Optics of the Eye

Start activity

Description of activity

Getting started:

Why and/or relation to 7 principles

Goals
Organizational:

Content:

Process:

Attitude:

Middle of activity

Why and/or relation to 7 principles

End of activity

Meaning making:
Optics of the Eye

Goals
Organizational:
- Content:
- Process:
- Attitude:

Getting started:
- Why and/or relation to 7 principles

Description of activity
- Why and/or relation to 7 principles

Start activity

Middle of activity

End of activity

Meaning making:
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

• Began planning/design at the 2003 PDW

• 2004 Target Audience: Community college students in engineering/sciences

• 2005 Target Audience: Undergraduate students 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
Optics of the Eye

Getting started:

Description of activity

Start activity

Why and/or relation to 7 principles

Middle of activity

Why and/or relation to 7 principles

End of activity

Meaning making:

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Optics of the Eye

Getting started:
- Gather materials - play & set-up
- Inquiry starters
- Early investigation - question strips
- Question Gallery - select question

Description of activity

Gather materials
- play & set-up

Optics of the eye

Inquiry starters

Why and/or relation to 7 principles

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Attitude:
- People learn things differently
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  - lecture, inquiry, lab tours

Middle of activity

Meaning making:

Synthesis

Optics of the eye

Early investigation - question strips

Question Gallery - select question

Small group investigations

Processing & write-up summaries

Reporting out - with Devil’s advocate

End of activity
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.
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
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

Getting started:
- Gather materials - play & set-up

Description of activity

Optics of the eye

Why and/or relation to 7 principles

Why and/or relation to 7 principles

Goals
Organizational:
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Process:
- make observations
- raise questions
- evaluate evidence
- communicate findings

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

Middle of activity

Meaning making:

Synthesis

Reporting out - with Devil’s advocate

Small group investigations

Processing & write-up summaries

Question Gallery - select question

Early investigation - question strips

Inquiry starters

End of activity

Start activity

End of activity
Optics of the Eye

Getting started:
- Gather materials - play & set-up

Why and/or relation to 7 principles
- At first, referred to optical set-ups as lens and screen (or image plane).
- Rest of inquiry, referred to optical set-ups as cornea, lens and retina

Description of activity
- Optics of the eye

Optics of the eye
- Early investigation - question strips
- Question Gallery - select question
- Small group investigations

Goals
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Process:
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PRIOR KNOWLEDGE
- Learners with optics backgrounds may recall terminology/bas

SITUATED LEARNING
- Learners will better remember how eye works optically if use eye terminology instead of pure optics terminology
- Want learners to remember properties of eye, not just of lenses and image formation

Synthesis
- Reporting out - with Devil's advocate
- Processing & write-up summaries

Meaning making:
- Inquiry starters
Optics of the Eye

Getting started:
- Optics of the eye
- Gather materials - play & set-up
- Inquiry starters

Description of activity

Why and/or relation to 7 principles
- Why and/or relation to 7 principles

Optics of the Eye

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Process:
- make observations
- raise questions
- evaluate evidence

Attitude:
- People learn things differently
- Different ways to teach and learn – lecture, inquiry, lab tours
- process information
- communicate findings

MOTIVATION
- Allow learner to select own question.
- Learners more likely to be motivated in investigation if they select a question they are genuinely interested in.

Used question strips and question gallery.

Middle of activity

Meaning making:
- Synthesis
- Reporting out - with Devil’s advocate
- Processing & write-up summaries

Small group investigations

End of activity

Start activity
Optics of the Eye

Getting started:

- Gather materials - play & set-up
- Early investigation - question strips
- Inquiry starters

Optics of the eye

Start activity

Why and/or relation to 7 principles

Make learners work in groups.

Description of activity

Optics of the eye

Why and/or relation to 7 principles

Middle of activity

Meaning making:

LEARNING COMMUNITIES
- Process & communicate thinking to group

DIFFERENCES AMONG LEARNERS
- Must work with people whose learning/communication styles are different from their own
- Must communicate knowledge in ways group can understand - also test of own understanding

Process:
- make observations
- raise questions
- evaluate evidence

Content (tiered):
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PROCESS:
- process information
- communicate findings

Small group investigations

Synthesis

Reporting out - with Devil's advocate

Processing & write-up summaries

End of activity
Optics of the Eye

**Goals**

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**Process:**
- make observations
- raise questions
- evaluate evidence

**Attitude:**
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- Different ways to teach and learn – lecture, inquiry, lab tours

**METACOGNITION**
- Want learners to have time to think about how they learned what they know as process observations and evidence for meaning before presenting out or to group

