GEOFF MATHEWS, P&A

PROJECT DESIGN AND MENTORING TACTICS

THANKS TO:

Vernadette Gonzales, UHM Honors

Kathy Cooksey, UH Hilo

Christoph Baranec, IfA

and plenty of other people whose ears I've bent on this topic the past few months

DRAWING ON MATERIAL FROM:

Severson 2010

Wiggins & McTigh, Learning by Design

Wisconsin Center for Mentoring Excellence

UCSC Institute for Scientist and Engineer Educators

Yale Summer Institutes on Scientific Teaching

WHAT WILL WE ACCOMPLISH TODAY?

- Generate and classify project ideas
- Outline one potential project, and list content, practice, and attitude learning goals
- Plan initial training
- Organize regular interactions

WHAT WILL YOU NEED TO DO LATER?

- fill in lots of blanks!

LEVELS OF UNDERGRADUATE MENTORING

1. entering freshman
2. sophomores and juniors
3. senior project
4. other

- What level are you considering?

TRAITS OF EFFECTIVE MENTORING

- Foster ownership
- Teach the practice of explaining
- Opportunities for recognition
- Formative assessment of progress
- Make norms of STEM culture accessible

from ISEE 14 year report, Metevier et al., 2015

GENERATE IDEAS FOR A POTENTIAL PROJECT

- Thinking through how you would carry out a project sets the stage for planning how to help a student plan and carry out a project

DEFINE THE PARAMETER SPACE

Think on your own for a minute:

- summarize your area of research expertise
- what are the big questions of your field?
- what are focused, investigable questions?

Share with a partner. Ask each other clarifying questions.

slide courtesy of Kathy Cooksey (UH Hilo), from IfA colloquium March 29, 2017

Research vs Traineeship

LIGO

VALPO

- Authentic investigation
- Autonomy
- Self-directed

- Authentic-feeling
- Guided
- Facilitated

- Both serve improve content knowledge and process skills
- Design for one can be modified for other
  - As well for labs

See Hawai`i/NASA Space Grant Consortium Fellowships *and* Traineeships

COSMOS Variable Stars Project (off my homepage)

Also see *Learning from Inquiry in Practice*, ASPCS, 436, 381

TYPES OF UNDERGRADUATE PROJECTS

1. traineeship - teach a specific skill or process
2. research - student practices judgement with feedback

- What type are you considering?

OUTLINE A PROJECT

Think on your own for a minute, and describe a project that would contribute to answering one of your focused questions by:

- designing and / or building a tool
- making measurements and finding patterns
- making a model
- comparing data to models

Share with a partner. Ask each other clarifying questions.

NO BATTLE PLAN SURVIVES CONTACT WITH THE ENEMY. – HELMUTH VON MOLTKE

PLANS ARE WORTHLESS, BUT PLANNING IS EVERYTHING. – DWIGHT D. EISENHOWER

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ADAPTING THE PLANNING SHEET TO A STUDENT INTERVIEW

1. Think on your own for a minute: how would you adapt this worksheet to help with initial meetings with a student?

2. Share your ideas with a partner.

3. Share with the whole workshop.

Using ① in mentoring

- ask student to interpret Figure
- can student make Figure?
- tutorials needed
  in writing! → student notes
- talk through the full project
  ↳ Frame specific project in context
- research ask what sounds interesting?
  ↳ goals, why research?, expectations

BACKWARDS DESIGN

- start at the end
- work backwards to the beginning
- identify key concepts and skills

Wiggins & McTigh, 1998, Learning by Design

Goals

Content

What observations do we use to select AGN?

intuition for noise + measurement error

research vs. content (types) knowledge)

+ chronist — theoretical concepts...

Redshift + cosmic time

Limitations of observational data

Magnitudes (astronomy)

Process

follow literature trail
"feed" numbers
plot • vs y + label
error bars
EM - fundamentals
Note taking / log work
Create and follow/adapt Research plan
Finding where/how to find relevant sources (studies)
Data manipulation
Communicating/orally presenting the findings
Write computer programs → calculations, make plots
Describe their work clearly
Find resources other than advisor

Attitude

"I don't know" is ok

Grit

Responsibility

Expect to grow

Curiosity

Growth Mindset

It's OK to Make Mistakes

be critical of own & others' work

self-confident in research

self-efficacy

motivation to conduct to research

simulate to test

adapt goals to reality

WHAT WOULD A FINISHED PROJECT LOOK LIKE?

