

Science of the Eye:

Bringing vision into the classroom



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How did this program start?

- Professor Jonathan King
(Department of Biology)

Massachusetts Darwin Bicentennial Project Events
- Eye Evolution Conference





Science of the Eye

Bringing vision into the classroom

- Funded by National Eye Institute
- Create curriculum units based on science research
- Provide professional development workshops



Science of the Eye Staff



Jonathan King
Professor of Biology



Ishara Mills-Henry
Program Director



Lisa Guisbond
Program Coordinator and
Public Relations Representative



Science of the Eye
Bringing vision into the classroom

Our Mission

- Our mission is to **support high school biology teachers** in their efforts to provide **high-quality, engaging and inspiring science education** focused on **vision and the eye**. We believe the best way to do this is through delivery of **inquiry-based, hands-on science instruction**.

Our Goals

- Provide **high-quality and useful professional development** to high school biology teachers, **emphasizing hands-on learning**.
- Engage high school biology teachers in **current vision research** and have them **bring their newfound knowledge and enthusiasm back to the classroom** to engage and excite their students.
- Develop and disseminate **biology curriculum modules for biology teachers** to use in their classrooms and labs.
- Facilitate **communication among researchers and high school teachers**.
- **Solicit feedback from classroom teachers** on what they need and what obstacles they face in providing engaging science instruction.
- **Increase knowledge and understanding about the human eye and eye disease**.
- Demonstrate to high school students the full range of **possibilities for careers related to the science of the eye**.
- **Increase access to high-quality laboratory science** opportunities for low-income urban students.

Goals of Science Education (Our Philosophy)

A. Scientific literate citizenry

- Understanding the nature and process of science

B. Increasing the Pipeline

- Promote interest in science among students



Importance of Sensory Physiology

- Teachers know that their students will be responsive to it
- Touch, smell, hearing, taste, **vision**

Why Vision?

- Teachers interested in their own eye health
- Relatable and tangible
- Connection to human diseases
- Everyday experience
- Involves multiple disciplines of science
- Allows teaching of the nature and process of science



Cataract

What do we do?

- **2 – 4 hour workshops**
 - MABT
 - MAST
 - STEM Ed (UMass Amherst)
 - Assist teachers with classroom
- **Cambridge Science Festival**
- **Darwin Bicentennial Project**

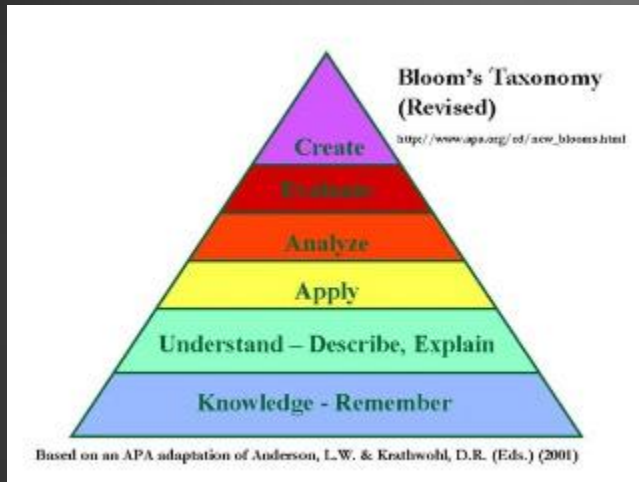


Outreach Partnerships

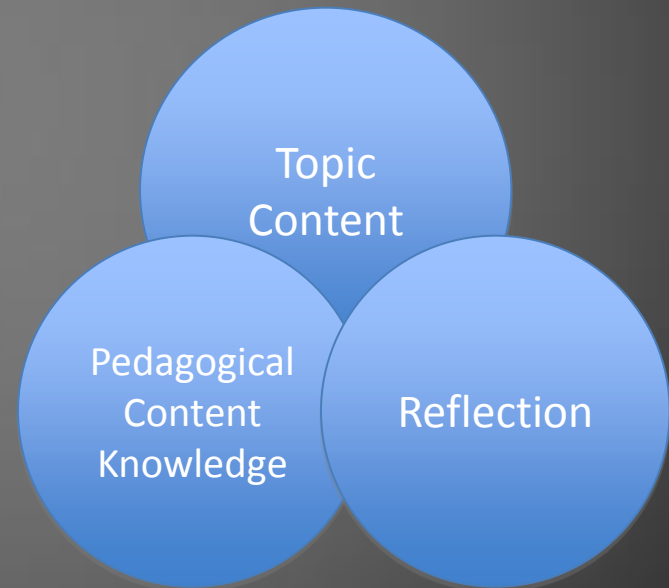
- Massachusetts Association of Biology Teachers (MABT) – local chapter for the NABT
- Established a formal partnership before we started

