving).

Intentional Learning: Students do goal-directed Personal Education by defining worthy goals-for-life (to improve their self and life-situations) and making practical plans for achieving their goals, by pursuing their goals with effective activities and intelligent effort.

Performance Objective = want **best performing** NOW.
Learning Objective = want **best learning** NOW
so can improve **best performing** LATER.

examples from basketball: you have
Learning Objective in early-season practice,
Performance Objective in late-season tournament game.

Maya Angelou describes Performing and Learning:

"**Do the best you can until you know better.**
Then when you know better, do better."

Or, with [my comments],

Do the best you can [with high Present Performing]
until you know better.
Then [later] **when you know better** [due to Present Learning]**,**
do better [with high Future Performing]**.**

Using an **Objective-to-Perform** usually is best short-term, but long-term it's best to ALSO sometimes use an **Objective-to-Learn.**

develop a **Checklist for Problem Solving** (making things better) with Actions in Design Process & from other sources, and use it consistently in relevant Areas of Life & Life-Situations.

When I make a mistake and – wanting to learn from the experience so I can "do it better" the next time – I ask "why?" the answer often is "my process wasn't effective" because some problem-solving actions had not been done well, or had even been omitted.

Often I could have avoided a "did it worse" mistake – and instead would have "done it better" — if (using **Actions in Design Process** as a checklist for questions) I had asked... Have I chosen a good Objective? (is this a wise use of my time?) Do I understand the Problem-Situation? Do I know what I want? (by defining Goals for a Problem-Solution); then, Have I Generated Options for a Solution? and Evaluated these Options? then... Have I Made a Decision, and Actualized the Solution with actions?

Now we'll look at
my model for
problem-solving
Design Process.

Earlier, I say that...

Later I'll show how my model for **Design Process** – for the Problem-Solving **PROCESS** that people use for most things we do in life — is an accurate description of how we actually use **creative-and-critical thinking** while we solve problems.

But...

before doing that, I'll comment on differences between my teaching style during the seminar and a teaching style that usually is much better for students in K-12.

Two Methods for Teaching Process-Principles:

Direct Explaining (by **teacher**),
Discovery Learning (by **student**).

NOW,
I'll do **show-and-tell** **to explain** our **Problem-Solving Process.**

LATER,
With students, usually **this is NOT a good teaching strategy.**

Instead, help students DISCOVER PRINCIPLES-for-Process,
by using **EXPERIENCES + REFLECTIONS → PRINCIPLES .**
Their **self-discovering** will be more **satisfying** and **effective**.

But for **NOW,** **Direct Explaining** will be useful.

COMMENTS added during the post-seminar revision:

The slides above & below are similar,
because I first made one (above) and then revised it.

I'm including both, because seeing the same idea twice
(especially if it's an important idea, like this one)
can be useful for understanding better.

I think the main "added value" in the revised slide (below)
is at the bottom, with its description of ERP as
Using a Process-of-Inquiry to Teach Principles-for-Inquiry

Two Methods for Teaching Process-Principles:

Direct Explaining (by **teacher**),
Discovery Learning (by **student**).

when we are not in a seminar
with very-brief TIME LIMITS,
help students DISCOVER
PRINCIPLES-for-Process,

EXPERIENCES + REFLECTIONS → PRINCIPLES

Their **ERP self-discovering** will be more **satisfying** and **effective**
when we
Use a Process-of-Inquiry to Teach Principles-for-Inquiry

But... there is an important factor to consider for K-12 students.

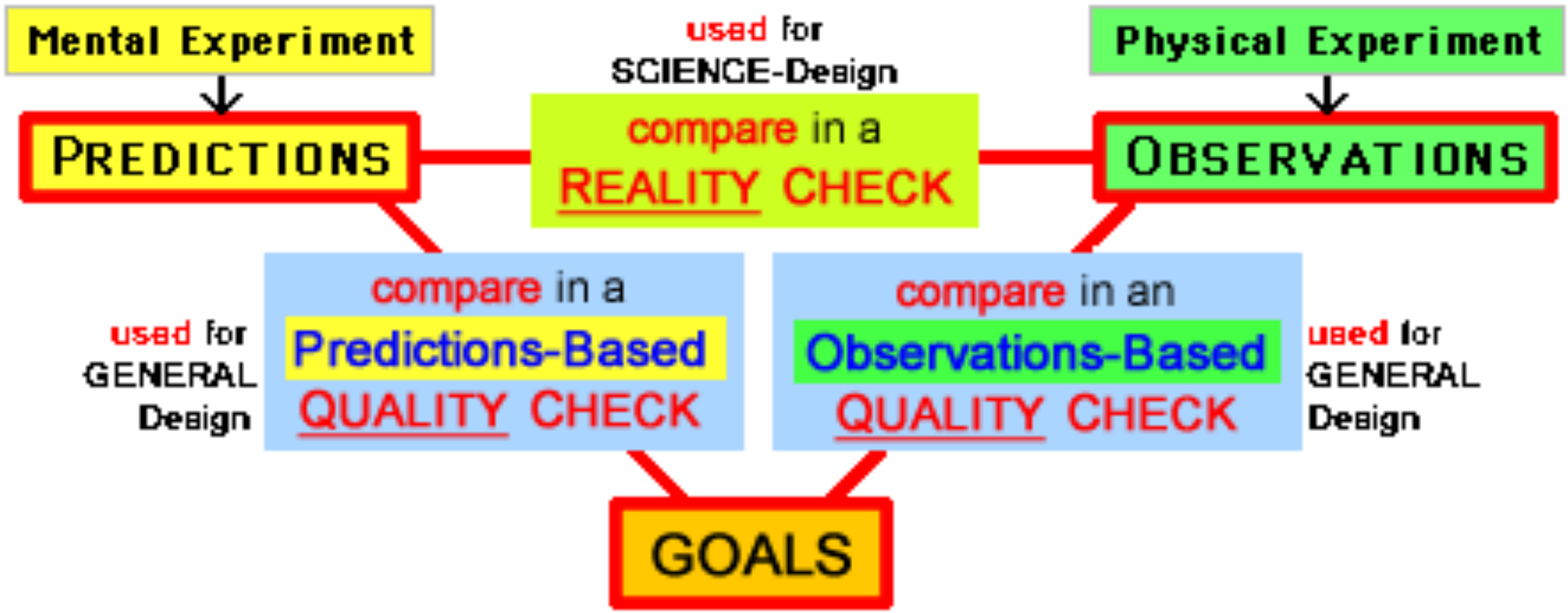
In college education
educators can control WHAT students study and WHEN,
but in a K-12 Curriculum
that integrates Design Process (and other models) into a coordinated **Wide-Spiral Curriculum** with spiral repetitions (so students have problem-solving experiences in all grades),
what a student learns in 1st Grade
will affect their "discovery learning" in 2nd Grade,
so instruction with ERP
(especially for Reflections)
will have to be adjusted.

Earlier, I say that...

Later I'll show how my model for **Design Process** ...

