Data Analysis and Interpretation:

(aka Research Practices)

A Mainland Internship Short Course Activity

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Mainland Short Course Goals

1. **Create a sense of community among the interns that will carry over throughout their summer internship experience.**
2. **Give interns an introduction to research environments and research practices.**
3. **Expose interns to various scientific content, emphasizing the research areas of the CfAO. (optics, astronomy, vision science, engineering)**
4. **Give interns an understanding of the CfAO's structure and their role in it.**

Our Motivation for this Activity

Mainland Short Course Goal #2:

Give interns an introduction to research environments and research practices.

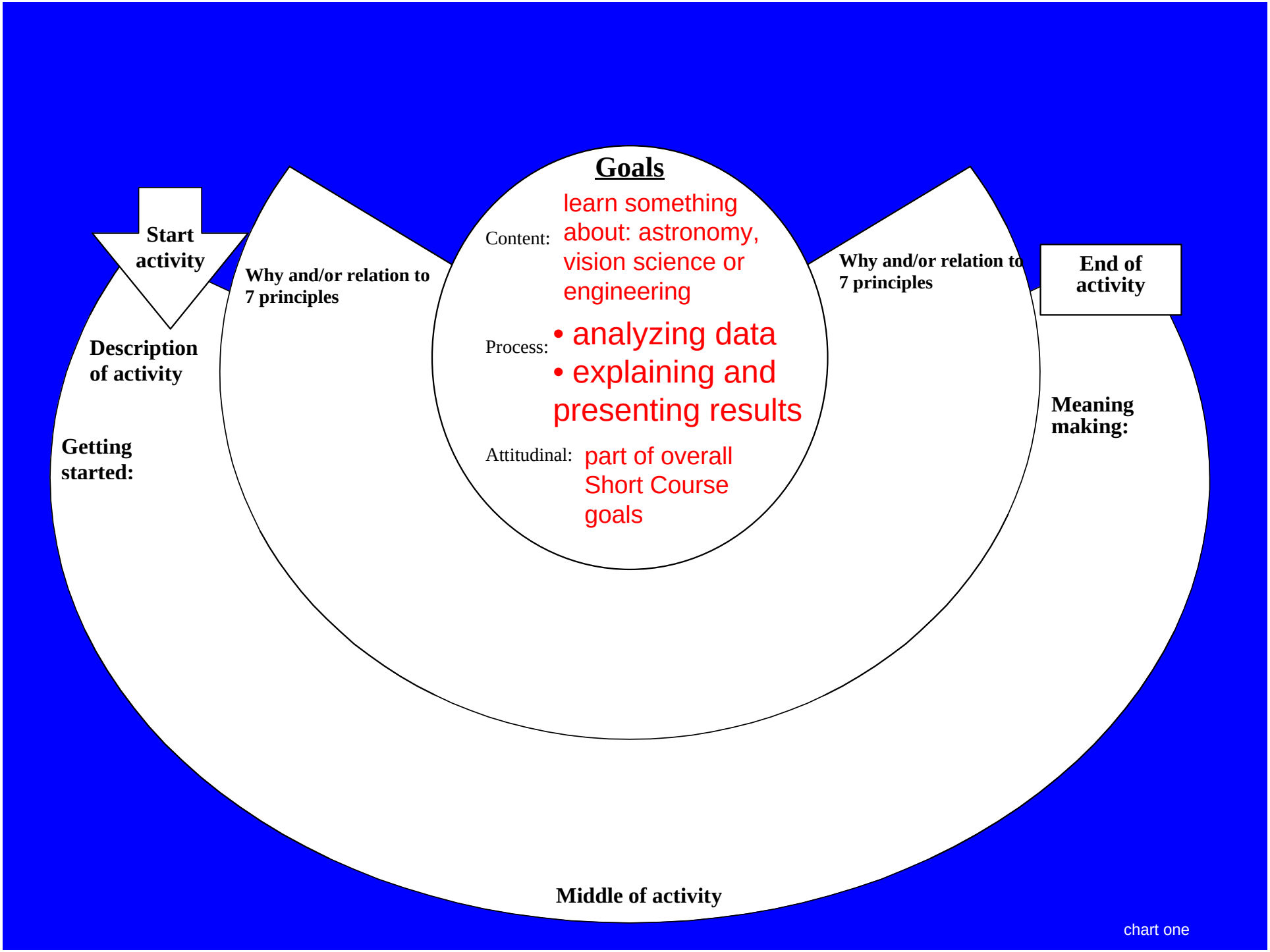
Research Practices: asking questions, formulating hypotheses, setting up experiments, analyzing data, explaining and presenting results (visually and orally)