Theoretical Framework

Teacher Professional Development:



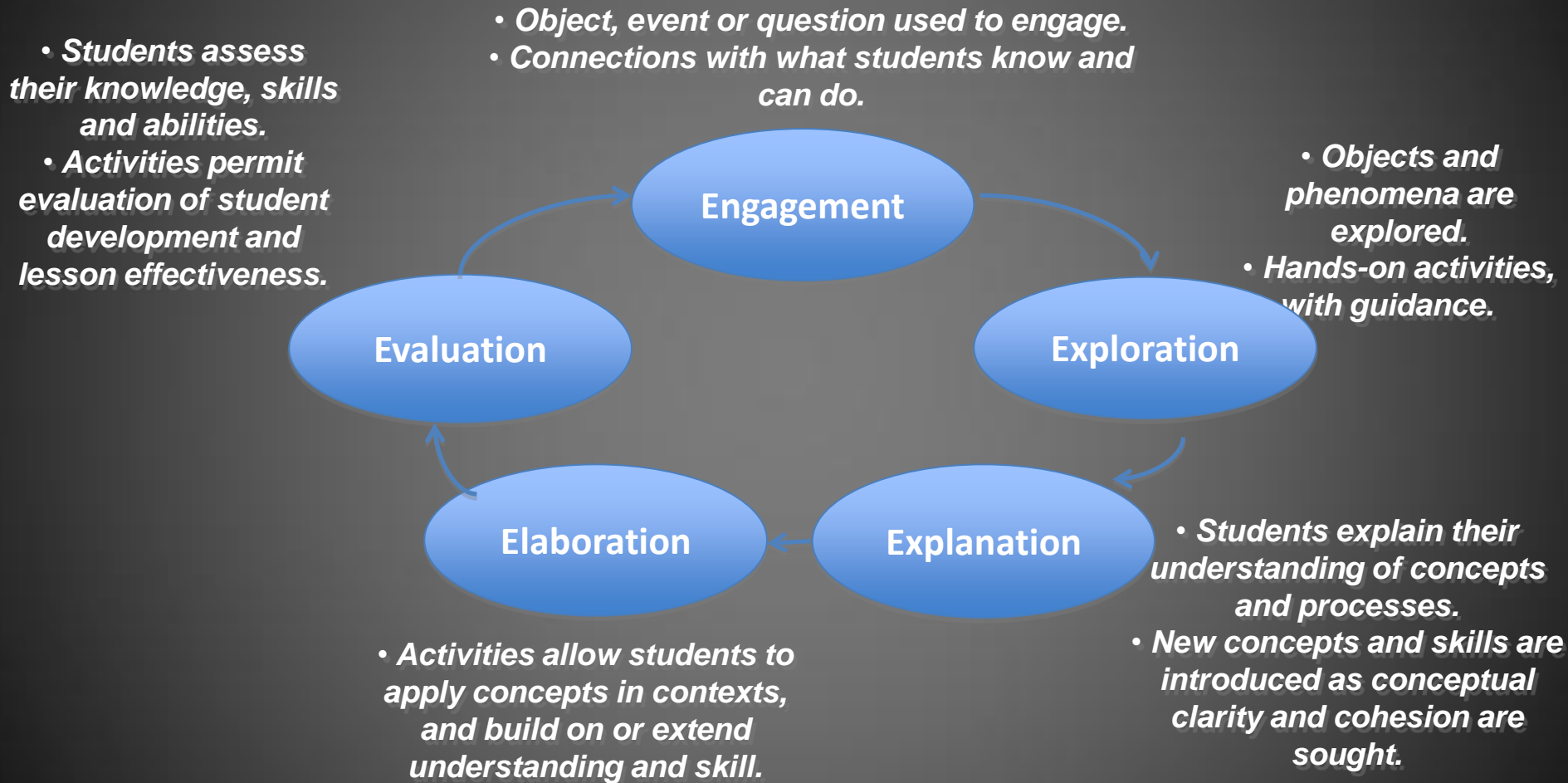
Common Threads for Professional Development