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**Getting started:**
- Optics of the Eye
- Gather materials - play & set-up

**Description of activity**
- Why and/or relation to 7 principles

**Start activity**
- Why and/or relation to 7 principles

**Middle of activity**
- Description of activity
- Optics of the eye
- Gather materials - play & set-up
- Inquiry starters
- Early investigation - question strips
- Question Gallery - select question
- Small group investigations

**End of activity**
- Why and/or relation to 7 principles

**Synthesis**
- Meaning making:
- Reporting out - with Devil's advocate
- Processing & write-up summaries
- Breaks

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**Optics of the Eye**
- Provide lunch break between investigation and synthesis with optional breaks during investigation
- Inquiry starters
- Early investigation - question strips
- Question Gallery - select question
- Small group investigations

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**Optics of the Eye**
- Introduction
- Why and/or relation to 7 principles
- Getting started:
- Optics of the Eye
- Gather materials - play & set-up
- Description of activity
- Optics of the eye
- Gather materials - play & set-up
- Inquiry starters
- Early investigation - question strips
- Question Gallery - select question
- Small group investigations

**End of activity**
- Why and/or relation to 7 principles

**Synthesis**
- Meaning making:
- Reporting out - with Devil's advocate
- Processing & write-up summaries
- Breaks

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**Optics of the Eye**
- Optics of the Eye
- Gather materials - play & set-up
- Description of activity
- Optics of the eye
- Gather materials - play & set-up
- Inquiry starters
- Early investigation - question strips
- Question Gallery - select question
- Small group investigations

**End of activity**
- Why and/or relation to 7 principles

**Synthesis**
- Meaning making:
- Reporting out - with Devil's advocate
- Processing & write-up summaries
- Breaks
### Goals

**Organizational:**
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### Process:
- make observations
- raise questions
- evaluate evidence

### Attitude:
- People learn things differently
- Different ways to teach and learn – lecture, inquiry, lab tours

### Motivation:
- Learners see they discovered content goals on own
- Adds to sense of self-worth and confidence

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### PRINCIPLED CONCEPTUAL KNOWLEDGE
- Articulate major concept goals/theories using learners observations and findings
- Wrap their evidence into concepts/principles
- Use model eye to make optics findings concrete w.r.t. eye itself

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### Synthesis
- Reporting out - with Devil's advocate
- Processing & write-up summaries
- Small group investigations
- Question Gallery - select question
- Early investigation - question strips
- Inquiry starters
- In-depth synthesis incorporating learner presentations and model eye

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### Getting started:
- Optics of the Eye
- Gather materials - play & set-up

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### Description of activity
- Why and/or relation to 7 principles

---

### Start activity

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### End of activity

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### Why and/or relation to 7 principles

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### Optics of the Eye
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

Getting started:
- Gather materials - play & set-up

Early investigation - question strips
- Inquiry starters

Question Gallery - select question

Middle of activity
- Process: • make observations • raise questions • evaluate evidence - record/graph data

Meaning making:
- Attitude: • Gain experience working with new people • People learn differently

Reporting out - with Devil's advocate
- Synthesis

why and/or relation to 7 principles
- Description of activity

Anatomy of eye

Goals Organizational:
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Process:
- make observations • raise questions • evaluate evidence - record/graph data

Attitude:
- Gain experience working with new people • People learn differently

Synthesis
- Processing & write-up summaries

Reporting out - with Devil's advocate
- End of activity

why and/or relation to 7 principles
- Start activity

Small group investigations

Middle of activity
- Question Gallery - select question

Early investigation - question strips
- Inquiry starters

Gather materials - play & set-up
- Getting started:

Anatomy of eye

Description of activity

why and/or relation to 7 principles
- Start activity

Start activity
Retinal Anatomy

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- 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

Getting started:
- Inqury starters
- Mini-lecture - thinking tool
- Gather materials - play & set-up

Description of activity

Anatomy of eye

Why and/or relation to 7 principles

Middle of activity

Early investigation - question strips

Meaning making:

Reporting out - with Devil’s advocate

Synthesis

Small group investigations

Processing & write-up summaries

End of activity

Why and/or relation to 7 principles

Retinal Anatomy

X

X

X

X

X
Retinal Anatomy

Schedule
Introductions, short talk
2 Inquiry starters presented
Preliminary investigations / group students in real-time
  according to verbalized questions (3-4 per group)
Inquiry exploration
Write-up results
Inquiry student presentations
Synthesis

TOTAL TIME

3 hours (5 h 15 min)