

Vision Science Inquiries: Optics of the Eye & Retinal Anatomy



Jason Porter, Lana Nagy

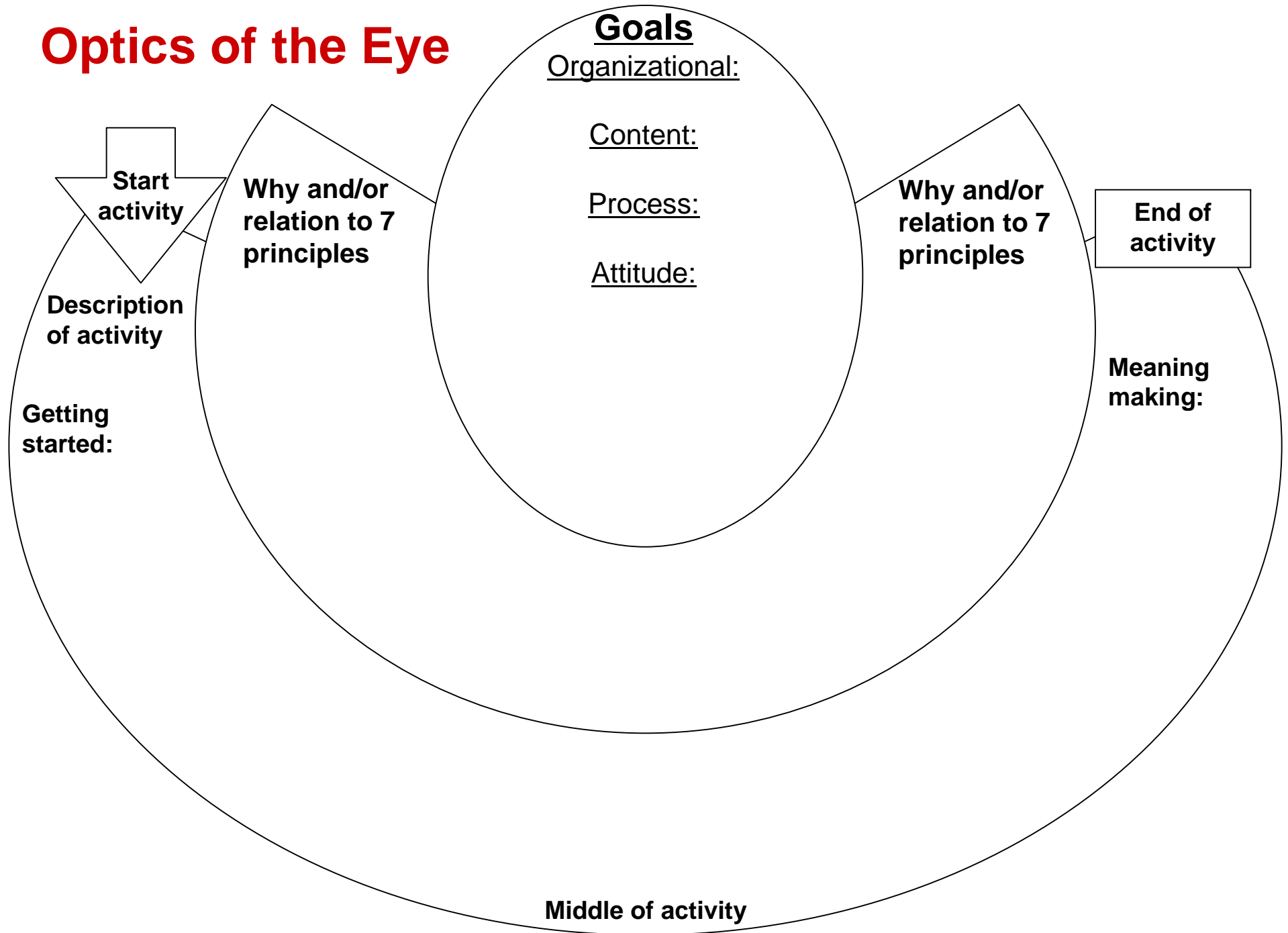
Joe Carroll, Jessica Wolfing, Dan Gray, Julianna Lin, David R. Williams

March 2005

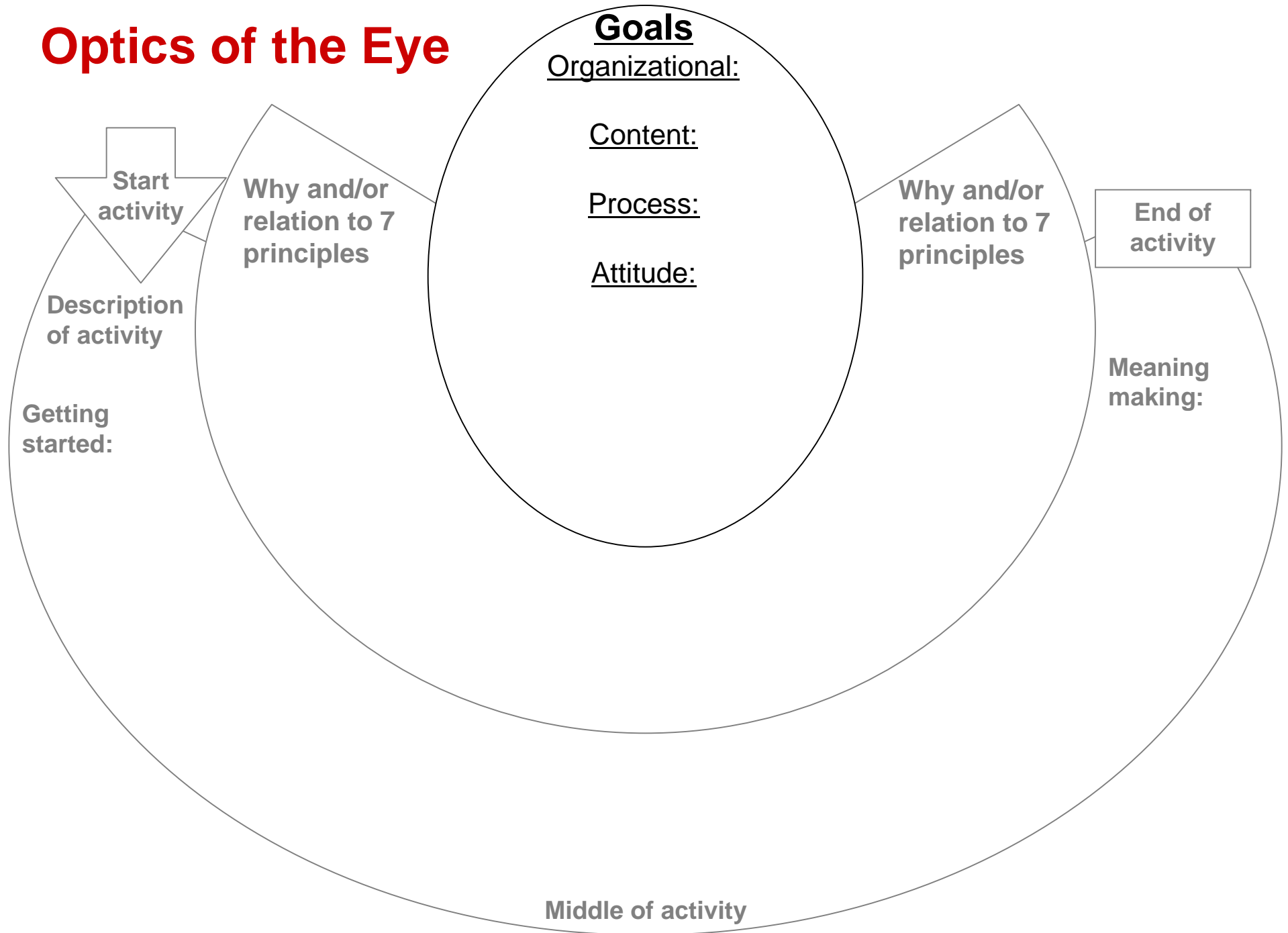
**Center for Visual Science
The Department of Biomedical Engineering
The Institute of Optics
University of Rochester**