Research Practices = Scientific Inquiry Skills

Our Motivation (cont.)

- several types of activities in the Short Course schedule: full inquiry (color, light and spectra), “speed” inquiry (retinal anatomy) as well as other labs, discussions, lectures, field trips, etc
- most of these activities address various elements of the scientific inquiry skills in Goal #2, as well as content goals (Goal #3: scientific content of the CfAO)

The activity formerly known as “Research Practices” (aka “Data Analysis and Interpretation”) focuses on analyzing data and explaining and presenting results.


Start activity
Why and/or relation to 7 principles
Goals
Content:
learn something about: astronomy, vision science or engineering
Process:
• analyzing data
• explaining and presenting results
Attitudinal:
part of overall Short Course goals
Why and/or relation to 7 principles
End of activity
Description of activity
Meaning making:
Getting started:
Middle of activity
chart one

Brief description of our design

- wanted an activity that would get them working with data and thinking about how to analyze and interpret it and then present it to others
- possible direct analog to what many would do during their internship: collect data of some sort, make sense of it and then present it at a group meeting or to an advisor
- may **not** have firm grounding in content behind their data (especially at beginning of summer)

Thinking about how to teach skills….

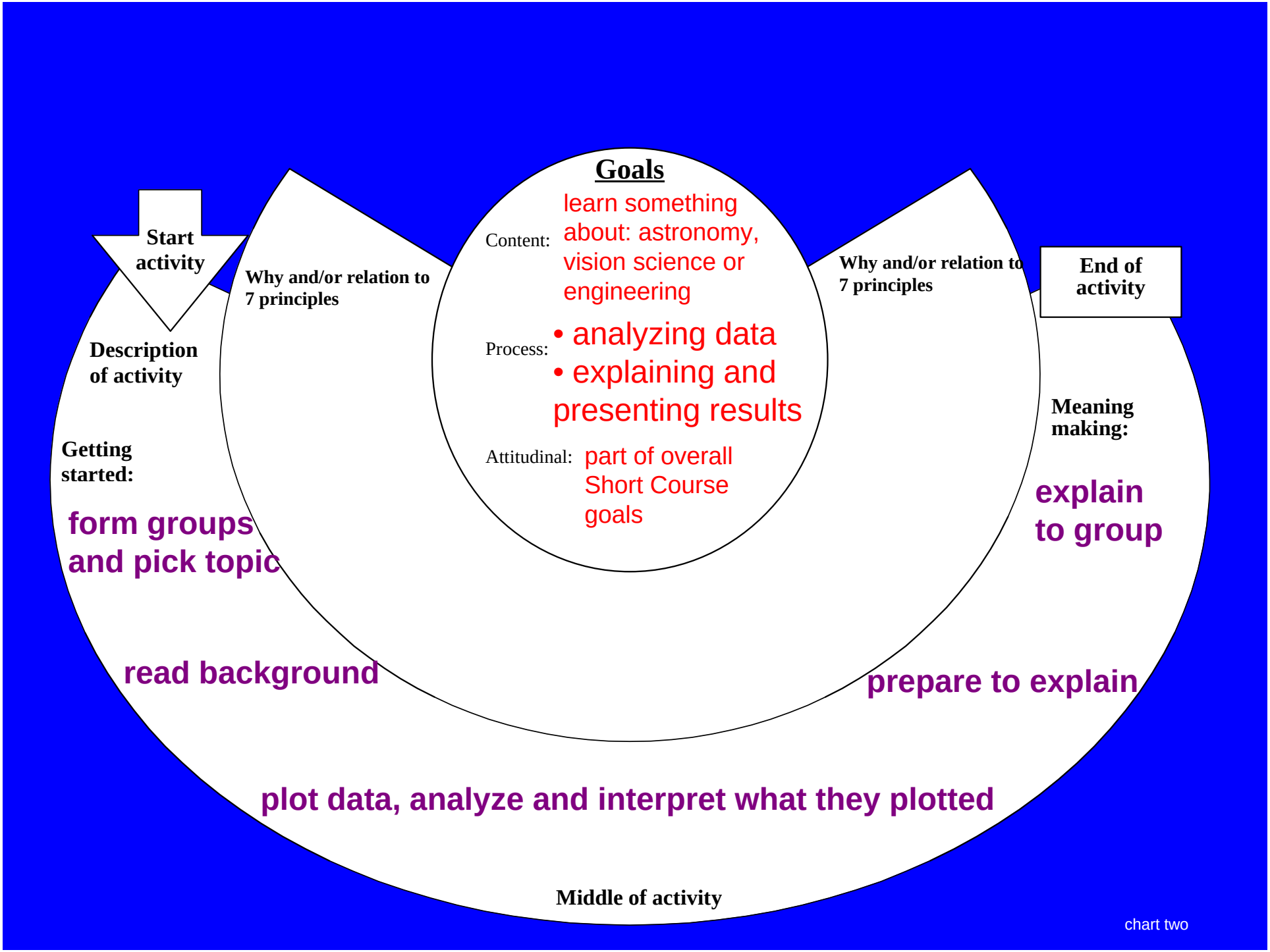
- Teaching skills (or process), not content was our goal.
- Question: How did we learn “research practices” or “inquiry skills” or how to “do science”? Labs, internships, discussions with older students?
- Wanted an activity that would be relevant to what they may do in the internship (authentic)….*had a sense* that it would be more useful to them and it would “stick” better if it were directly applicable.
- Now: We know our “hunch” is actually grounded in learning theory:

Principle 6: Situated Learning - The practices and activities in which people engage while learning shape what is learned.