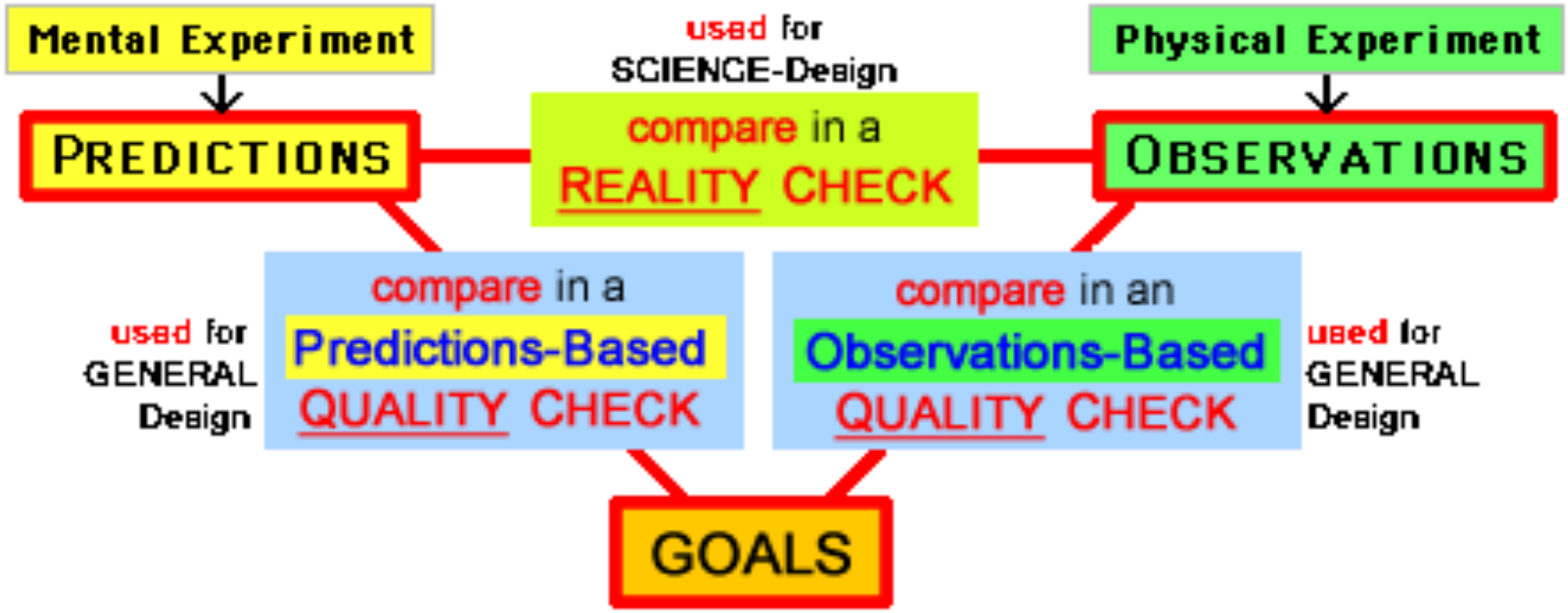
Now it's "Later" and I'll describe my model,
beginning with the most beautiful diagram,
with two colorful-and-logical triangles:
look at the next diagram and find them.

Then (although probably it won't be necessary)
I'll explain "what the triangles are"
and why they're important.

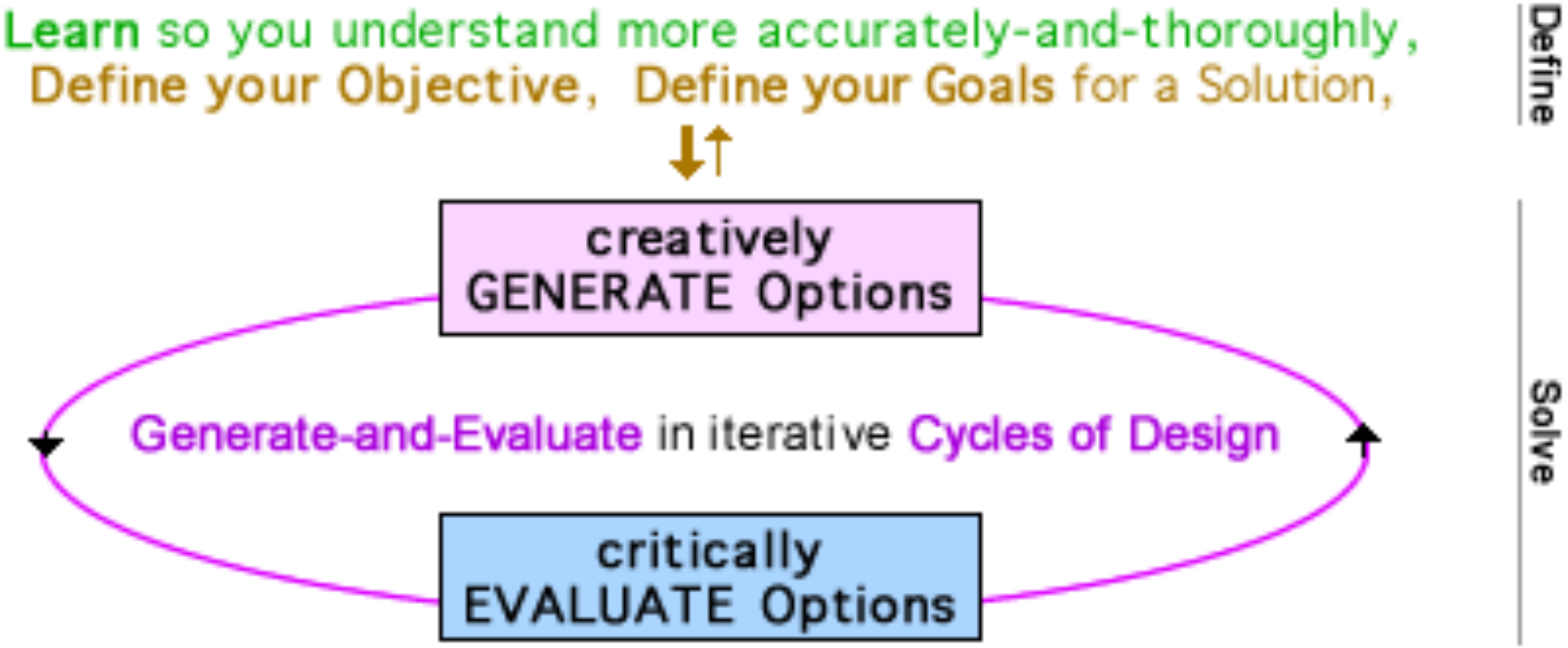

Mental Experiment
used for
SCIENCE-Design
Physical Experiment
PREDICTIONS
compare in a
REALITY CHECK
OBSERVATIONS
used for
GENERAL
Design
compare in a
Predictions-Based
QUALITY CHECK
compare in an
Observations-Based
QUALITY CHECK
used for
GENERAL
Design
GOALS

THE TWO TRIANGLES:

one has **3 Elements** (Predictions & Observations, Goals);
the other has **3 Comparisons AND two kinds of Design**
because there are two ways to think about this triangle,
by describing the WHAT of its evaluative Actions,
and the WHY of each ACTION.



Define – Solve – Decide & Do



Define – Solve – Decide & Do

1 - Define a Problem

Choose an Area-of-Life with a thing you want to make better.

Ben Franklin: "Time is the stuff Life is made of" so choose wisely, asking "What's the best use of my time right now? and later?"

Learn about the Problem-**Situation**, to better **Understand** it,
Choose **an Objective** (choose what you want to make better),
Define **GOALS** (what do you want? what will make it better?).

Define – Solve – Decide & Do

1 - Define a Problem

Define GOALS (= what will make it better?)