Center for Adaptive Optics

Optics of the Eye



Optics of the Eye



Optics of the Eye

- **Began planning/design at the 2003 PDW**
- **2004 Target Audience: Community college students in engineering/sciences**
- **2005 Target Audience: Undergraduate students in in engineering/sciences**
- **Developed and facilitated 5 Vision Science Inquiries:**
 - Tested on subgroup before implementing with students
 - 2 based on color vision
 - 3 based on optics of eye

Goals

Organizational:

- Design and facilitate new vision science inquiries for future outreach
- Recruit students to apply for Mainland Internship program
- Recruit students to apply for graduate school in engineering/sciences
- Connect with minority serving institutions in Rochester area

Content (tiered):

- Image inverted on retina
- Causes/correction of near-/farsightedness
- Lens changes shape to focus on objects at different distances (accommodation)

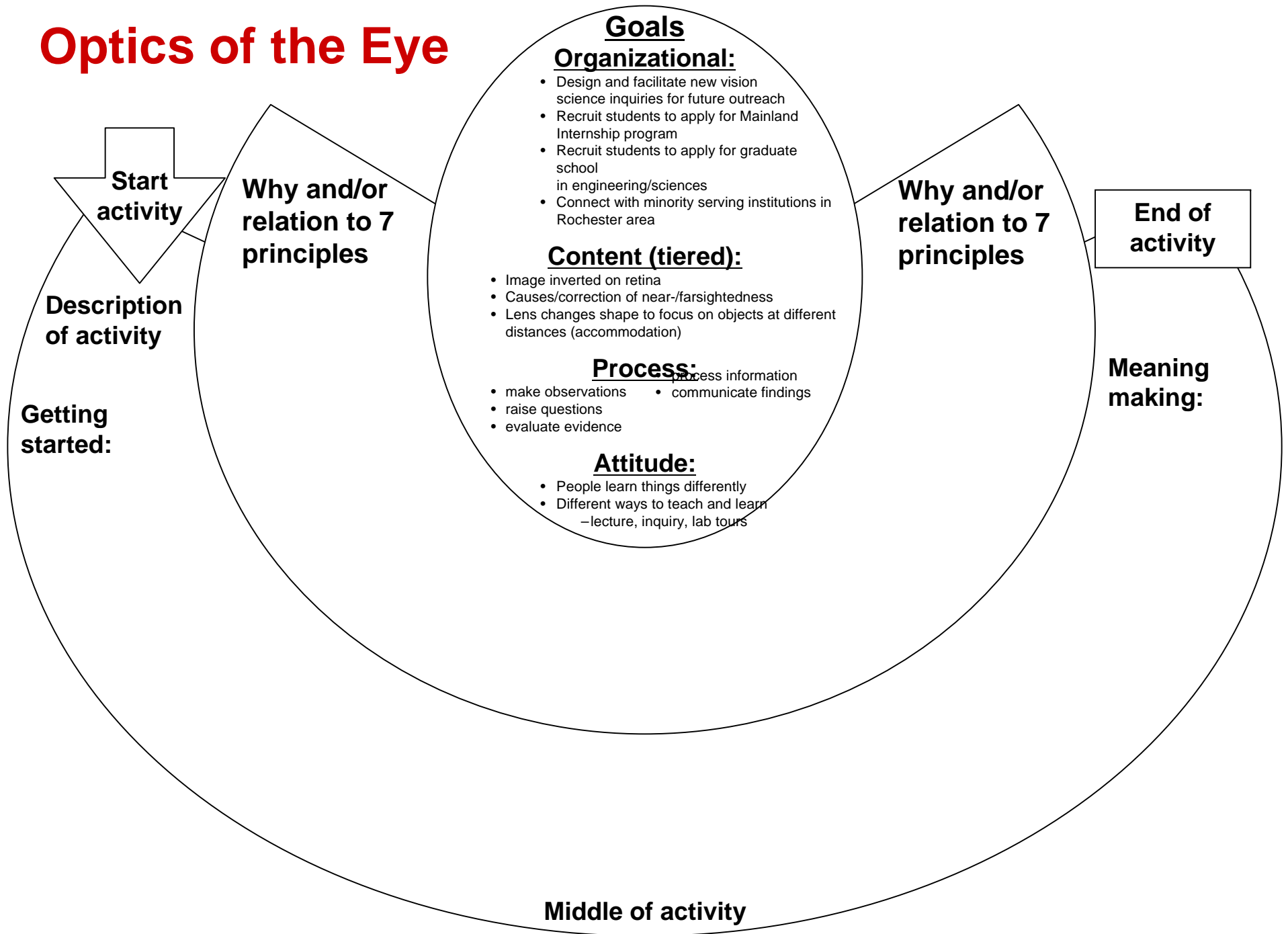
Process:

- make observations
- raise questions
- evaluate evidence
- process information
- communicate findings

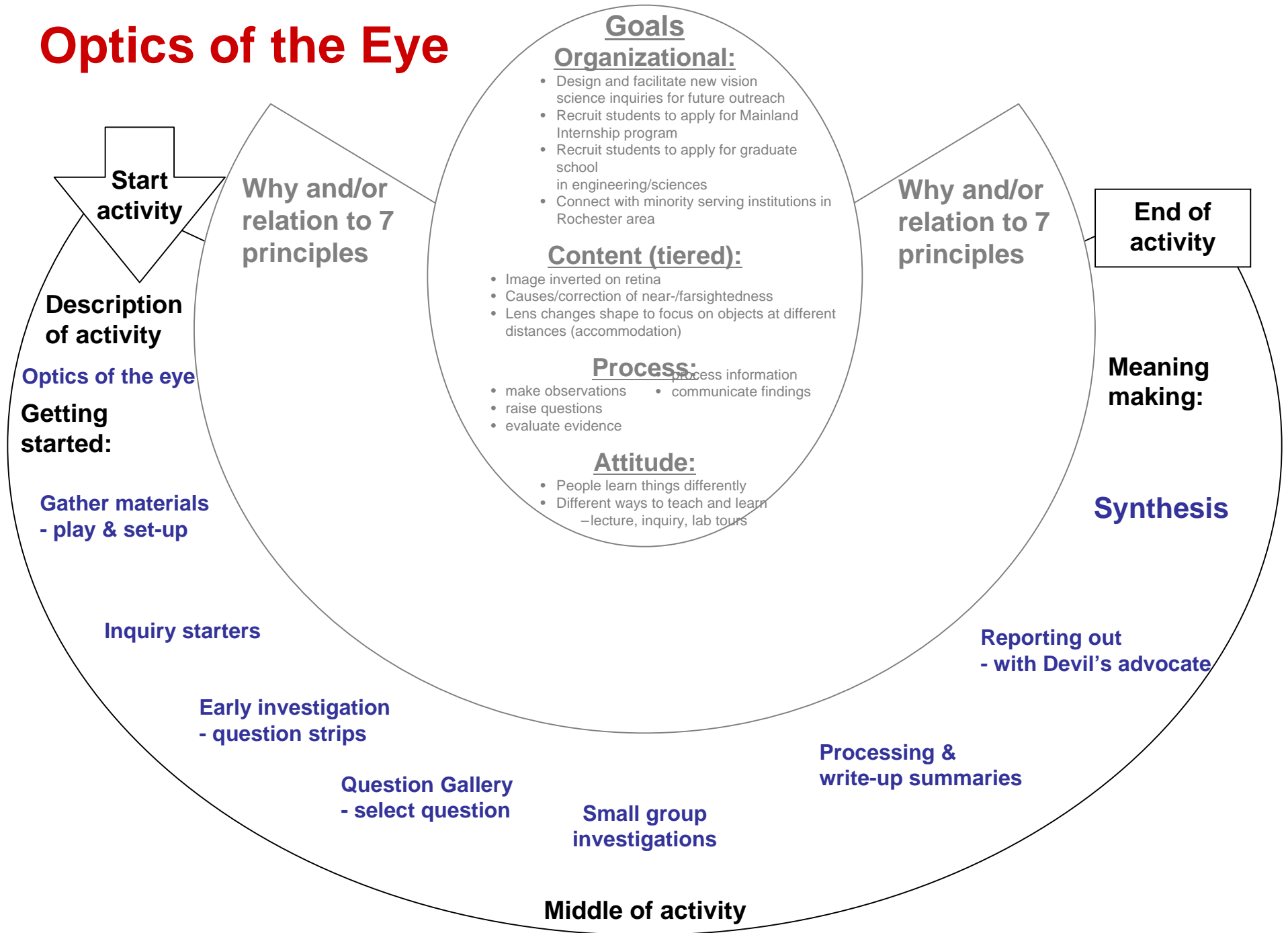
Attitude:

- People learn things differently
- Different ways to teach and learn
 - lecture, inquiry, lab tours

Optics of the Eye



Optics of the Eye



Optics of the Eye

Schedule

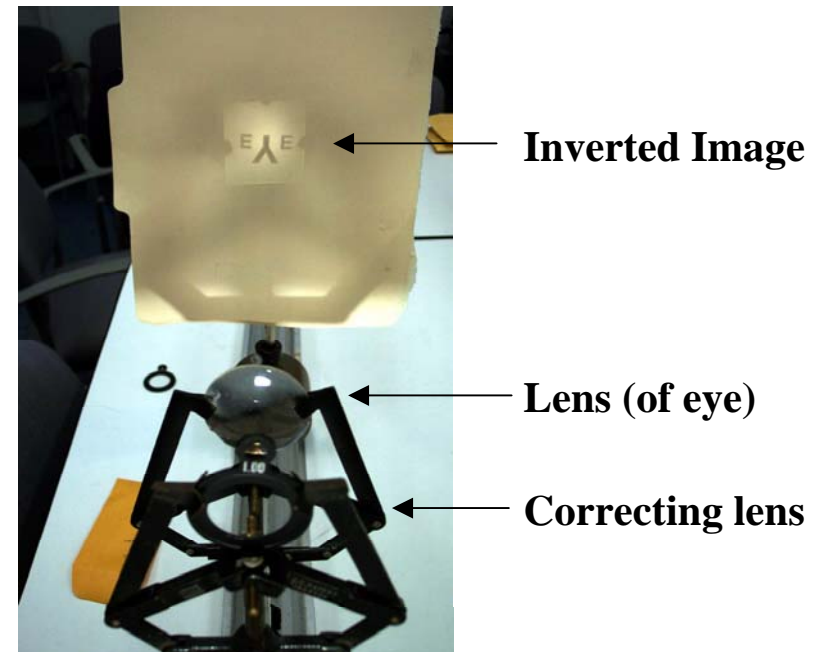
Introductions, welcome, setting the stage for inquiry	30 min
Inquiry starters/Preliminary investigations/Development of questions	40 min
Break/Questions are sorted	20 min
Full inquiry exploration	2 h 45 min
Lunch (working lunch if students desire)	1 h
Inquiry student presentations and synthesis	1 h
Break	15 min
Research talk - Vision research with AO	30 min
Lab tour of 2nd generation AO system	25 min
CfAO Presentation - Internship Opportunities	20 min
Wrap-up, Survey and thank-yous	30 min
TOTAL TIME	8 h 15 min



Optics of the Eye Starters

Image Inversion and Axial Length Errors:

- Optical rails were set-up with an object (a transparency with a picture on it), a lens (lens/cornea), and an image plane (retina).
- 3 rails for emmetropic (no correction), myopic (nearsighted), and hyperopic (farsighted) eyes.
- Myopic and hyperopic eyes also had a secondary set of lenses used to correct for their refractive error.
- Learners were shown all three cases and how certain lenses sharpened or blurred the image.

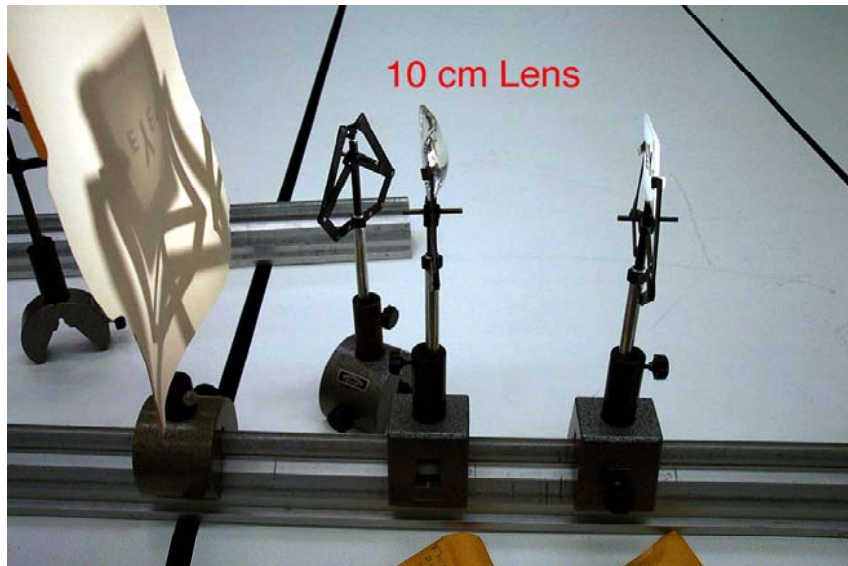




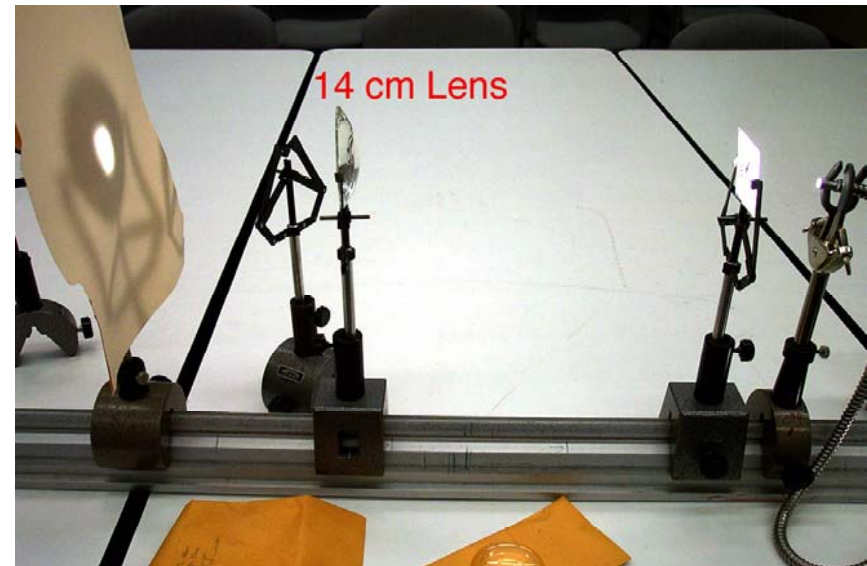
Optics of the Eye Starters

Accommodation:

- Learners read an eye chart from near and far distances - noted could read to same line at both locations.
- Moved to optical rail - Image in focus for near object, but moved object further away and the image was out of focus.
- Changed the lens in the set-up - Image in focus for distant object, but moved object closer and the image was out of focus.



