Levels of Inquiry: Learning Sequence Exercise

Using your knowledge of **Levels of inquiry: Hierarchies of pedagogical practices and inquiry processes** (Wenning, C.J. (2005). *Journal of Physics Teacher Education Online,* 2(3), February 2005, pp. 3-11), create your own inquiry spectrum of physics lessons from a single topic area using the examples found below. Be prepared to present and explain your inquiry spectrum to the class.

Pinhole Projection	**Discovery Learning:** Students ***observe*** pinhole projection with the use of two index cards and a clear light bulb with a large filament. The first index card with the pinhole is held closer to lamp; the second index card is held in the shadow of the first. Students see image produced on second index card. Student ***formulate*** initial ideas as to the process of image formation. They ***draw conclusions*** about inversion, distinction between image and object, and note that distance of the object (d_o) and distance of the image (d_i) (both measured from the pinhole) have an effect on image height (h_i). The object height (h_o) is fixed. Students image brightly-lit objects outside the classroom window or overhead lamps in similar fashion. Students ***communicate results*** as they relate to both inversion of image and color.	**Interactive Demonstration:** The instructor explains to students the use of a pinhole camera – two boxes sliding in and out of one another with a pinhole in one end (aluminum foil) and a projection screen (white vellum or wax paper) on the other. Students ***predict*** what would happen to h_i if d_i and d_o were varied. Students are further asked to ***explain*** what would happen if the size of the pinhole and the number of the pinholes were increased. Students are given pinhole cameras and asked to interact with them in any meaningful fashion using artificial light sources to ***acquire and process data.*** Students complete a worksheet attempting to ***explain*** the various observed phenomena. They ***formulate and revise explanations using logic and evidence.*** Image inversion and increasing/decreasing size also ***explained*** using models.	**Inquiry Lesson:** Students ***design and conduct investigations*** that call for qualitative ***measurements*** with the assistance of the instructor to find simple relationship between d_i and h_i when d_o and h_o are fixed. (No measuring devices are permitted at this stage of the activity.) Students conduct another controlled activity the goal of which is to ***describe the relationship*** between d_o and h_i when d_i and h_o are held constant. Students write conceptual relationships such as "When d_i increases, h_i increases if all else is held constant." Students are asked to how they might conduct a controlled experiment to determine the mathematical relationship(s) between the associated variables.	**Inquiry Lab:** Students are engaged ***designing investigations*** in which variables are controlled, and ***measuring metrically*** is used as a means for quantifying data. The lab activity is "jig sawed" so that several simple relationship from the inquiry lesson can be evaluated. For instance, Groups will ***establish empirical laws*** on the basis of evidence and logic. For instance, they will find the relationship between d_o and h_i when d_i is held constant. Another group will find the relationship between d_i and h_i when d_o is held constant. The first group will find an inverse relationship; the second group will find a proportional relationship. Drawing these relationships together, and looking at the system parameter of h_o, students find with the assistance of the teacher that: $magnficiation = \frac{h_i}{h_o} = \frac{d_i}{d_o}$. (A negative sign can be introduced as appropriate if the distances are considered vector quantities.)
	Hypothetical inquiry: Students will use their knowledge of geometry (similar triangles) to ***synthesizing complex hypothetical explanations*** deriving the relationship $\frac{h_i}{h_o} = \frac{d_i}{d_o}$ noting that magnification is merely a definition. They will ***generate predictions*** through the process of deduction, and ***solve complex real-word problems*** as provided by the teacher.			