Shulman, Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1-22

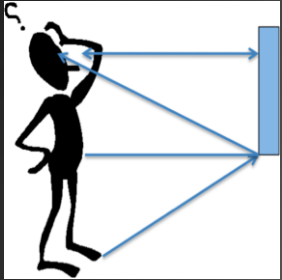
Theoretical Framework

(5E model of inquiry)

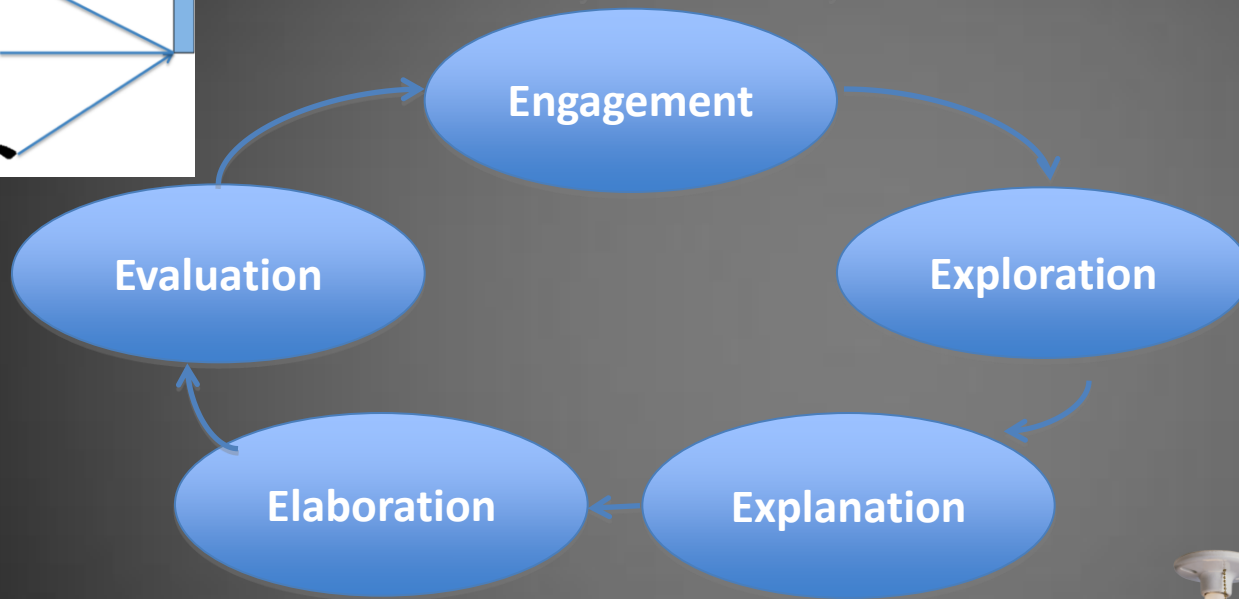


Adapted from Bybee, R.W. et al. 1989

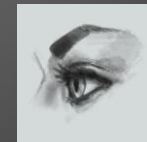
Theoretical Framework (5E model of inquiry)



What length does a mirror have to be to see your entire body?