Near Object



Distant Object



Initial Exploration and Questions

- **Learners explored the phenomena and formulated questions.**



- **A short break was given – questions sorted and students interacted socially.**
- **Learners picked questions that interested them and formed groups for in-depth investigation.**
- **Facilitators offered possible ideas (when asked) or suggestions when needed to build momentum.**



Group Exploration

Observed that one group was struggling a bit in the beginning.

- **Chose an advanced question - didn't fully understand the basics needed to answer their original question.**
- **Made the group step back to explore some of the basic properties of lenses and provide some possible directions.**
- **After understanding underlying concepts, learners moved forward in their investigation of the original question, but never fully got there.**
- **Learners were NOT disappointed they did not fully answer original question.**
 - **Were happy they had better understanding of other topics they could report out on.**

**Providing a thinking tool -
poking holes in foil**





Group Exploration

One group had an optics related question that turned into a psychophysics investigation.

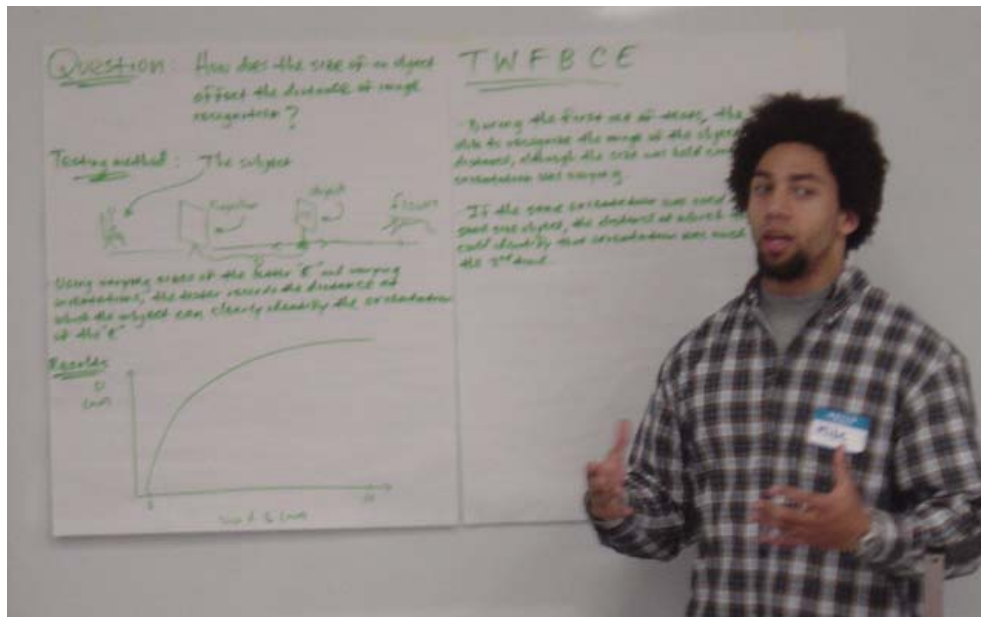
- **Didn't want to stifle their creativity, but also didn't want them to pursue a path we might not be prepared to investigate (materials, etc.).**
- **Let them explore to see how things would unfold.**
 - **Learning process for learners and facilitators.**
- **Facilitators had difficulty guiding in unfamiliar territory, and didn't know if we were properly guiding them to a correct conclusion until the end.**





Sharing out with 'Devil's Advocate'

- Learners shared the conclusions that they came to, even if they weren't for the same question that they started with.
- The group that was wandering down an unexpected path came to the right conclusion
 - Devil's advocates challenged their understanding
- Learners enjoyed hearing about what each group learned





Synthesis

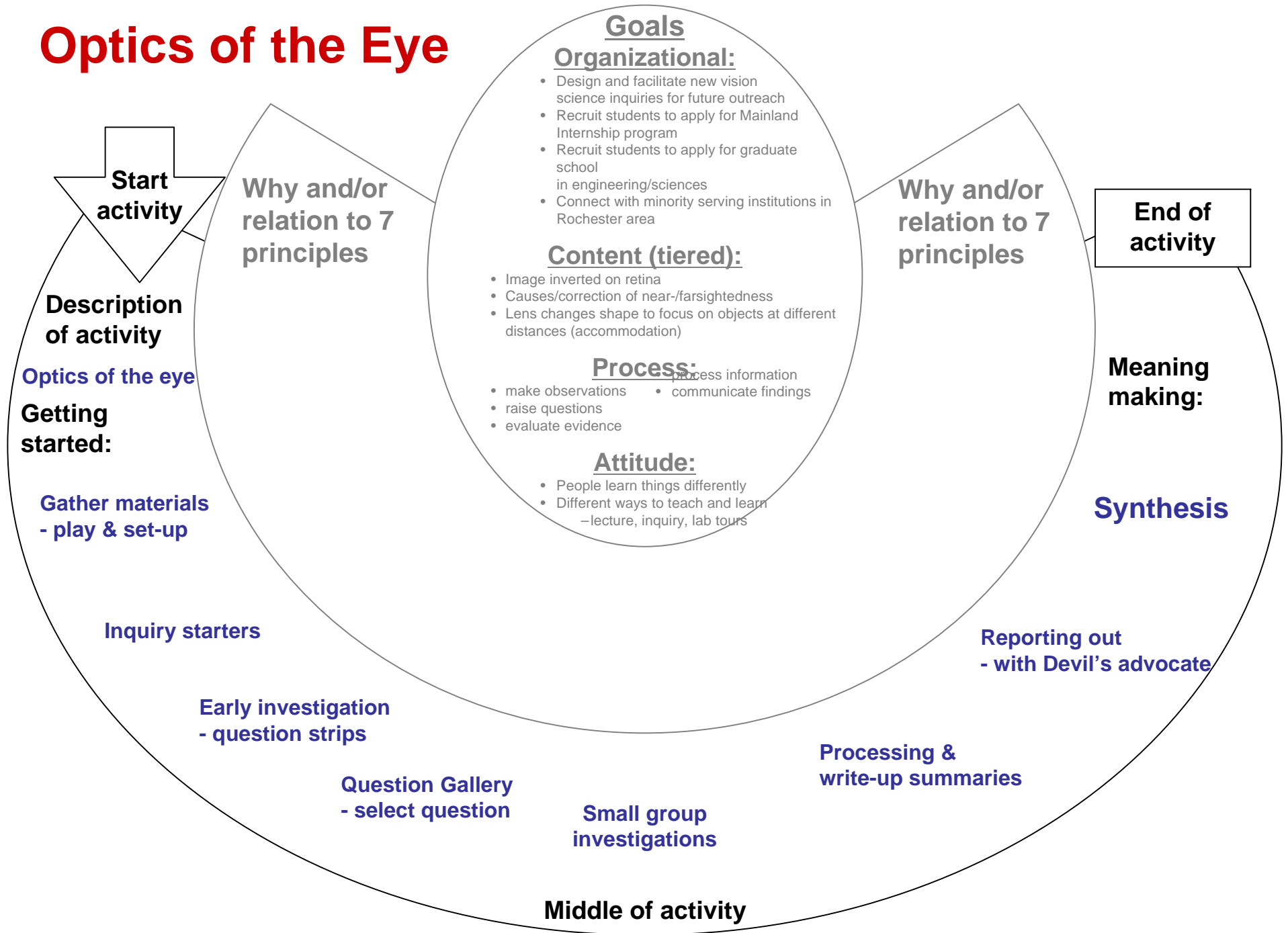
- Our concept goals were explained and the learners observations were included to reinforce their findings.
 - Acknowledgement was given to all groups.
 - Facilitators learned something new about facilitation.
-
- Learners stated that the synthesis was a *very* important tool to help bring all of the concepts together.