- necessary knowledge?
- student would be able to do…?
- attitudes?

KEY STEPS IN THE PROJECT

- intermediate products?
- triage points?
- decision points (i.e., what kind of analysis would be best to pursue)?

ADAPTING THE PLANNING SHEET TO A STUDENT MEETING

1. Think on your own for a minute: how could you adapt this worksheet to help with initial and weekly meetings with a student?

2. Share your ideas with a partner.

3. Share with the whole workshop.

Using (2) in mentoring

- Start w/ goal, see steps to get there
- timeline
- weekly - do backwards design
  goals → steps
- goals will shift, revisit big picture
- understand why goals change!
- weekly reflection

WHAT DO STUDENTS NEED TO GET STARTED?

- knowledge needed?
- be able to do?
- attitudes needed?

TUTORIAL

step-by-step practice of a key skill

3) Inspect the data. There are some things to notice:
   A) Three "sheets" of data – M80, M54, and NGC 1851 (the tabs at the bottom of the screen). This activity uses the data on M80.
   B) Each star has been given an ID number (in this case, 1 through 500)
   C) Each star has a listed brightness in **blue** (the column F450W) and in **red** (F814W). IMPORTANT: when using magnitudes (mags) a higher number indicates a fainter star, and a value of "-99" here means it was too faint to be detected

HR diagram data WORKING.xls

	A	B	C	D	E	F	G	H	I
1	ID number	F450W (mags)	F814W (mags)						
2	1	18.887	17.514						
3	2	20.982	20.227						
4	3	21.933	20.858						
5	4	-99	-99						
6	5	-99	-99						
7	6	-99	-99						
8	7	-99	-99						
9	8	-99	-99						
10	9	23.244	22.059						
11	10	-99	-99						
12	11	24.223	22.74						
13	12	-99	-99						
14	13	-99	-99						
15	14	24.381	22.927						
16	15	-99	-99						
17	16	-99	23.355						
18	17	-99	-99						

M80 M54 NGC1851

Look at the first 20 stars on the list.

How many were detected in both blue and red light?

How many were seen in neither?

How many stars were seen in just red light?

OUTLINE A TRAINING TASK

1. Work on this on your own

2. Share your outline with a partner. Ask each other questions to help break down steps into discrete steps that could be conveyed with a sample line of code, screenshot, etc.

A good initial task is one that:

- can be broken down into a series of concrete steps
- includes many places where the student can self-check their progress
- has many points where changes could be made to achieve different outcomes (e.g., take a median rather than a mean)

Features to include in a tutorial

- screenshot

- task with space to write/show output → email this output to me
  "are your values between X & Y?" → here's what you should get
- example commands, canned input → example output ← how would you change this to get X or Y?
  ↳ diagnose system problems and UI problems
- concept map to assess student understanding
- list of relevant resources for additional reading on aspects of the task → helps students expand beyond tutorial
- imperfect example → assess curiosity, interest, self-motivation
- point out that specific tool is one example of a class
- explore some options and explain why (i.e. context)

MENTORING PRACTICES

- big picture organization
- weekly practices
- awareness of, and strategies for avoiding, pitfalls

MAKE A TIMELINE WITH YOUR STUDENT

- Final product
- Draft of final product
- Benchmark: components of final product
- Decision / triage points

REGULAR COMMUNICATIONS

- Pre-meeting report of tasks done, attempted efforts, and next steps
- Inclusion in research group meetings
- Check efforts against timeline, periodically adjust timeline
- Have student email meeting notes after each meeting

SOCIAL CHALLENGES

- Imposter syndrome
- Stereotype threat
- Implicit bias

- Growth mindset
- Affirmation exercises
- Awareness of stereotype threat
- Awareness of implicit bias

GETTING INVOLVED WITH MENTORING UNDERGRADUATES

- X99 courses
- Capstone research courses (e.g., ASTR 494, HON 495)
- Undergraduate Research Opportunities Program / Space Grant / Associated Students of UH / SEED grants
- NSF REU Supplements
- Fund students as part of Broader Impacts