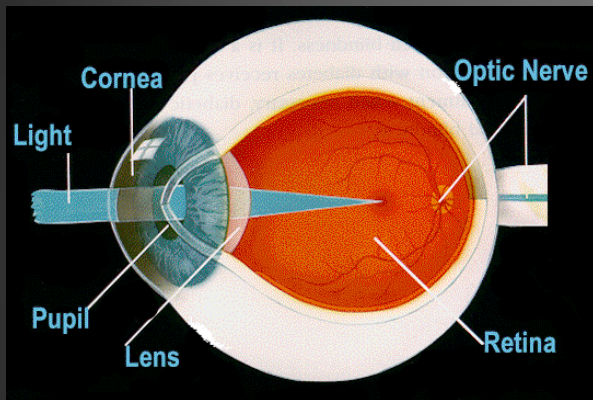


Retest their initial ideas

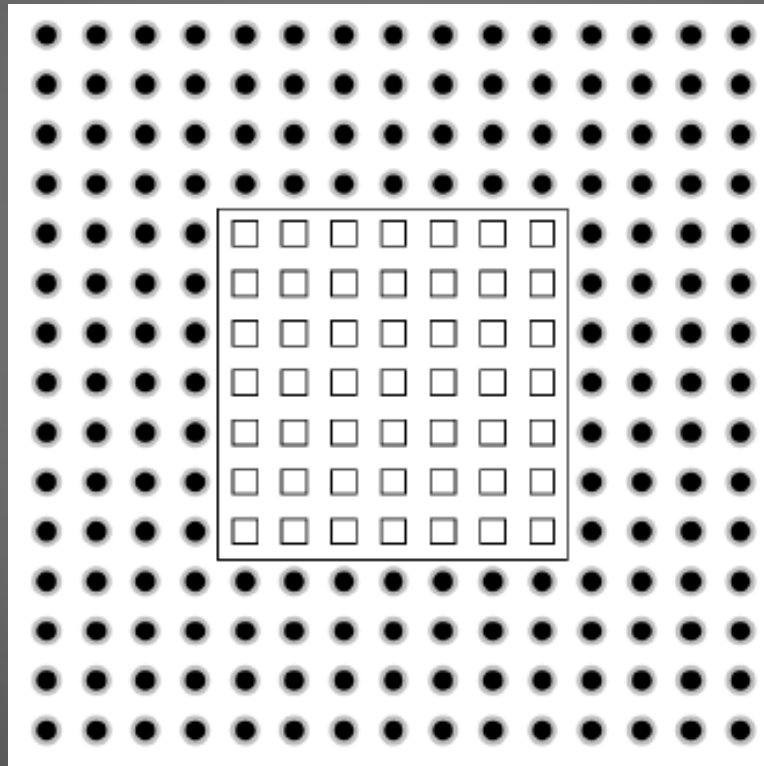


Eye Anatomy and Eye Disease

- Using eye diseases to explain eye anatomy

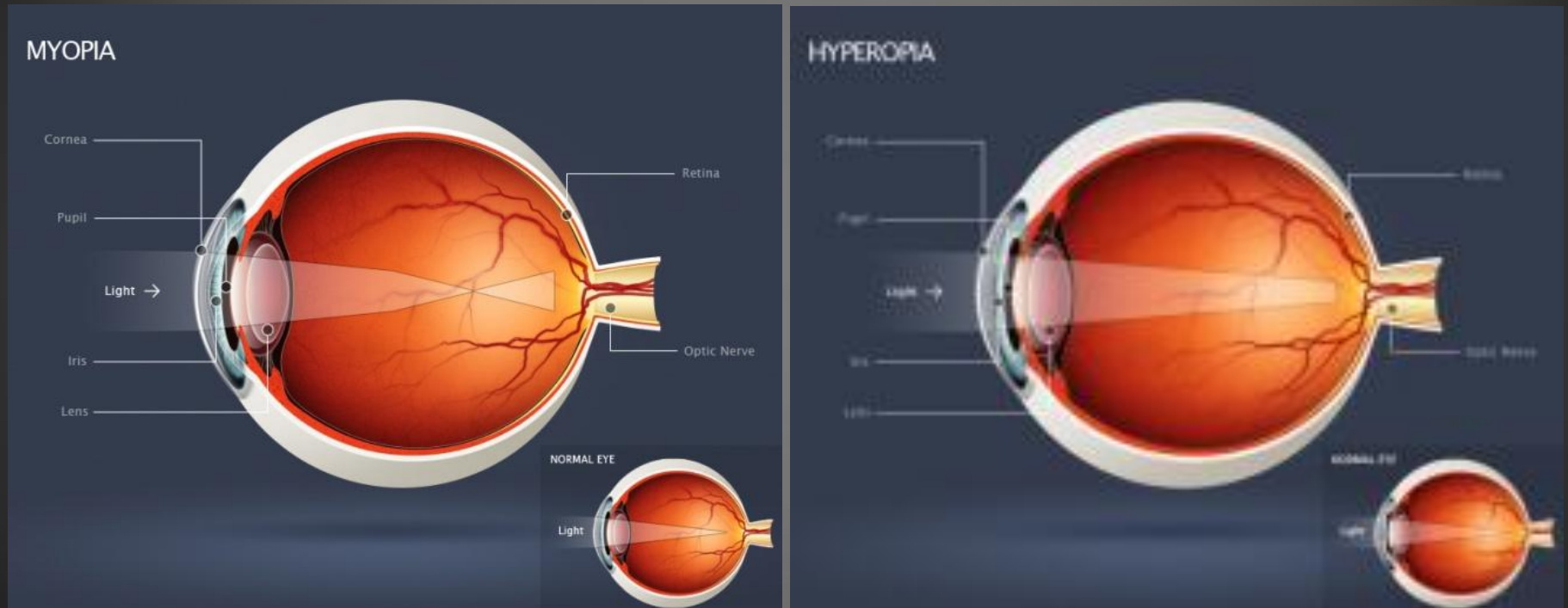


Eye movements

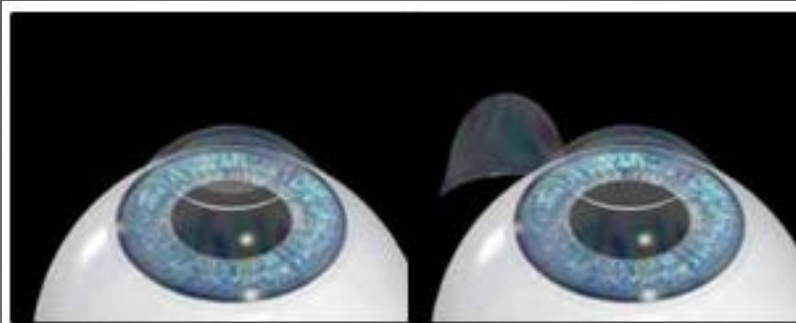


Myopia – Nearsightedness

Hyperopia - Farsightedness



Lasik



Step 1: Corneal flap is created with a microkeratome.