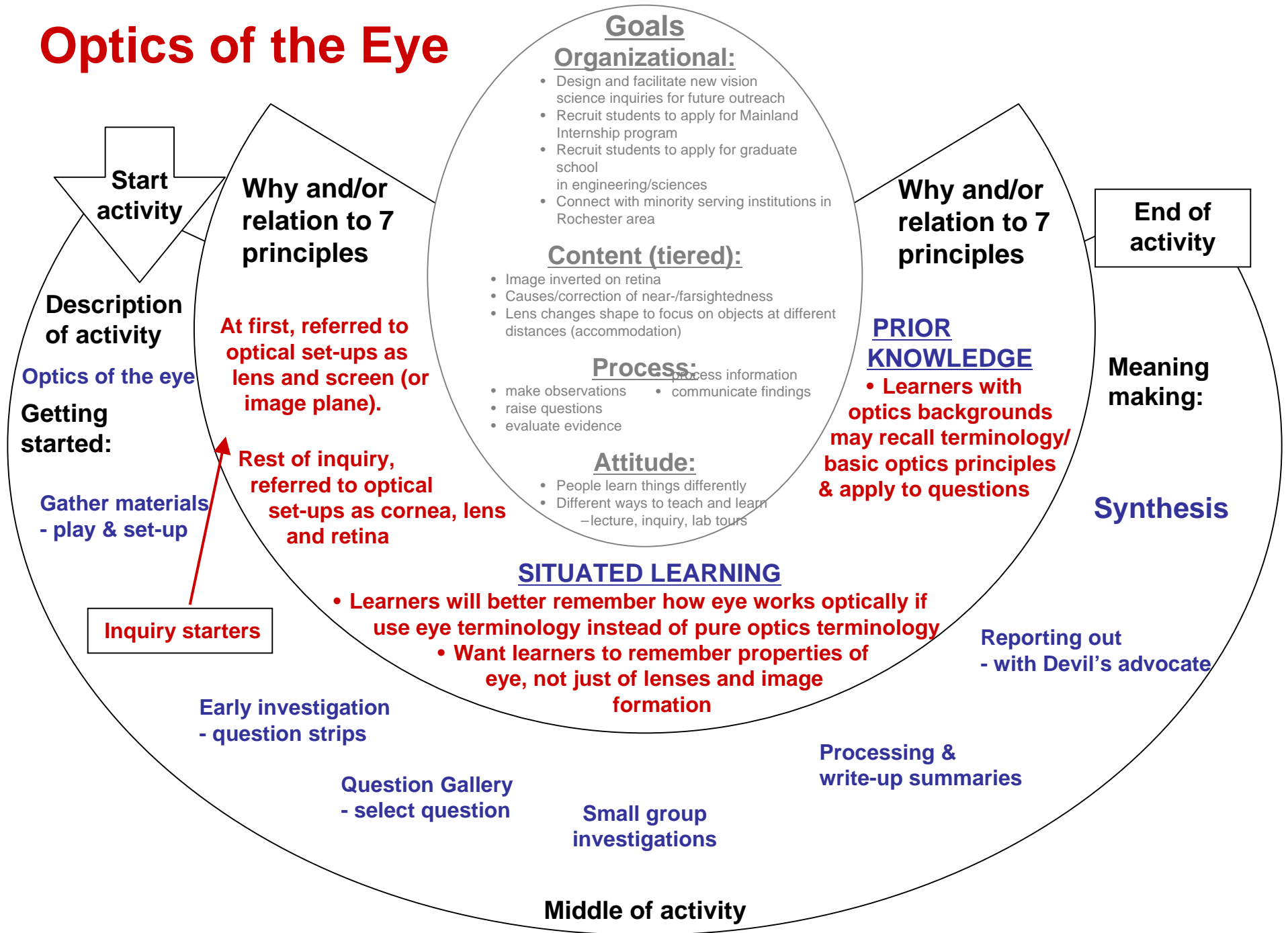
Optics of the Eye

***Connecting Theory
and Practice***

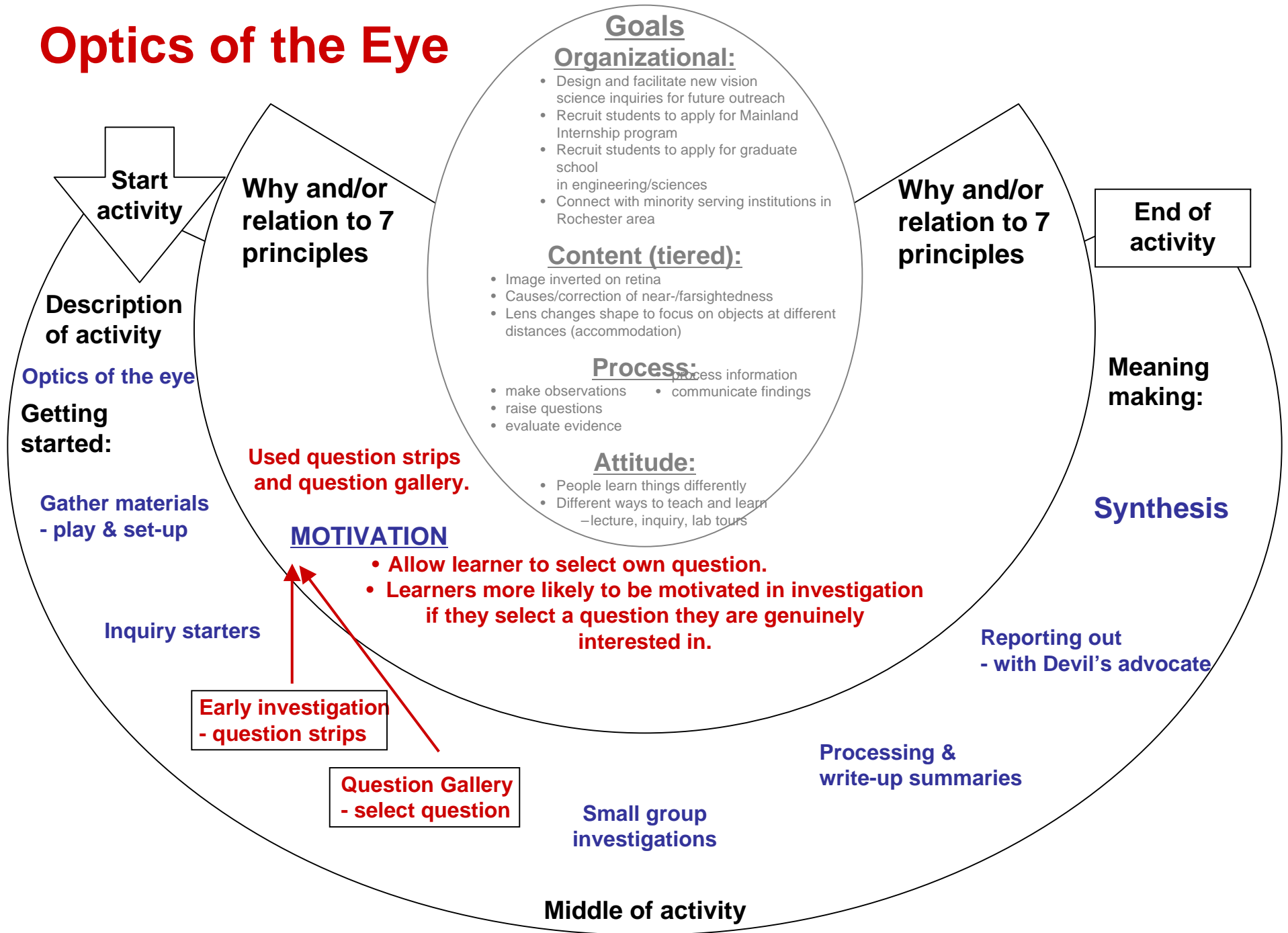