2 - Solve this Problem

creatively **Generate Ideas** (for Options)

critically **Evaluate Ideas** (for Options)

Ideas = Options for a Problem-**Solution**
with interplay between **creative** thinking & **critical** thinking
during **creative-and-critical** **Process of Problem Solving.**

Define – Solve – Decide & Do

1 - Define a Problem

2 - Solve this Problem
creatively Generate Ideas (for Options)
critically Evaluate Ideas (for Options)

3 – Decide & Do (not shown in the diagram)
Solve this Problem (in Reality: Actualize Problem-SOLUTION)

Decide — when Evaluating → Choosing an Option
Do Actions — that are required to Actualize This Option,
so This Option becomes a Problem-SOLUTION.

you Evaluate by Using Experiments:

another broad definition (useful for building bridges)

EXPERIMENT = any Situation that **produces Experiences,** is any **opportunity** to get **Experimental Information** – when you

make PREDICTIONS in a **MENTAL Experiment** (internal)

by **imagining Situation** → "what **would happen** if..."

make OBSERVATIONS in a **PHYSICAL Experiment** (external)

by **actualizing Situation** → "what **does happen** when..."

you Evaluate by Using Experiments:

another **broad definition** (**useful** for **building bridges**)

EXPERIMENT = any Situation that **produces Experiences,** is any **opportunity** to get **Experimental Information.**

EXPERIMENT = any **Situation** that **lets you Predict,**
any **Situation** that **lets you Observe.**

EXPERIMENT = Prediction-Situation or **Observation-Situation**.

you Evaluate by Using Experiments:

another **broad definition** (**useful** for **building bridges**)

EXPERIMENT = any Situation that **produces Experiences.**

EXPERIMENTAL DESIGN: In a **broad general strategy,**
ask "**what can we do** (re: our Problem) **to get Useful Information?**"
imagine "**IF** we do this Experiment, **what might happen,**" and
"**what could we learn** that might be **interesting or useful?**"

you Evaluate by Using Experiments:

another **broad definition** **(useful** for **building edu-bridges)**

EXPERIMENT = any Situation that **produces Experiences.**

EXPERIMENTAL DESIGN: In a **broad general strategy,**
ask "**what can we do** (re: our Problem) **to get Useful Information?**"

also – We can help students learn **logically Designing** Experiments,
re: ways to **make E-Information more useful** for Problem Solving
(e.g. Isolate & Control Variables; Control Groups; blind Obs,...).

you Evaluate by Using Experiments:

HOW do you Use?

you Do Comparisons to

make a REALITY Check
(in SCIENCE-Design)

or

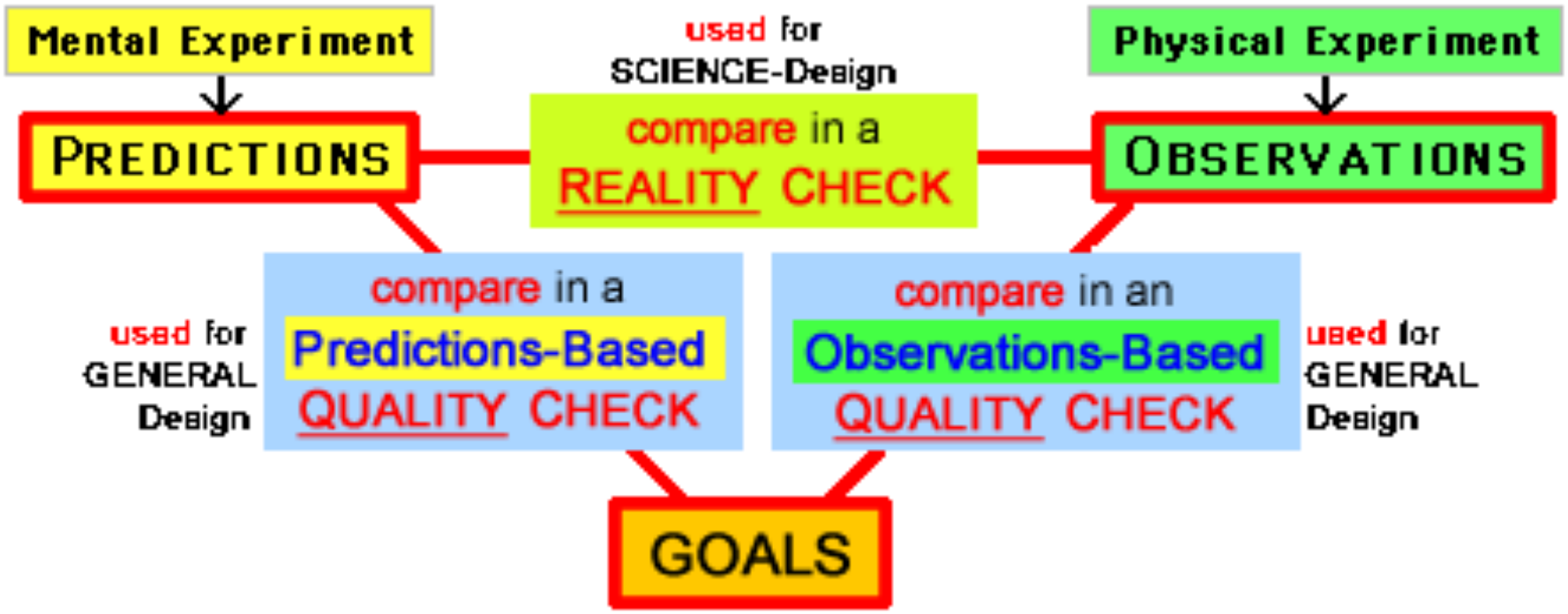
make a QUALITY Check
(in GENERAL Design)

3 Elements are used in 3 Comparisons for GENERAL Design and SCIENCE-Design:

SCIENCE-Design – using Experimental Information

and

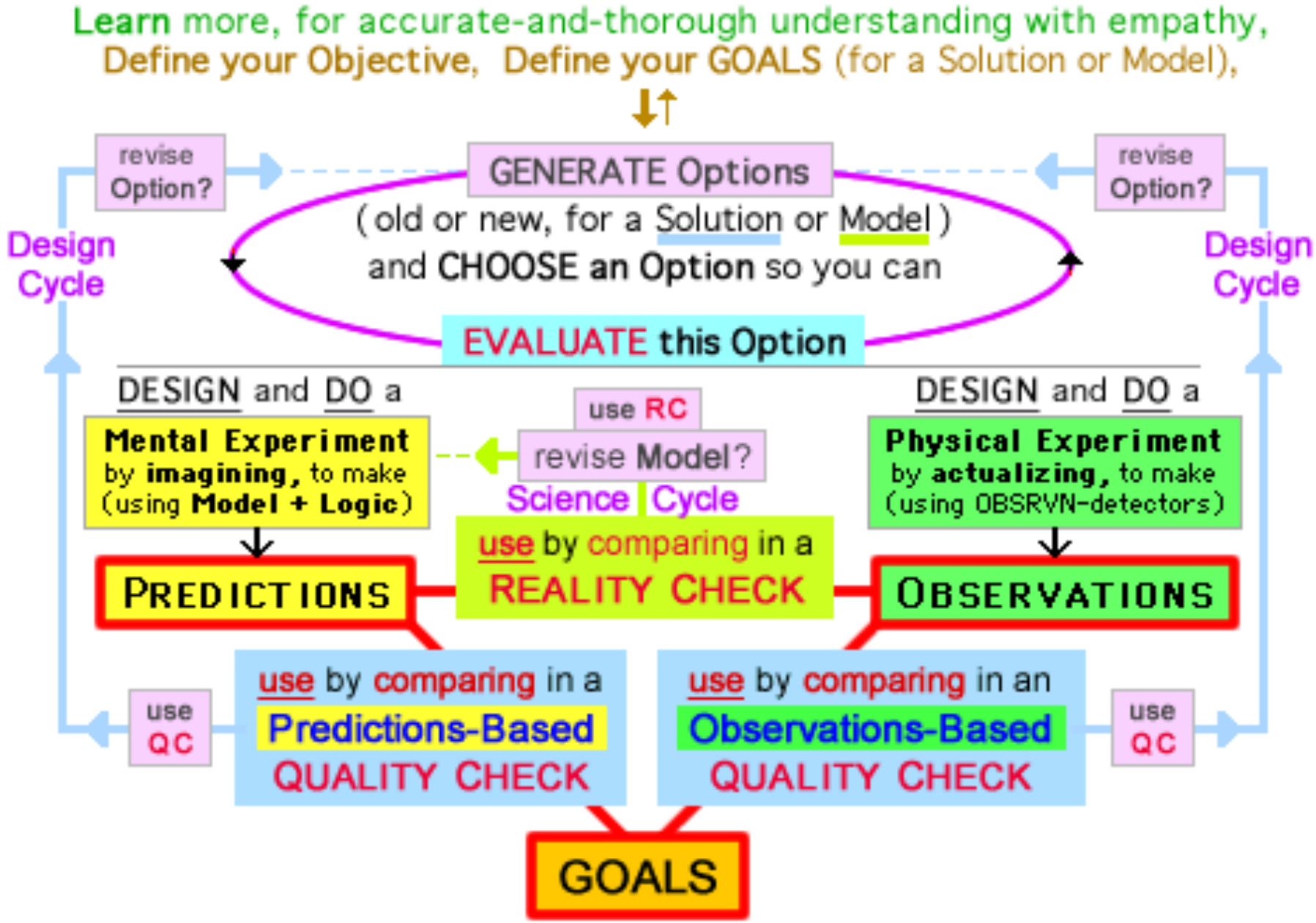
GENERAL Design – using Experimental Information

