

# Student Understanding of Wavefront Aberrometry\*

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## Introduction

- Part of Modern Miracle Medical Machines
  - Introductory physics concepts applied to medical imaging techniques
  - Investigate application of previous knowledge to new contexts
- Wavefront Aberrometry
  - Relatively new method of vision diagnosis

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## Physics of Wavefront Aberrometry

- A low-power laser beam is shone into the eye and focused on the retina.
- The light is reflected back through the eye.
  - It passes through the media, lens, and cornea, so it picks up those aberrations.
- Light exits the eye through an array of tiny lenses.



Image from [www.zyoptix.com](http://www.zyoptix.com)



Image from [www.optics.ru](http://www.optics.ru)

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## Studying Knowledge Transfer

- Same basic content knowledge
  - Simple geometric optics
- New context
  - Wavefront aberrometry
    - Ascertained that students did not see before

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## Methodology

- Teaching/Learning Interviews (Engelhardt, 2003)
  - 5 groups, 13 total participants
  - Post-instruction in light, geometric optics



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## Meaningful Understanding Analysis

- Adapted from Lawson et al (2000) and Nieswandt and Bellomo (JRST, to be published)
- Types of Concepts\* - observability
  - **Descriptive** - directly observable
    - size, intensity, position
  - **Hypothetical** - observable given apparatus
    - focal point, atomic spectra
  - **Theoretical** - not observable
    - wavefronts, phase

\* Defined from Student Perspective

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## Meaningful Understanding Analysis

- Adapted from Lawson et al (2000) and Nieswandt and Bellomo (JRST, to be published)
- Links between Concepts
  - Single-level links
    - Descriptive-descriptive
  - Cross-level links
    - Descriptive-hypothetical
  - Multi-level links
    - Descriptive-hypothetical-theoretical

\* Types of links allow for a sense of the depth of understanding

## Example #1 - Identifying Concepts

*Interviewer: So what do you think would happen to the grid pattern if the lens of the eye had some sort of defect?*

Student 1: I think instead of being like, right now you have one of these shapes [hexagon], like, I think that one of the points would move in toward center. Because it would, like instead of light going uniformly through [the lens] and creating this pattern, one would kind of like warp in this direction.

Student 2: Yeah, well, I think light would be hitting the smaller [array] lenses at a different angle because of the increased or decreased focal length of the lens [at the site of the defect]

## Example #2 - Identifying Links

*Interviewer: What do you think would happen to the grid pattern if the lens of the eye had a defect?*

Student 3: [Look at] where it doesn't focus correctly.

*Interviewer: Where what doesn't focus correctly?*

Student 3: The reflecting light. Like the intensity of the light.

Student 4: The reflected light is going through one of the little lenses. If one of them, if something is wrong with the dot, like it's a whole lot dimmer than the rest of them or something, then there's something wrong with that part of the eye.

Each student exhibits a Descriptive-Hypothetical (Cross-level) Link.

## Summary of Concepts

"What do you think will happen to the grid pattern if there is an aberration in the lens of the eye?"

Types of Concepts	
Total Concepts	29
Descriptive Concepts	15
Hypothetical Concepts	11
Theoretical Concepts	3

## Summary of Links

Types of Concept Links	
Total Concept Links	13
One-concept Level Descriptive-descriptive (1) Theoretical-theoretical (1)	2
Cross-concept Level Descriptive-hypothetical (10) Hypothetical-theoretical (1)	11

## Summary

- Useful method for eliciting concepts and links
  - Fewer theoretical concepts used
    - Consistent with prior meaningful understanding studies
  - Similar numbers of descriptive, hypothetical
    - Because post-instruction?
- Students *are able* to link together concepts
- Students exhibit difficulty in utilizing and linking higher-level (theoretical) concepts
  - Indicates understanding is not as deep as some hope



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