but we’ll get back to that….

Brief description of our design (cont.)

- had 2-2.5 hours for the activity
- created 9 different topics: 1-2 engineering, 2 vision science, 5-6 astro/physics
- worked in groups of 2-3 students
- instructors served as facilitators (assisting but also probing students' reasoning)


Start activity
Description of activity
Getting started:
form groups and pick topic
Why and/or relation to 7 principles
read background
Goals
Content: learn something about: astronomy, vision science or engineering
Process: • analyzing data • explaining and presenting results
Attitudinal: part of overall Short Course goals
Why and/or relation to 7 principles
prepare to explain
plot data, analyze and interpret what they plotted
Middle of activity
End of activity
Meaning making:
explain to group
chart two

Example: Hubble's Law

Hubble's Law: Galaxy Distances

1. Introduction and Background

During our lecture on Tuesday, Shelley talked about the expansion of the universe. To remind you, Edwin Hubble discovered that the universe is expanding and the farther away a galaxy is, the faster it is moving away from us. This is known as Hubble's Law.

Astronomers can measure how fast an object is traveling away from or towards us by looking at the spectrum of the galaxy. Recall the sodium light from yesterday's inquiry; the sodium light spectrum showed emission lines. Galaxies also can have emission lines that come from the stars and gas inside of them. When a galaxy is moving away from us, those absorption lines appear to be shifted to a longer wavelength. (This is due to the Doppler Shift.)

Astronomers can measure the distance to *some* galaxies using a number of methods. However, it is very difficult to measure the distance to most galaxies. Hubble measured velocities for galaxies that he knew the distance to and noticed that the two were related. This was a great discovery! Measuring the velocity of galaxy is fairly easy (just look at its spectrum) and now we can use the velocity to determine the distance.