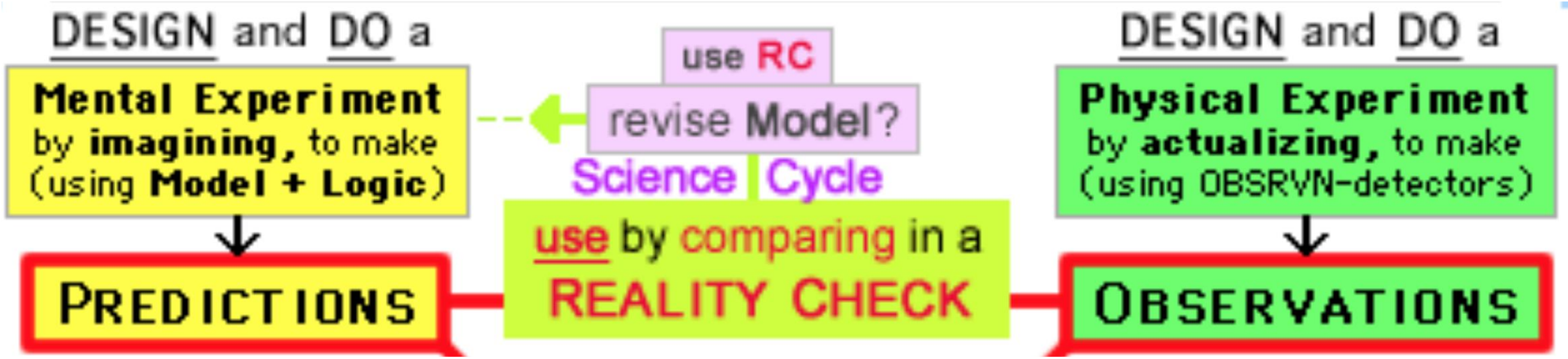


The next diagram is **more complex,**
because it
shows **details** for **both** kinds of design.

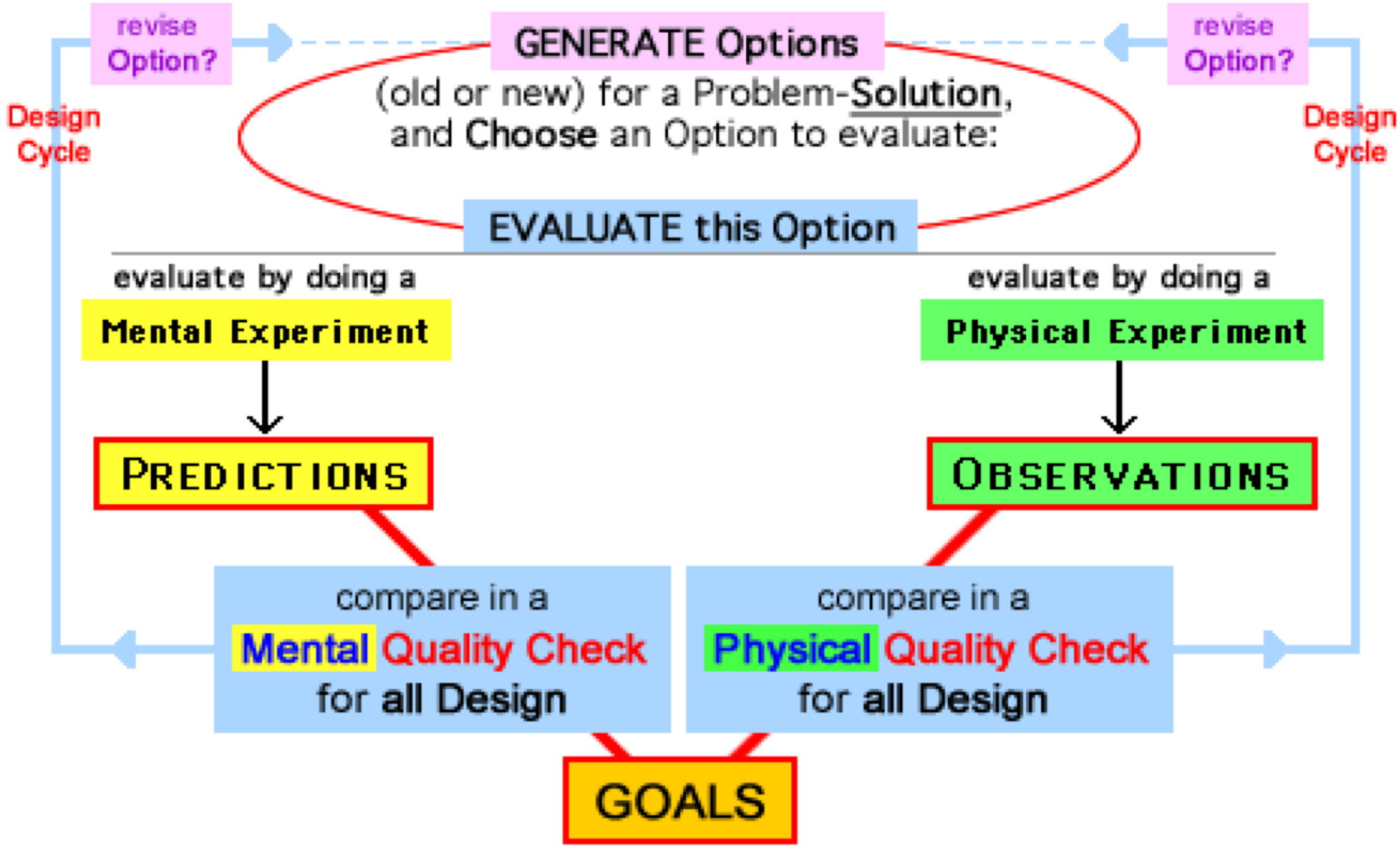
Many projects do involve both kinds of design,
and **eventually** you'll understand **the whole** of
how the two kinds of design productively interact.

