

Meaningful Understanding Analysis for Examining Student Responses in the Context of Wavefront Aberrometry

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Meaningful Understanding Analysis^{1,2}

Types of Concepts*

Descriptive Concepts – concepts that can be directly observed (no special apparatus or setup is necessary)

Hypothetical Concepts – concepts that could be observed if given appropriate apparatus or setup, but are not directly observable

Theoretical Concepts – concepts that cannot be directly observed, and no special apparatus or setup enables their observation

* Concept categories are defined from the student perspective, therefore from the knowledge-level of an introductory physics student.

Types of Concept Links

Single-level Links – associating two or more concepts of the same level

Cross-level Links – a concept of one level associated with a concept of another level

Multi-level Links – creating an association between at least three concepts, one at each level

Example #1

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

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.

Methodology

Group Teaching/Learning Interviews³

- 5 groups – 13 total students
- Enrolled in 2nd semester algebra-based physics
- Post-instruction in light, lenses, human eye

Phenomenographic Approach⁴

- Bracket preconceived notions
- Elicit variations among/across groups

Context – Wavefront Aberrometry^{5,6}



Examples of Concepts in each Category

- Descriptive Concepts: Size, Position, Brightness/Intensity
- Hypothetical Concepts: Focal point, Atomic spectra, UV light
- Theoretical Concepts: Wavefronts, Phase, Propagation of light



Conclusions

- Feasible to conduct a meaningful understanding analysis
- Students do utilize different concepts to construct an understanding
 - Primarily low-level concepts – agrees with studies by Lawson et al and Nieswandt and Bellomo
 - Significant number of hypothetical – potentially because students were post-instruction
- Students are able to link concepts together
 - Difficulty linking higher-level concepts – indication that understanding is not as deep

Future Work

- Same analysis for individuals, pre-instructions, etc
- Explore potential meaning of un-linked concepts

References

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