Optics of the Eye



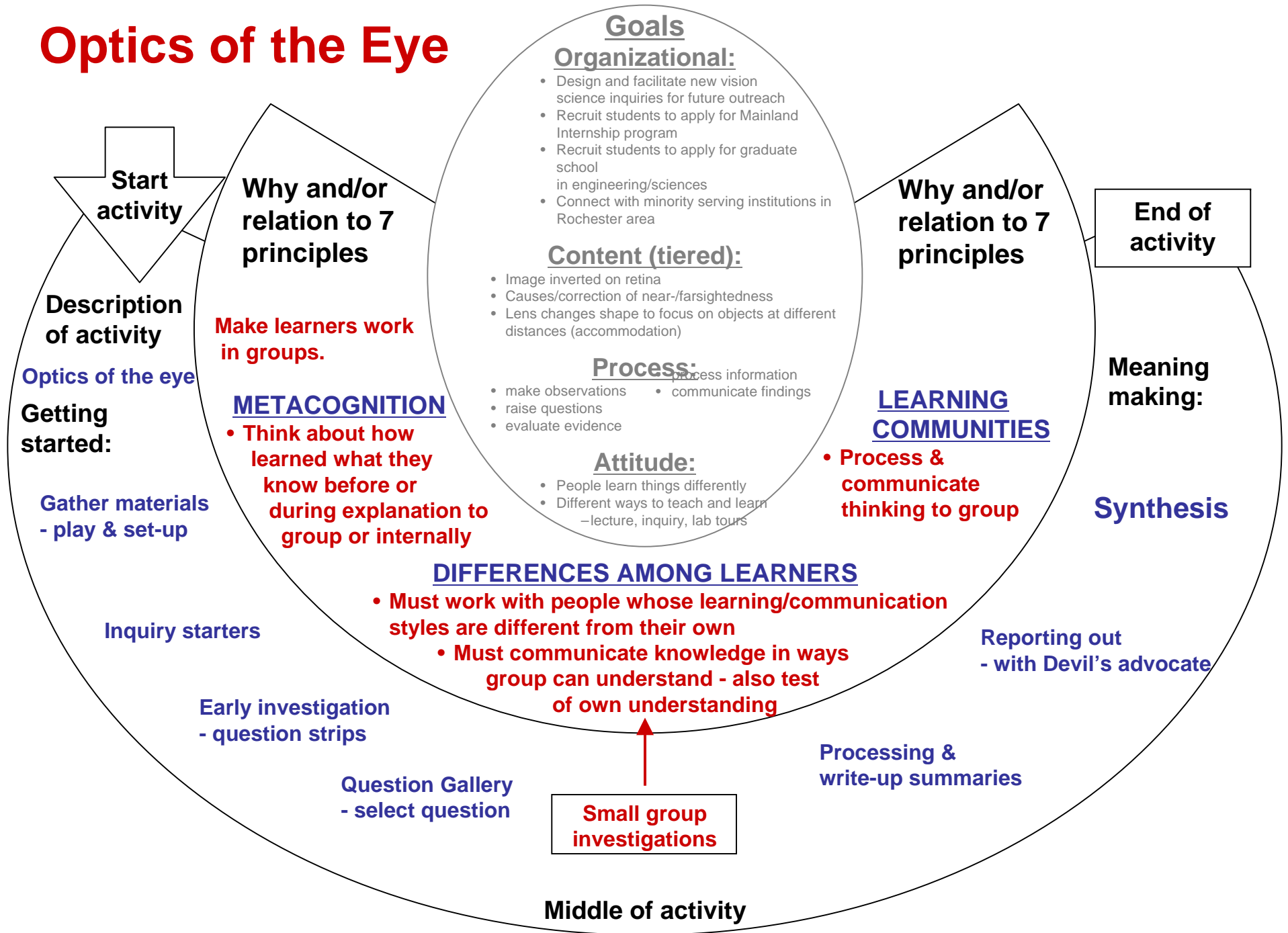
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