Step 2: The corneal flap is folded back.



Step 3: Excimer laser beam reshapes the cornea.

Step 4: The corneal flap is folded back in place.

Utilizing Model Organisms

- Eye Development
- Eye Evolution
 - *Drosophila* (Retinal Determination Network, e.g. Pax 6)
 - Zebrafish (Opsins)



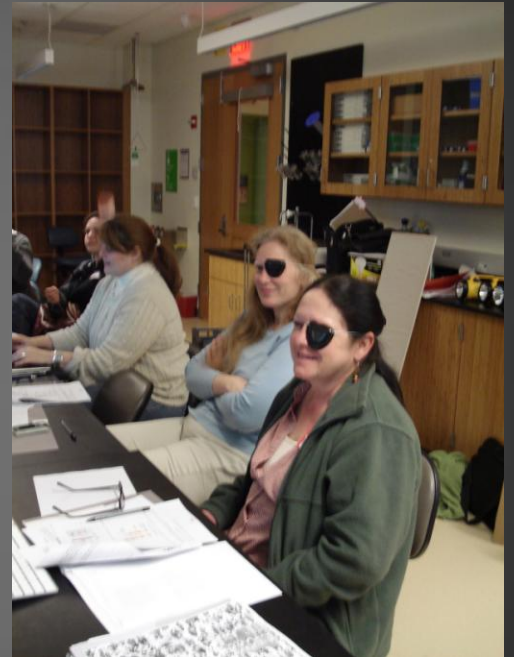
Color Vision

- The Retina
- Rods and Cone Function
- Phototransduction
- Color Opponency
- Diseases
- Bionic Eye