Plot the data in Table 1 and see if you can determine the relationship between velocity and distance. (Just leave the units as they are and plot the two quantities against each other.) What form does the plot take? What type of relationship is this? Can you write an equation to describe this plot? If you were given the velocity of a new galaxy, could you determine the distance to it?

Table 1: Selected Bright Galaxies

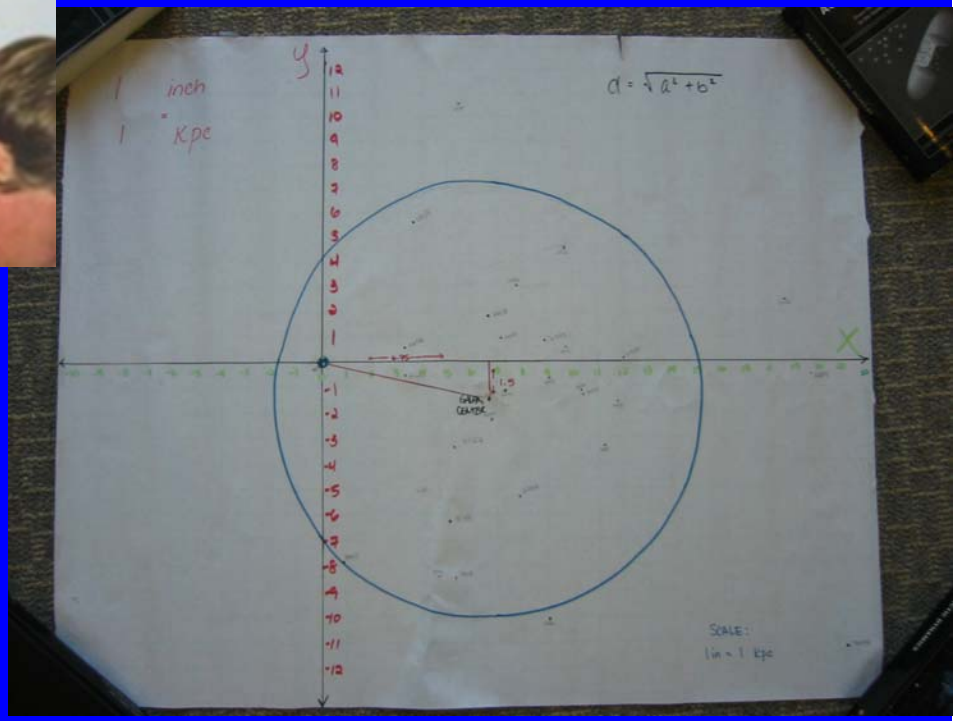
Galaxy Name	Distance (Megaparsecs)	Radial Velocity (km/s)
Fornax A	30	1713
Messier 66	12	593
Messier 106	10	520
NGC 4449	5	250
Messier 87	22	1136
Messier 104	17	873
Messier 64	7	350
Messier 63	11	550
NGC 6744	13	663