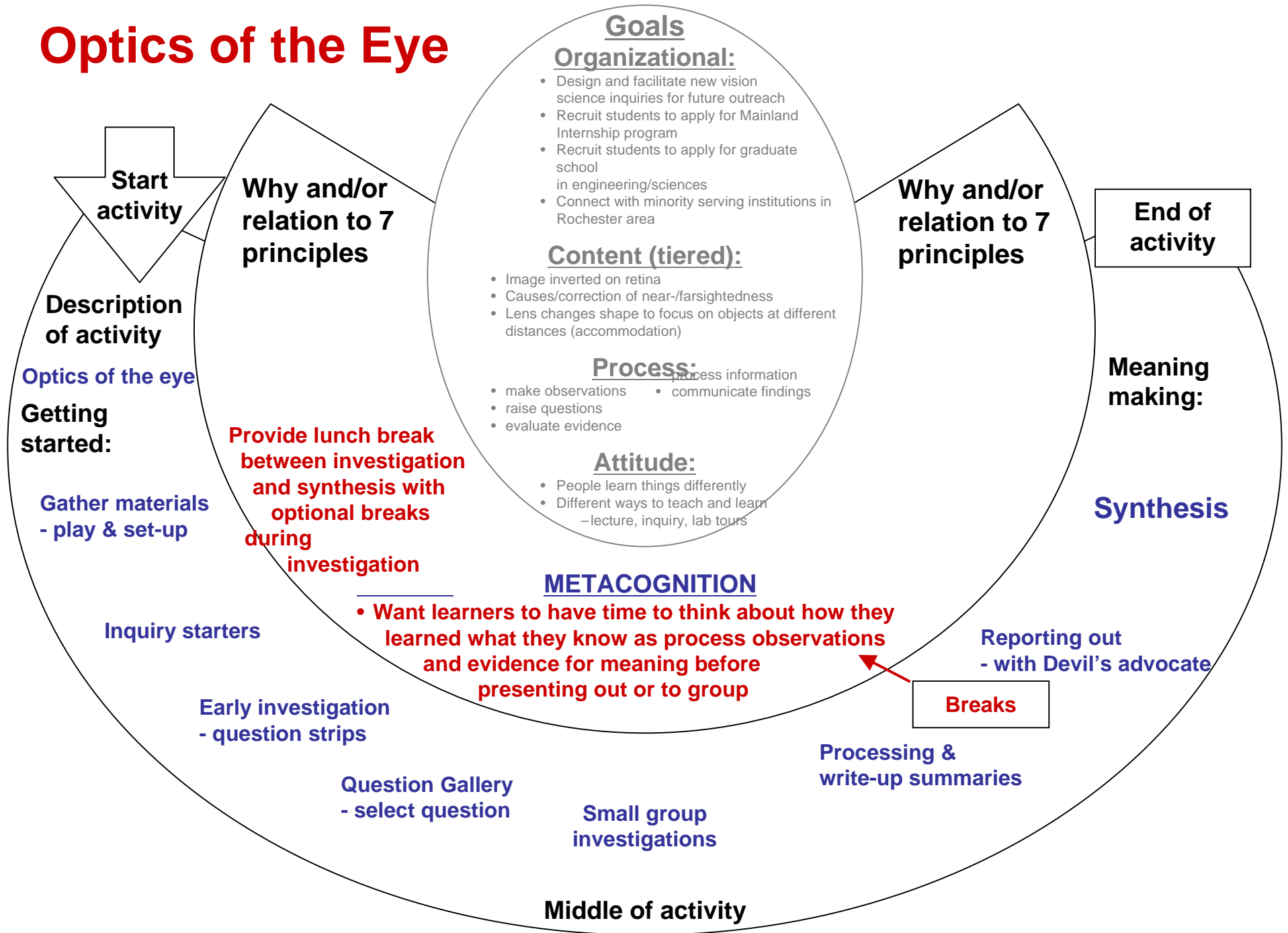
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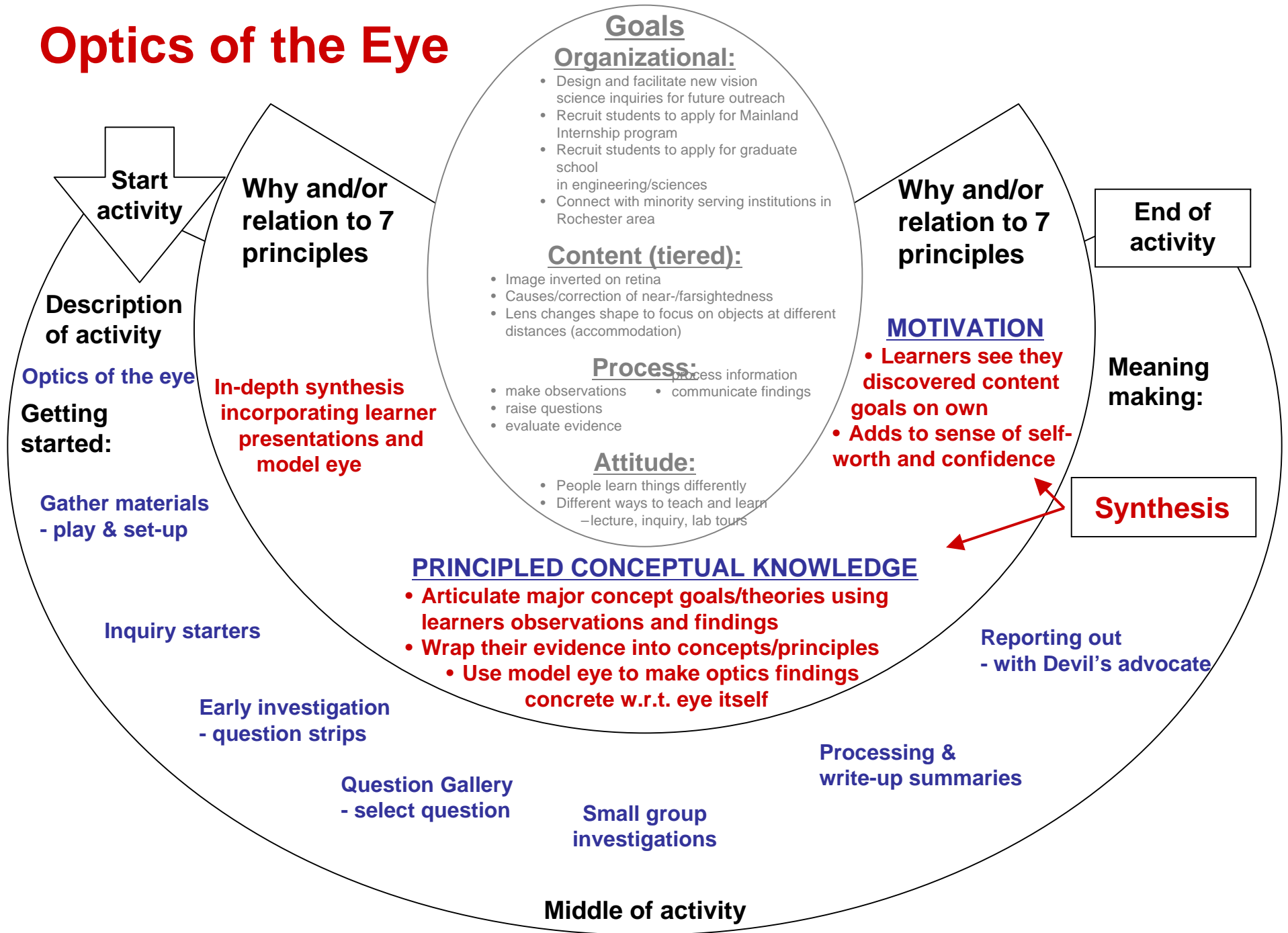
Optics of the Eye



