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從高中學生解釋物理現象的表徵與評價探討其概念架構與認識取向

An Investigation of Senior High Students' Conceptual Frameworks and Epistemological Views through Their Representations and Evaluations of Explaining Phenomena in Physics

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中文摘要

本研究是研究者在任教的高中，以一個班級的學生為主要研究對象，並從內容取向與認識取向兩方面，探討學生解釋物理現象的內涵。在內容取向方面，是以面鏡反射、水與光的折射、及繞射現象為主要題材，讓學生在各單元教學前，以開放式紙筆測驗的方式作答，嘗試表達並解釋不同情境下，發生該物理現象的情況以及相關問題，研究者意欲從中了解學生理解該物理現象的情況，並找出學生的概念架構。認識取向的主要資料來源，則是在相關單元的教學之後，研究者根據學生回答上述開放式紙筆損嚇問題的分析資料所得，再加上教學過程中使用的解釋方法，形成一份由不同解釋模式組成的半開放性問卷，請學生根據自己的感受，評價這些解釋模式的可接受程度，並嘗試表達自己做出評價的依據，從而了解學生在認識取向這方面的看法。研究者根據這些以紙筆形式回答的資料以及晤談轉錄的輔助，採用質的資料分析，探討四個主要問題：一、學生用以解釋面鏡成像、折射、繞射等現象的概念架構，二、學生在不同情境下概念架構的運用或轉移的情況，三、學生對於面鏡成像、折射、繞射等物理現象的不同解釋模式的可接受程度，以及四、追求理解的學習中，學生概念架構與認識取向扮演的角色分別為何？研究結果顯示，學生在教學前解釋面鏡成像、折射、繞射等現象，呈現許多不同的解釋方式，包括對稱作圖的成像方式以及成像隨鏡面作彈性變形等等面鏡成像的解釋方法；學生並認為折射是不同介質問發生的現象，因此，深水淺水都是水，不會發生折射現象的想法；以及繞射是入射波與障礙物或周圍介質產生交互作用的結果等等另有架構。而且，這些概念架構在不同情境間的運用，會因情境差距的不同呈現了一致性、情境固著或無法順利轉移的情況。學生對於物理解釋的認識取向，則可從兩方面加以說明，一是將解釋視為傳達理念的工具，學生普遍喜歡作圖的、簡捷公式化的、以及易於想像的動態解釋模式；學生亦顯出對解釋本身合理性的要求，包括，與自己生活經驗比較，認為解釋內容要與現象具因果關係，以及解釋方式必須能同時解釋不同情境的一致性要求等等看法。大體上，學生對於回答解釋、評鑑類型的問題頗感困難，係因與學校傳統的評量方式要求不同所致。本研究的發現應可作為改革高中科學教學之參考。

Abstract

The purpose of this study was to investigate a class of senior high students' explanations of physical phenomena by means of content and epistemological approaches. First, in content approach, three topics, including image reflection, the refraction of water and light, and phenomena in diffraction, were presented to the students as open-ended questions before instruction. All the students were asked to express and explain their opinions of these physical phenomena. Second, in epistemological approach, a semi-structured questionnaire consisting of different models of explanation was developed, according to the students' responses in the previous open-ended questions and the teacher's explanations during instruction. Third, the students were asked not only to evaluate the acceptability of these explanations but also to give reasons. The qualitative method was used to analyze the students' responses in pencil-and-paper tests and interviews. This study focused on the following research questions: (a) What were the students' conceptual frameworks for explaining phenomena in mirror image formation, refraction, and diffraction? (b) How did the students use and shift their conceptual frameworks in different situations? (c) What was the students' levels of agreement with these various models of explanation? and (d) What were the roles of students' conceptual frameworks and epistemological approaches in the process of understanding concepts? It was revealed that the senior high students employed various ways to explain physical phenomena in mirror image formation, refraction, and diffraction. For mirror image formation, the students tended to be influenced by written words, symmetric diagrams, or shape changing on the mirror surface's curve. For refraction, many students argued there was no refraction in a sink of water even it was shallow at one side and deep at the other side, because refraction happened between different media only. For diffraction, the students preferred to think that diffraction was the result of the interaction between incident-waves and obstacles/media. It emerged that students' frameworks were coherent, situation-fixed, or hard to transfer in different situations. On the other hand, students' epistemology approaches showed that most students tended to accept diagrammatic, simple formulated, and easy imagined dynamic models of explanations. In addition, the students also paid attention to the reasonableness of explanations, especially relating explanations to his own life experiences, asking if the explanation really explains the phenomena, and being able to apply the explanations to every key situations. Generally speaking, most senior high students felt difficult to explain and evaluate phenomena in physics learning, because such demands were quite rare in traditional assessment in high schools.