Primary-school children's conceptions of light and their relation to the historical progression of optics

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Abstract

The current study assessed children's ideas on light and optics using a cross-sectional design. Given current literature and theory within cognitive psychology, history of science and science education, it was expected that (i) older children would be more likely than younger children to have a modern scientific understanding of light concepts; (ii) for many of the light concepts, there would be a parallel between the pattern of progression and change in children's conceptions of light and scientists' conceptions of light throughout history, and, finally; (iii) employing a historical lens would allow for a better understanding of not only the age-related patterns in children's ideas of light but also children's age specific alternative conceptions of light.

A Light Core Concepts Questionnaire (LCCQ) was administered to participants (N=757) from across a wide age group (6 to 12 years). The participants were representative of ethnic groups attending a range of primary schools situated in a large New Zealand city. None of the participants had received classroom instruction in light and optics. The verbally delivered LCCQ was used to elicit children's responses about prerequisite concepts necessary for a scientific understanding of the physics of light and employed two-choice, multi-choice and open-ended questions. Some questions were specifically designed to compare children's conceptual understanding on light and optics with ideas adopted throughout the history of science.

The results of the current research found that with increasing age (6 to 12 years old) children's modern scientific understanding for many concepts on the physics of light increases. In comparison with other research, a higher proportion of children participating in the current study held correct views at younger ages. On easily observable phenomena, children as young as 7 years could identify common light sources and knew that some objects are reflectors of light. By age 12, the majority of children could correctly identify more abstract concepts such as what causes colours in rainbows.

Results of the present research indicate there is a parallel between the age-related patterns of children's ideas on light and the historical progression of scientific knowledge of the physics of light. With regard to light and vision, both early scientists and children held a similar range of alternative beliefs, that is, extramission, intromission or Eastern Islamic theories. Similar beliefs were shared about other concepts that were accepted as true theories in the history of science. For example, colour is the property of the object and when an object is placed in water it becomes distorted because water is less perfect than air.

The results indicate that the pattern of alternative conceptions held by children as they relate to history provides further understanding of why there are differences in children's beliefs about light and optics across age groups. For more difficult concepts, children and early scientists initially formulate similar theories based on their observations and what appears to be commonsense. As they reconceptualise their ideas, children and scientists formulate similar more abstract theories. In addition to discussing the value of the history of science as a lens to better understand children's conceptions, the implications of these results are discussed as they relate to specific kinds of interventions or instructional approaches to elicit successful conceptual change in the classroom.

Dedication

I dedicate this thesis to my father Noy George
who first kindled my interest in science and history
as we made car journeys together in the Humber Super Snipe.

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