But it will be easier to reach this "eventually"
if we **temporarily** look at only the **parts**
that are being used if we're doing either
only **SCIENCE**-Design or only **GENERAL** Design**.**


Learn more, for accurate-and-thorough understanding with empathy,
Define your Objective, Define your GOALS (for a Solution or Model),
revise Option?
GENERATE Options
(old or new, for a Solution or Model)
and CHOOSE an Option so you can
EVALUATE this Option
revise Option?
Design Cycle
Design Cycle
DESIGN and DO a
Mental Experiment
by imagining, to make
(using Model + Logic)
use RC
revise Model?
Science Cycle
DESIGN and DO a
Physical Experiment
by actualizing, to make
(using OBSRVN-detectors)
use by comparing in a
REALITY CHECK
PREDICTIONS
OBSERVATIONS
use QC
use by comparing in a
Predictions-Based
QUALITY CHECK
use by comparing in an
Observations-Based
QUALITY CHECK
use QC
GOALS



you **compare Predictions with Observations,** so you can
ask The Science Question: "am I surprised?"
because (**oops**) something is wrong with
my **THEORY** (about how the world works) **so revise Theory?**
or my **PREDICTIONS** (my Process-of-Predicting),
the **OBSERVATIONS** (re: Process, Instruments,...),
the **EXPERIMENT** (understanding of Situation? or ...).


revise Option?
GENERATE Options
(old or new) for a Problem-Solution,
and Choose an Option to evaluate:
revise Option?
Design Cycle
Design Cycle
EVALUATE this Option
evaluate by doing a
Mental Experiment
evaluate by doing a
Physical Experiment
PREDICTIONS
OBSERVATIONS
compare in a
Mental Quality Check
for all Design
compare in a
Physical Quality Check
for all Design
GOALS

Quality Checks = asking **The Design Question**

How?

you **compare GOALS** with **PREDICTIONS** or **OBSERVATIONS**

so you can ask

THE Design Question (e.g. THE **Engineering Question**):
"**How close is the match?**" when you compare
what you **will get** if **This Option.** (**Predicted** Characteristics)
what you **want** in a **Problem-Solution.** (**Desired** Characteristics)
your **Predictions** versus your **Goals**

How do you define Quality?

In a **Quality Check,**
IF there **is** a **close match**
of Predictions with Goals,
This Option has **high Quality,**
with **Quality defined by your Goals,**
so **This Option** might be a good **Solution.**

How do you define Quality?

In a **Quality Check,**
IF there **is** a **close match**
of Predictions with Goals,

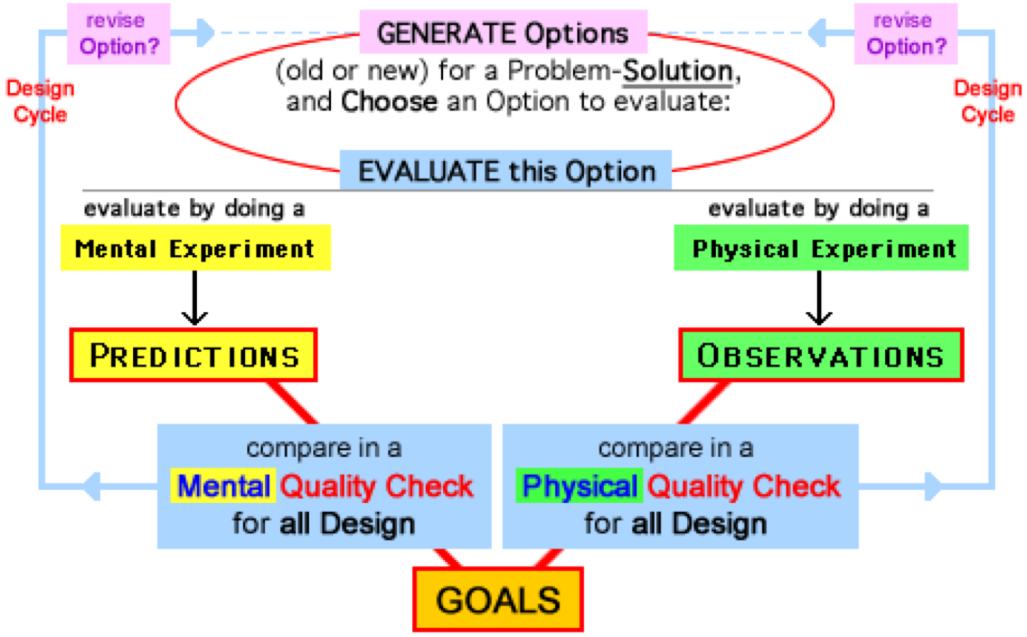
This Option might be a good **Solution.**

But what can you do
if there **is not** a **close match?**

You can ask
"**should I revise This Option?**"

IF **there is not a close match** between Predictions and Goals,
ask "What are **the mis-matches?** what are **the causes?**"
and "**How can I revise This Option** to **get a closer match?**"

a Cycle of Design
can be **first Generate** and **then Evaluate,**
and also **first Evaluate** and **then Generate.**



GUIDED GENERATION

uses productive interactions between
Critical Thinking and **Creative Thinking**
so you are being productively
Critical-and-Creative.

in **a critical-and-creative process of Guided Generation**
your **critical Evaluation** of **the Old Option**
stimulates and **guides**
your **creative Generation** of **a revised New Option**.

stimulates – revising **is motivated** by "**I want a better match.**"
guides – revising **is guided** by "**how can I get a better match?**"

a **Quality Check** can use
Predictions or **Observations**:

We've looked at a **Predictions-Based Quality Check**, and
you also can do an **Observations-Based Quality Check**
to ask **THE Design Question** by comparing
what you **did get** what you **want**
with **This Option.** in a **Problem-Solution.**
(**Observed** Characteristics) (**Desired** Characteristics)
your **Observations** versus your **Goals**

a **Quality Check** can use
Predictions or **Observations**:

Predictions-Based Quality Check compares **Predictions** with **Goals.**
Observations-Based Quality Check compares **Observations** with **Goals.**

{note: both Q-Checks are done mentally, so we don't do a Physical Q-Check.}

Action-Diagrams and Action-Decisions:

each **Actions-Diagram** shows **multiple actions** that occur
at different times during a process of problem solving.

each describes **the same Problem-Solving Process**, but...
with **different choices** (about the actions to include);
each is **useful** for describing PS-Process **in different ways,**
each is **useful** for education **in different ways.**

For every PS-Project the **sequence of actions** can be **different**,
because **making Action-Decisions** about "what to do next"
IS like a Hockey Player's flexible **goal-directed improvising**,
IS NOT like a Figure Skater's rigid **choreography**.

useful analogies? **Hockey Player** (**yes**), but ~~Figure Skater~~ (**no**).

Other Model-inventors agree with me in thinking that
we should avoid a "choreographed process"
because this isn't the way people typically solve problems.

But there are important differences between my Model and most other Models. Partly it's the length of the "sequences" used in my Model and their Model. My sequences are made from small elements, in a way that most Models don't use. This is described in depth **HERE** (and I recommend reading it) but I've constructed new analogies – described in the next two slides – that are useful when we're thinking about an essential difference between my Model and most other Models.