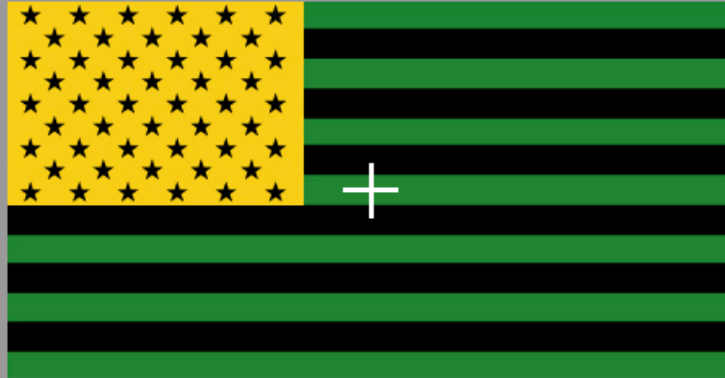


Pirates of the Caribbean

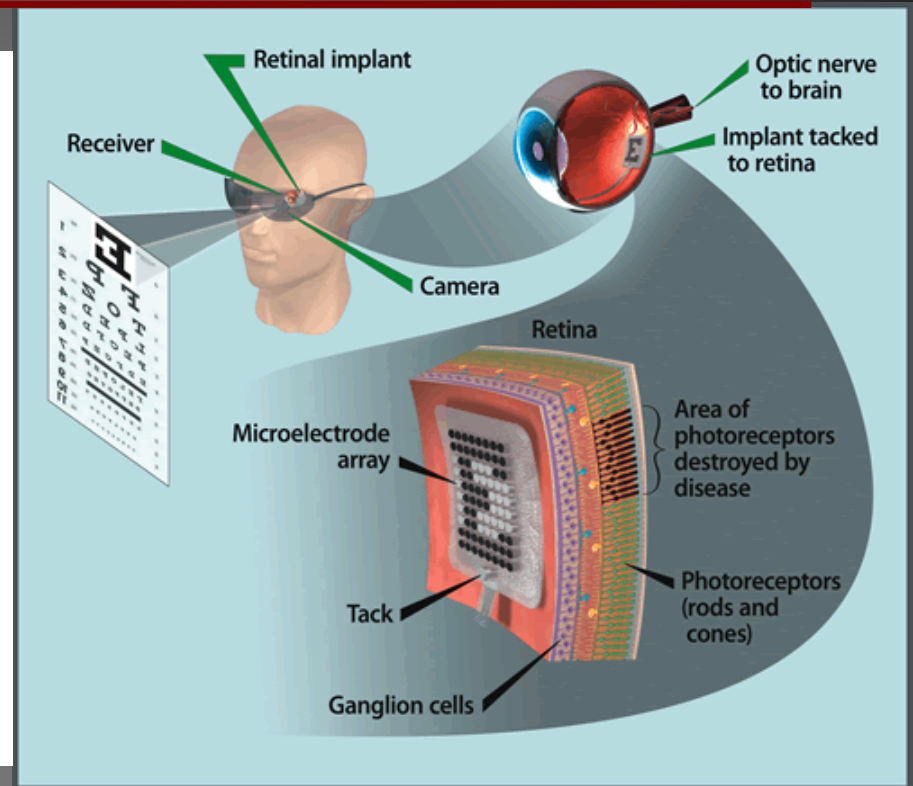
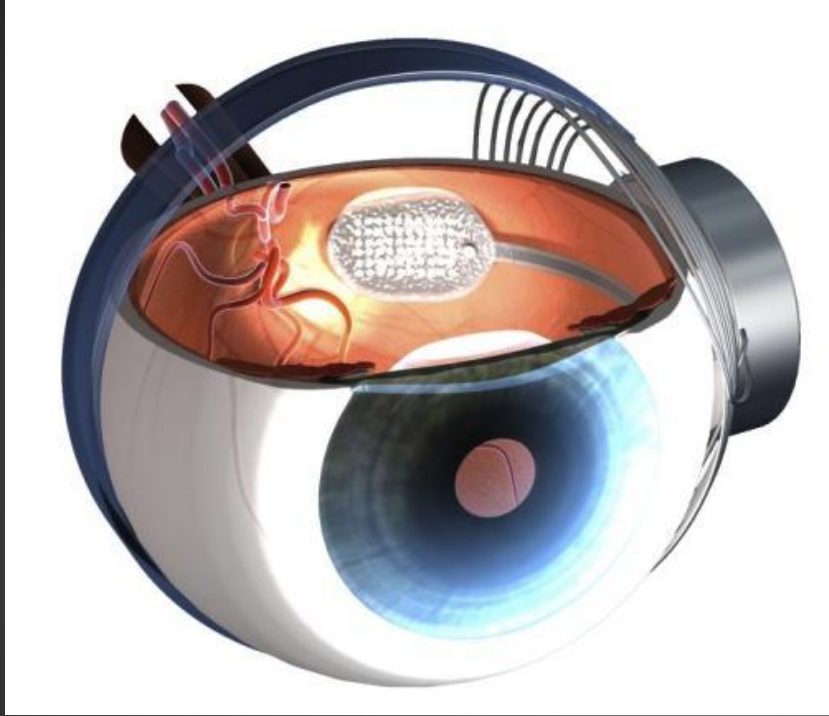
- Dark Adaptation
- Role of Rods and Cones