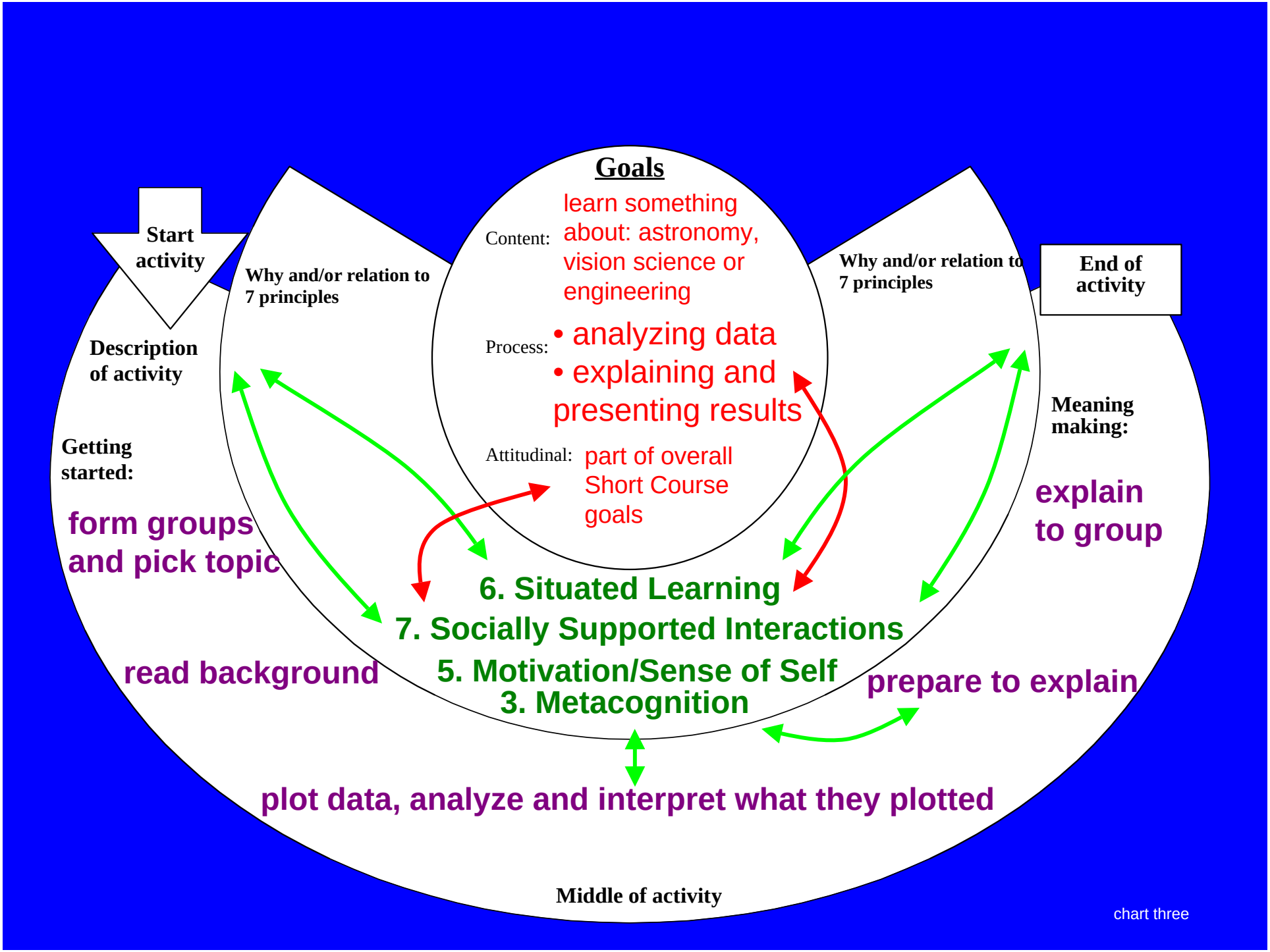
Background Information

Questions to answer

Data

More Pictures




Start activity
Description of activity
Getting started:
form groups and pick topic
Why and/or relation to 7 principles
Goals
Content: learn something about: astronomy, vision science or engineering
Process: • analyzing data • explaining and presenting results
Attitudinal: part of overall Short Course goals
6. Situated Learning
7. Socially Supported Interactions
5. Motivation/Sense of Self
3. Metacognition
read background
plot data, analyze and interpret what they plotted
Why and/or relation to 7 principles
Meaning making:
explain to group
prepare to explain
End of activity
Middle of activity
chart three

Future Improvements?

Always revisiting activities to make improvements or changes as we learn more:

- make metacognitive strategies more explicit so students will learn to ask the questions of themselves
- incorporate more process skills: add a writing component? "heckle" more? (more questioning like an advisor might)
- there are probably many more improvements…but **overall, we think it's been a effective activity**