As explained in the previous slide, "my sequences are made from small elements" in a way that isn't used in other Models. Here are two useful analogies:

I use elements that are short-time actions; these typically are combined in sequences (that can be short or longer), sort of like ATOMS combining to form MOLECULES of different sizes. By contrast, the sequences in Other Models usually are much longer "phases," analogous to OBJECTS made of molecules.

But although I use short-term actions, they're composed of much shorter neurological actions that are analogous to sub-atomics like protons-neutrons-electrons, or quarks or strings.

Or... in addition to the "chemistry" analogy (in previous slide) with my ATOMS forming MOLECULES that in their phases form OBJECTS, we can think of my elements being like **LEGO Blocks,** and their phases are like **LEGO Objects** made from Blocks.

My Model and **Other Models:**
Cooperation, not Competition

My Model **with** Other Models,
not
My Model **versus** Other Models.

We should develop instruction to creatively combine different Models-for-Process, so **the combination is more effective than any single Model by itself.**

STRUCTURES + STRATEGIES
STRUCTURES (for Instruction) **+ STRATEGIES** (for Thinking)

My Model and Other Models:

We should develop instruction that combines different Models-for-Process creatively, so the combination is more effective for teaching ideas-and-skills. We want the Models to interact in ways that are synergistically supportive, that make the combination of Models better than any Model by itself.

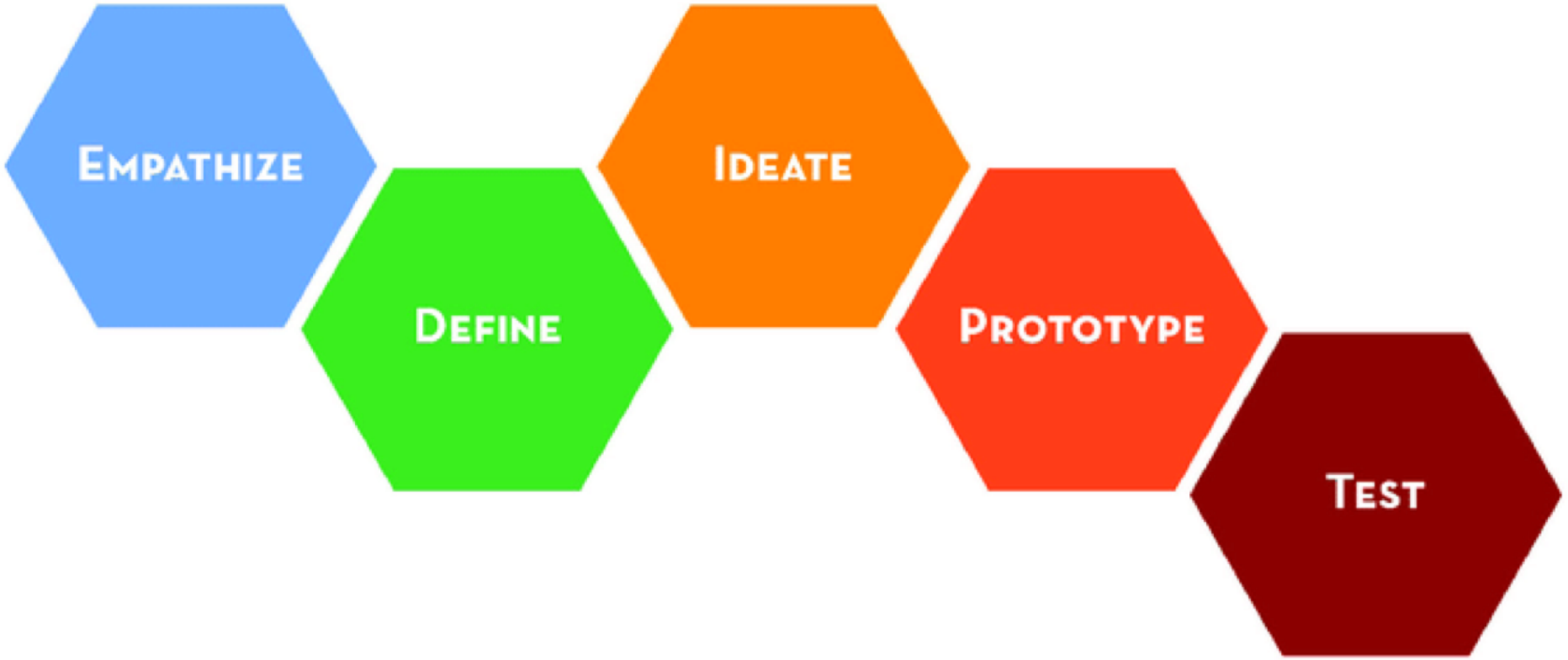
Structures and Strategies: Typically, a Model-for-Process is educationally useful by providing **structures** (for instruction) and **strategies** (for thinking). Each Model has structures & strategies, so each offers its own benefits for students. When we effectively combine the structures & strategies from two (or more) Models, we combine their benefits.

Using Model-Structures to provide Structure for Instruction:

Jeremy Utley, Director of Executive Education for Stanford's d.school, explains how their model [the next slide shows its 5 Modes] provides "a shared language and a shared approach" that can be "a useful scaffold to structure an experience for the purpose of learning."

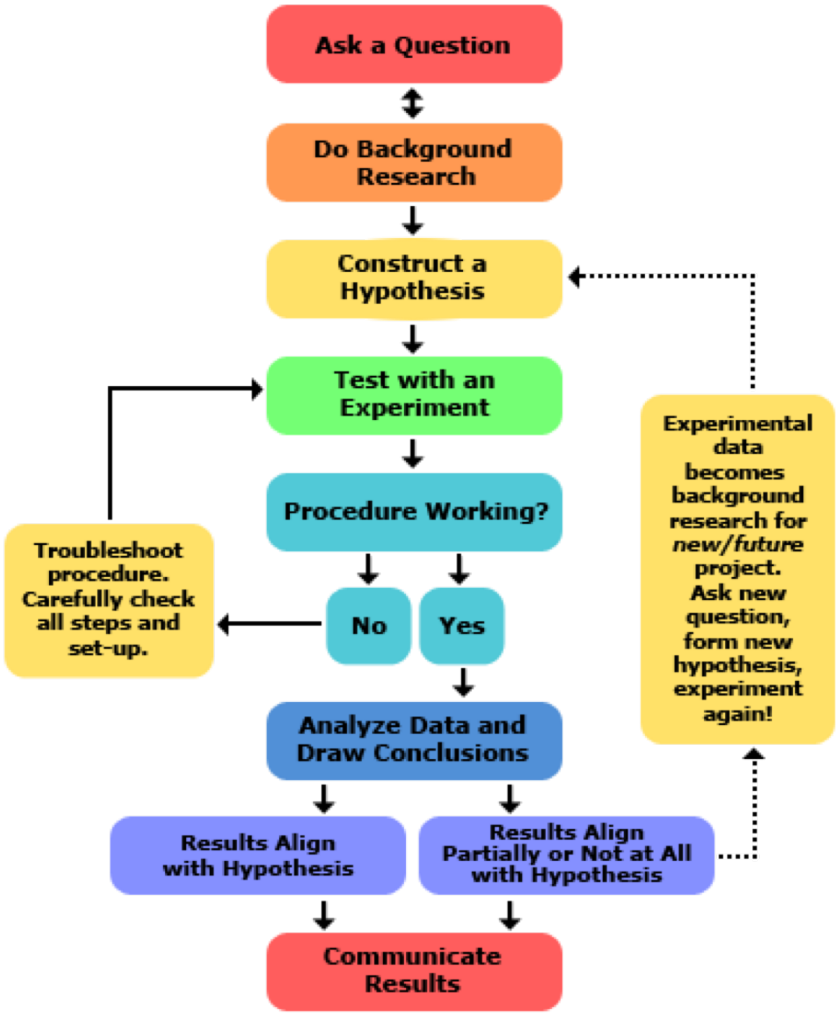
When students work in groups and everyone is thinking about the first *mode* (Empathize) in d.school's model, this whole-classroom focus makes it easier for a teacher to share ideas and guide students so they can use-and-understand the tools in this mode, so they will learn how to empathize more effectively using d.school's *mindset* of Focusing on Human Values. After awhile all students move on to the next mode (Define), and so on, in their "experience for the purpose of learning." And a teacher will use "the phases" with flexibility when it's useful.

d.school (of Stanford) uses these five **Modes**
(plus their **Methods** and **Mindsets**)
to "structure an experience for the purpose of learning."