Stare at the white cross for 30 seconds



Bionic Eye



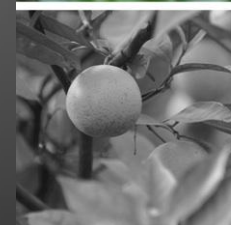
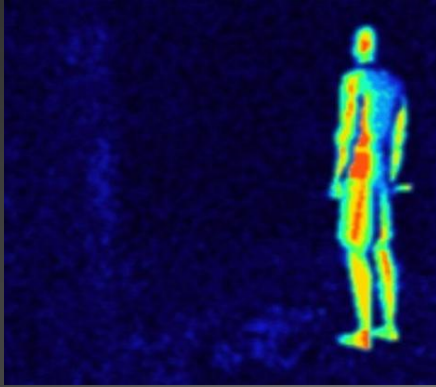
- Do you think that individuals with the “Bionic” eye implant will be able to perceive images immediately?
- Do you think that the “Bionic” eye implant, individuals will be able to see colors?

Crystallins

- Learning protein structure
 - StarBiochem (OEIT)
- Protein deposition diseases
 - Cataract
 - Chaperonins (in the works)

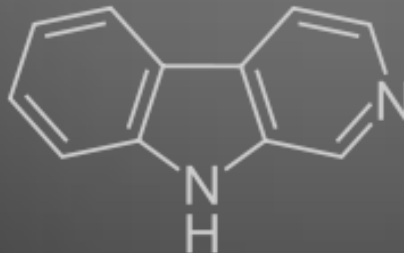
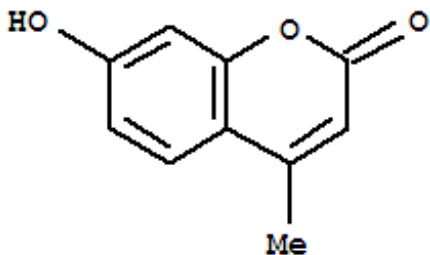


What do animals see?



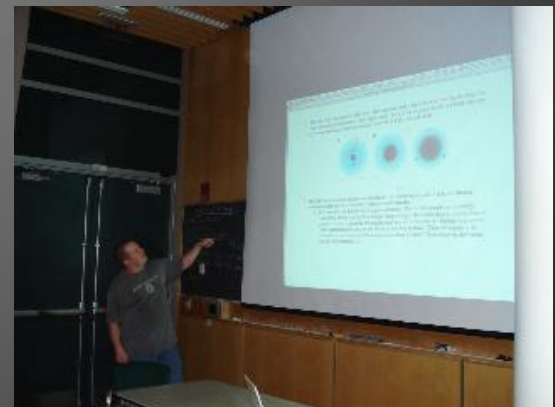
Animal Vision

- Scorpions fluorescence under UV light.
- Exoskeleton contains Beta carboline and 7-hydroxy-4-methylcoumarin
- Recent studies suggested its for detection and avoidance of the UV light.
- Ability to discriminate between species?
- Mating, navigation, ?)



Summer Program

- Partnership with HHMI and Department of Biology
- Two-week lecture and laboratory experience
- 13 summer program participants



Accomplishments

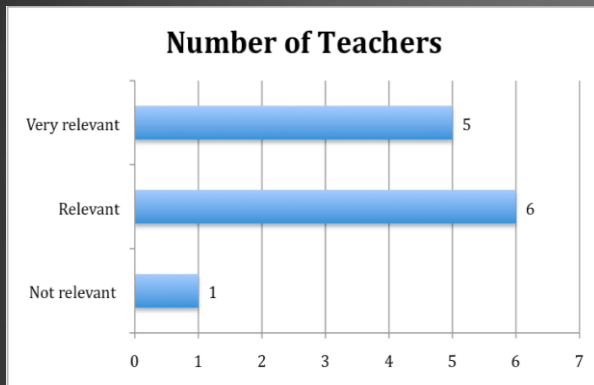
- Professional Development for over 200 teachers
- Formal partnerships with local teacher chapters – MABT and MAST
- Ongoing collaboration and communication with teachers
- Summer program alumni have developed lesson plans
- Mass. Darwin Bicentennial Project
→ Massachusetts Darwin Society



