PARALLEL CONCEPTIONS IN THE DOMAIN OF FORCE AND MOTION

SUSANN HARTMANN, HANS NIEDDERER

University of Bremen, Germany

ABSTRACT

The basic assumption, for which we try to provide evidence in this paper, is that students always use multiple explanations before and after teaching. Other studies also give evidence of competing conceptions used in one content area, yet often a variation of context is seen as the cause of multiplicity. The study presented here focuses on individual answers within one context. A total of 47 students from grade 7 up to university level participated in interviews which dealt with three qualitative tasks in the domain of force and motion. As the interview technique was based on waiting and asking questions of specification without giving additional information, the context is assumed to be stable when dealing with one task. Data interpretation focused on 27 students from four different schools (age 16), who were interviewed before and after they attended a class in mechanics. Results show that most answers, even with respect to one task, reveal multiple explanations.

1. THEORETICAL BACKGROUND

Students' ideas about physical phenomena have been studied and described for many years. While some researchers focus on the difference between everyday life and scientific thinking (Duit et al., 1981; Reif & Larkin, 1991), others emphasize that both perspectives have much in common (Westra, 2003). The question of coherence and stability was raised in connection to this discussion. How unstable and fragmented is thinking in everyday life? Much research has been undertaken to clarify this question but no agreement has been reached so far. Viennot's statement gives a short insight into this debate: "...if common knowledge is indeed made up of bits and pieces, they are rather large; zones of coherence have, in fact, emerged from what first seemed a muddle of unrelated errors." (Viennot, 2001, p. 11). If we think of students' knowledge as scattered in bits and pieces (diSessa, 1993), multiplicity may seem natural.

In many empirical studies multiple conceptions were found to be related to context variations (Gunstone & Watts, 1985; Gerdes & Schecker, 1999). But is it possible to find competing conceptions in the answer of one person to one task if we look at conceptions which have the magnitude of explanations? An explanation is more than a small piece of thought as it combines several elements. Multiplicity in this paper is defined as the ability to form more than one explanation to a given task;

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in this paper the terms *multiple explanations* and *parallel conceptions* are used interchangeably. To us an explanation can be viewed as a cluster of elements that are linked to each other. Parallel conceptions have also been described as multiple cognitive layers in students' understanding (Petri & Niedderer, 2003).

In other studies parallel conceptions were also found. Tytler (1998) describes the answer of a student called "Noel": "In generating all these explanations, he is drawing on a cocktail of conceptions to which he accords varying allegiance. (...) Noel is not only generating different conceptions for different tasks, but is doing so within tasks" (p. 911). Maloney and Siegler (1993) state: "For years after encountering physics concepts, students may possess not a single coherent understanding but rather a variety of alternative understandings that coexist and compete with one another" (p. 283). Taber (2000) concludes from his observations "...an individual learner can simultaneously hold in cognitive structure several alternative stable and coherent explanatory schemes that are applied to the same concept area" (p. 399).

We know little from these studies about context variations as a possible cause for multiplicity. It is therefore difficult to tell whether parallel conceptions in one concept area, or in respect to one task, were due to shifts in context. Contexts may differ in place and surrounding (Roth, 1996), in time (length of an interview), in interactions, and thematically (task). In designing our study we kept all of these 4 parameters as constant as possible. We are aware that slight variations, especially those due to interactions, are inevitable.

Aim

Our main research aim was to find out whether or not students' answers to questions about force and motion revealed the existence of multiple explanations, even if the context did not change. As our interview technique carefully avoided giving additional information, but relied on waiting and asking questions of specification, we have assumed that the context is stable when dealing with one task.

Relevance

If students usually formulate more than one explanation with respect to one task in a given context when they are given sufficient time, there is an urgent need to consider multiple points of view in a classroom situation. Teaching strategies that allow students to consider competing answers and to develop criteria for judging their appropriateness are then more valuable than other strategies. With respect to multiplicity, learning means to develop the abilities to distinguish different views and to find the strengths and weaknesses of each.