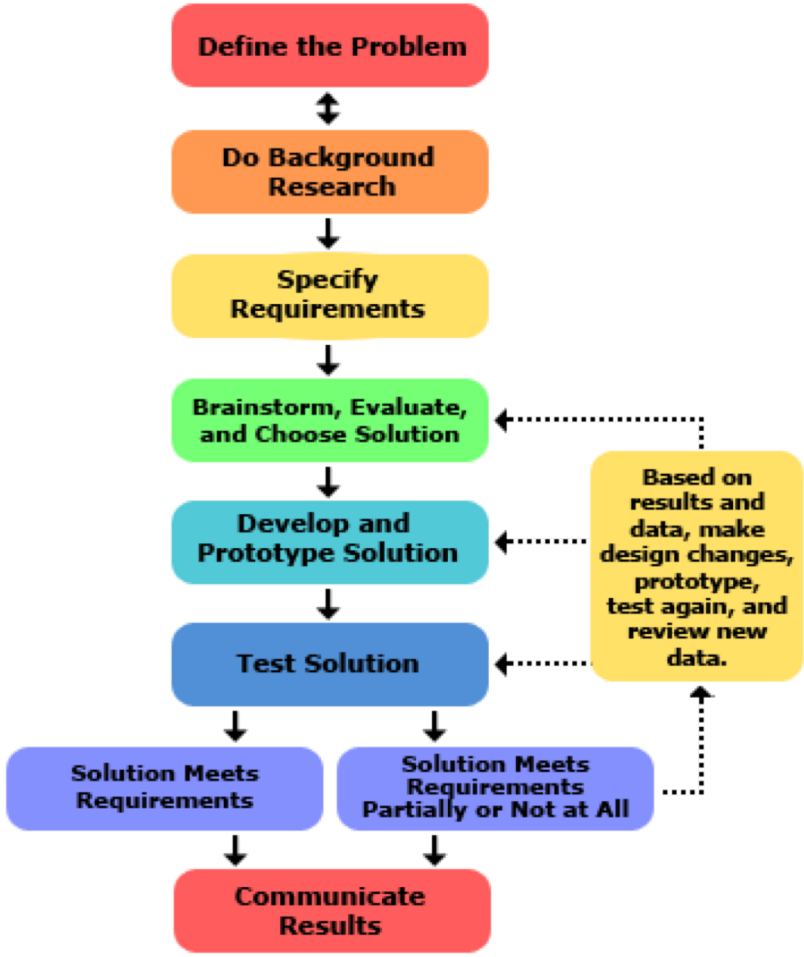


Science Buddies:

Scientific Method



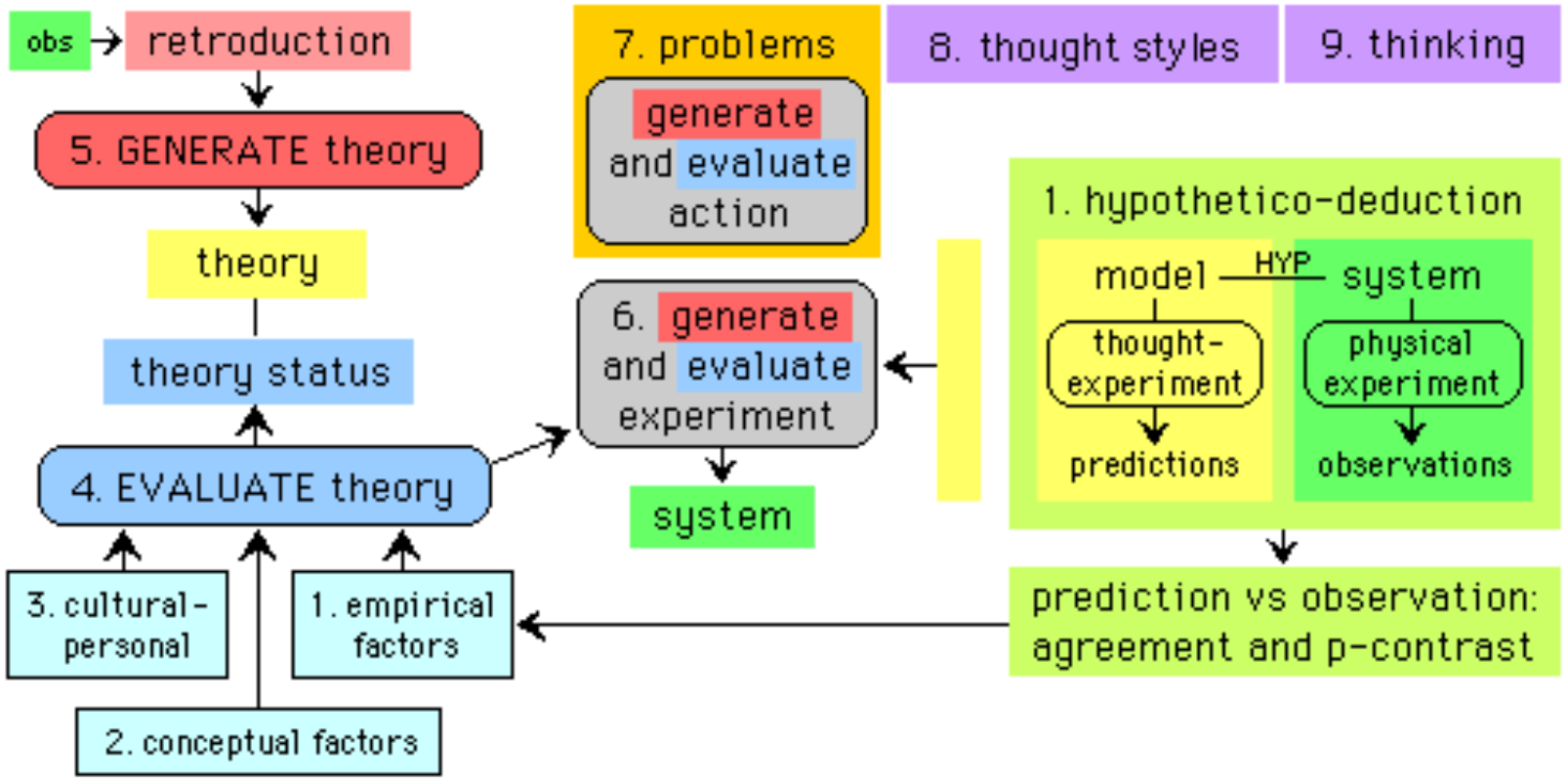
Engineering Design Method

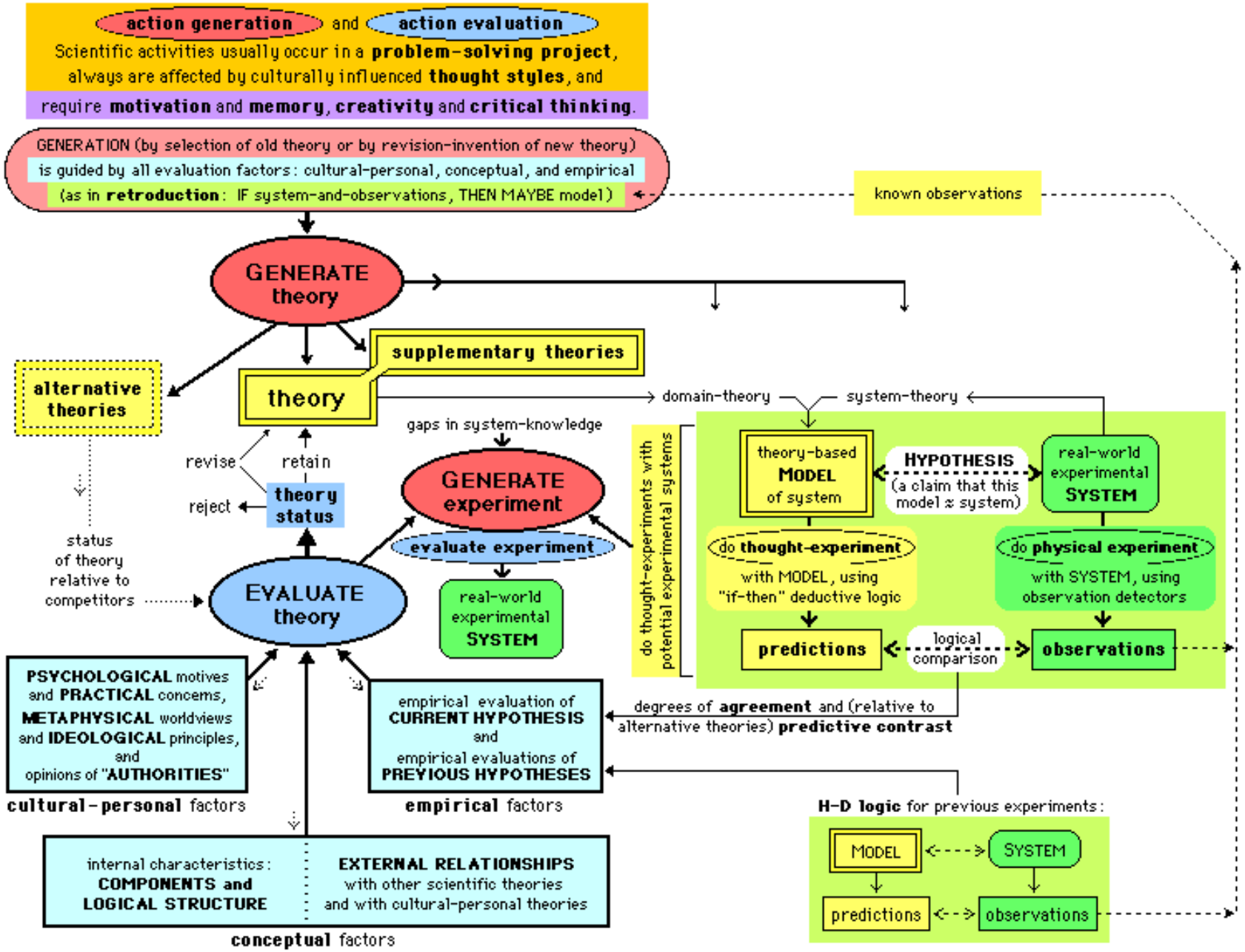


This a condensed mini-version of the model I developed for my PhD Dissertation.
The next slide has the full-detail version of the diagram I made for

Integrated Scientific Method

that is described (briefly & deeply) in **a collection of web-pages and word-documents.**




action generation and action evaluation
Scientific activities usually occur in a problem-solving project, always are affected by culturally influenced thought styles, and require motivation and memory, creativity and critical thinking.
GENERATION (by selection of old theory or by revision-invention of new theory) is guided by all evaluation factors: cultural-personal, conceptual, and empirical (as in retroduction: IF system-and-observations, THEN MAYBE model)
known observations
GENERATE theory
supplementary theories
theory
alternative theories
domain-theory
system-theory
gaps in system-knowledge
revise
retain
reject
theory status
GENERATE experiment
evaluate experiment
real-world experimental SYSTEM
status of theory relative to competitors
EVALUATE theory
do thought-experiments with potential experimental systems
theory-based MODEL of system
HYPOTHESIS (a claim that this model ≈ system)
real-world experimental SYSTEM
do thought-experiment with MODEL, using "if-then" deductive logic
do physical experiment with SYSTEM, using observation detectors
predictions
logical comparison
observations
degrees of agreement and (relative to alternative theories) predictive contrast
PSYCHOLOGICAL motives and PRACTICAL concerns, METAPHYSICAL worldviews and IDEOLOGICAL principles, and opinions of "AUTHORITIES"
cultural-personal factors
empirical evaluation of CURRENT HYPOTHESIS and empirical evaluations of PREVIOUS HYPOTHESES
empirical factors
H-D logic for previous experiments:
MODEL
SYSTEM
predictions
observations
internal characteristics: COMPONENTS and LOGICAL STRUCTURE
EXTERNAL RELATIONSHIPS with other scientific theories and with cultural-personal theories
conceptual factors

Maybe the next two slides were not necessary.
I made them because I was embarrassed
about having TMI-per-slide on many slides,
so I wanted to minimize "the damage" if
people were distracted by reading the TMI.
And I wanted to apologize, saying "I knew better
than to use PowerPoint in this way, but did it anyway."

a tip for multi-tasking:

DON'T DO IT .

(i.e. don't **TRY** to do it – because **we cannot do it**)

("**multi**" really **shifts back-and-forth,** therefore **lose a lot**)

TIMINGS for Single-Tasking:

during the seminar, **LISTEN.**

after the seminar, **READ,**

EducationForProblemSolving.net/eed/

or

use LINKS in my bio: OSU-EED Seminar Page

Using PowerPoint Effectively:

When I began developing this PowerPoint, one of my goals was to **avoid TMI-per-Slide,** but... **I didn't achieve this goal,** and many slides do have Too Much Information.

{ reasons to avoid TMI with Ppt – because humans cannot "multi"task – are explained in **an excellent summary of research-about-Ppt**. }

Therefore, because people are limited in how we multi-task (instead of "multi" we shift back-and-forth between different mental tasks, so it isn't really "multi") I urge you to focus on what I'm saying — without trying to get all information from a slide — so you can understand better with high-quality thinking in this one mode. Then if you want, later you can use this PowerPoint for a review of the many ideas.

This PowerPoint will end on the next slide,
by describing Pros & Cons of providing Lots of Information,
which is USEFUL in some ways, but NON-USEFUL in other ways.

TMI – Pros and Cons:

My making-of-slides (with many having TMI) has its
CONS because **TMI can distract listeners** during the seminar
IF they try to multitask (poorly) by **listening-AND-reading,** and
PROS because **Too Much Information can be useful now,**
when you're reading this after the seminar, because
This Information helps explain the ideas (filling the gaps now
that were filled during the seminar with info I gave by talking.

But...
if you want to deeply understand (and I hope you will),
I recommend reading the Introductory Overview
(including its Short Overview) in my edu-homepage,
as explained **near the beginning of this PowerPoint.**