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What if you don't have time for full inquiry?

- **Can still conduct a successful inquiry exercise**
- **Consider time-saving alterations:**
 - Provide a little more information at some point of the activity
 - Eliminate a strategy or tool that suits your strengths
 - Restrict materials
- *Important to not short-change the synthesis!*

Retinal Anatomy

Joy Martin, Julianna Lin,
Seth Pantanelli, Kerry Highbarger

- **Began planning/design at the 2004 PDW**
- **2004 Target Audience:**
Undergraduate students in CfAO Mainland Internship Short Course
- **Developed and facilitated Vision Science Inquiries in:**
 - retinal anatomy
 - color vision
 - spatial vision
- **Time Restriction:**
 - **3 hours total time!!**
 - (Optics of eye - 5+ hours)

Goals

Organizational:

- Design and facilitate new vision science inquiries for future outreach
- Get students in Mainland Internship program thinking about scientific process

Content:

- Size/location of retinal features can be roughly determined using non-invasive techniques
- Visual acuity varies with retinal location
- Color vision varies with retinal location
- Two above concepts due to sampling theorem
- Blind spot corresponds to optic nerve location

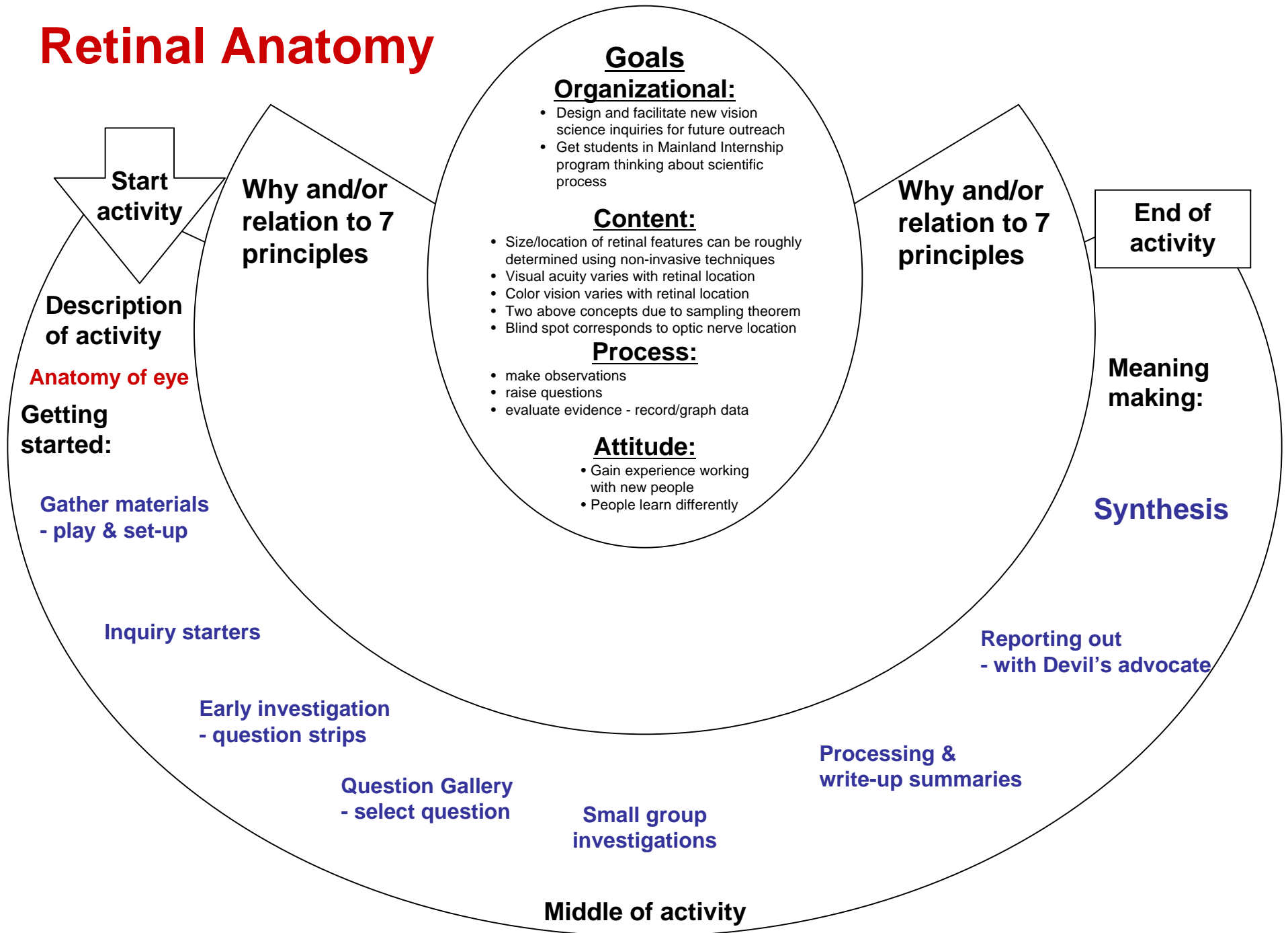
Process:

- make observations
- raise questions
- evaluate evidence - record/graph data

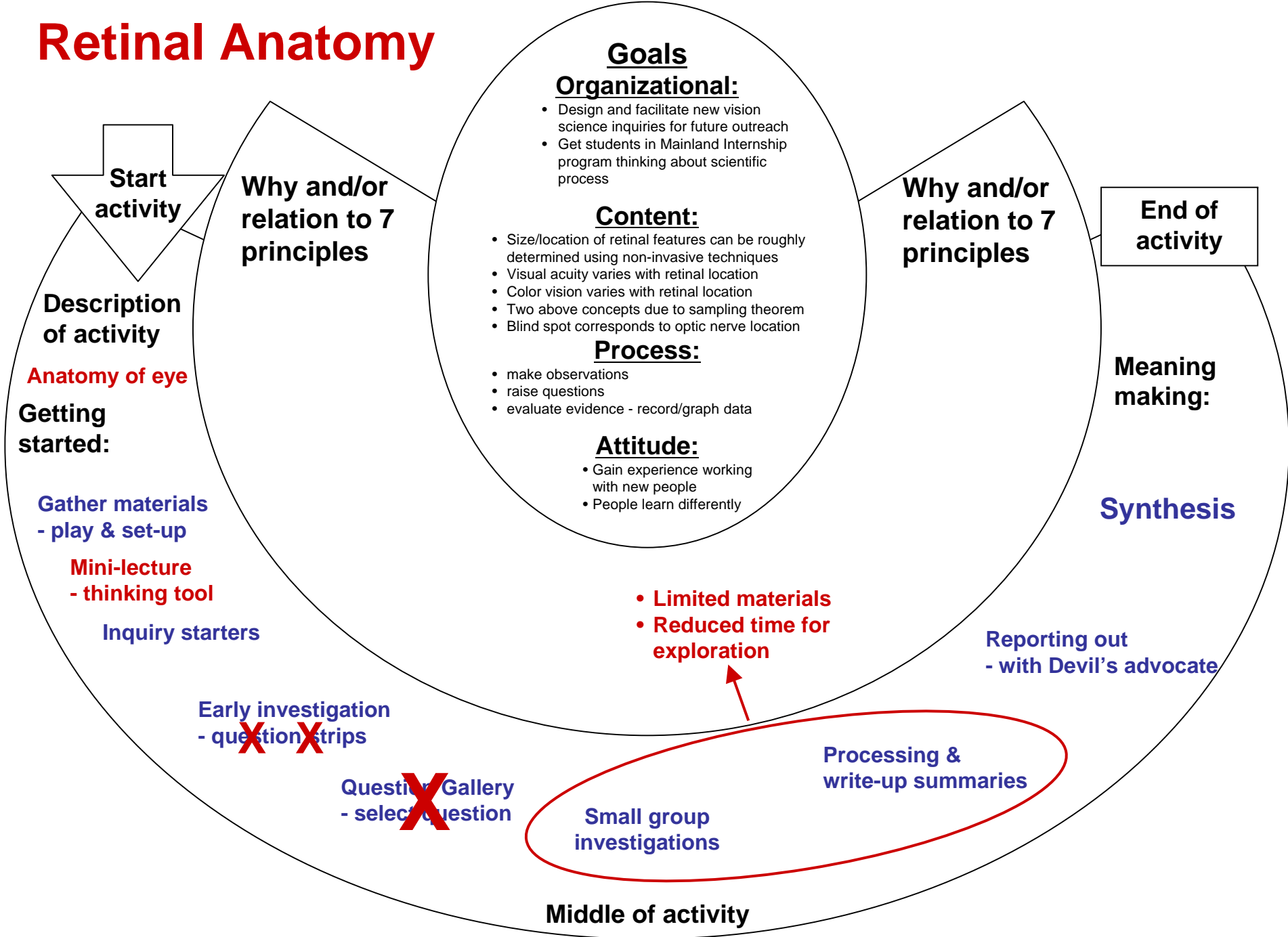
Attitude:

- Gain experience working with new people
 - People learn differently

Retinal Anatomy



Retinal Anatomy



Retinal Anatomy

Schedule

Introductions, short talk	30 min	(30 min)
2 Inquiry starters presented	10 min	} (1 h)
Preliminary investigations / group students in real-time according to verbalized questions (3-4 per group)	20 min	
Inquiry exploration	45 min	(2 h 45 min)
Write-up results	15 min	
Inquiry student presentations	30 min	} (1 h)
Synthesis	30 min	
TOTAL TIME	3 hours	(5 h 15 min)