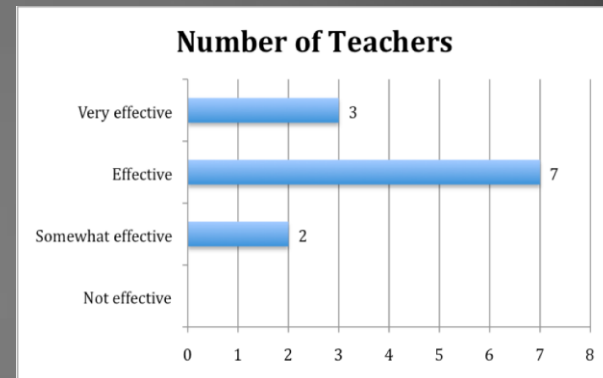
Results (Quantitative)

- Workshop @ MASS STEM ED (UMASS AMHERST)

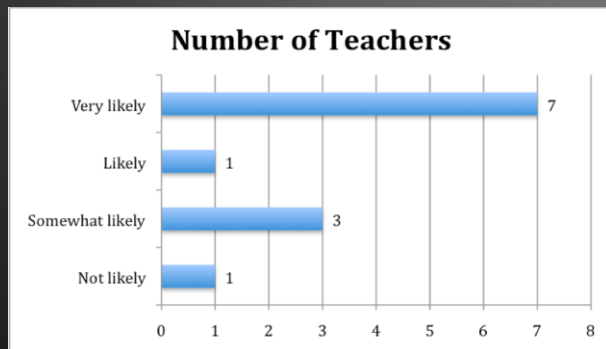
How relevant was this workshop to your classroom teaching?



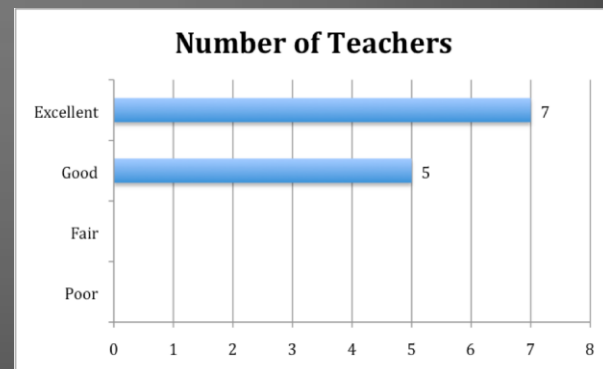
How effective was the presentation of activities and topics in this workshop?



How likely are you to use the activities and materials from this workshop in your classroom?



Overall, you would rate this workshop:



Results (Qualitative)

- Comments:

- Excellent workshop that will inspire my teaching
- A remarkably rich combination of labs, lectures, activities, and guest lecturers. Info enriched my personal knowledge and can be leveraged in my classroom.
- Wow! You gave a sampling of a lot of great activities in a short period of time. I like the balance of content and offerings of activities. I feel very interested in learning more about the more “advanced” end of the information and finding ways to make it accessible to youth- would like to try the act out model, Thank you

Improvements:

- Can't think of any – possibly a kit with a classroom set of materials if a grant is there for it.
- Add development of the vertebrate eye to discussions (or separate session)
- - A little more structure to the “down time”
- - More opportunity to develop labs using material and ideas brought in by Ishara (great ideas)
- - More use of analyzing proteins on computer
- - More discussion time on results

Problems and Limitations

- Reaching mostly suburban teachers
- Limited engagement of urban and rural school districts
- Time Limitations
 - “This [content] is not on the MCAS (Massachusetts Comprehensive Assessment System) test
 - “Wish I could incorporate this into my curriculum, but I have to get through the standards first.”

Barriers

- Professional Development Mechanisms
(different for each school district)

Next Steps

- More effective outreach
 - Teacher unions
 - Two teacher unions – MTA (Local chapter of the National Education Association) and AFT (Local Chapter of the National Federation of Teachers)
 - AFT – mostly urban - Arrange for us to make contact with science teachers in urban schools
- Regional (Northeast)
- National
 - Workshops at National Science Meetings
 - ARVO and ASBMB (Train-the-Trainer, assisting others with initiating programs in their state)
 - NABT and NSTA

Acknowledgements

- Professor Jonathan King
- Lisa Guisbond
- MABT (Massachusetts Association of Biology Teachers)
- King Lab members
- TERC
- Check us out @ www.scienceoftheeye.org
- Ishara's email: imills@mit.edu

