

On the use of phenomenography in the analysis of qualitative data

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ABSTRACT

In this paper we describe phenomenography and demonstrate its use in two separate studies; an investigation of students' understandings of gravity and a comparison of two groups of students awareness of the utility of physics.

INTRODUCTION

Consider the idea that learning can be described in terms of a description of *what students learn* rather than a description of *how much* they learn.[1] We are concerned with the range and complexity of what students learn, and the patterns and trends in their responses. Correctness and understanding are not part of the description of what students learn. Those aspects can be studied later. This kind of approach has been the basis for many earlier studies and is characteristic of a methodology called phenomenography. [2,3,4,5] Marton [6], a proponent of phenomenography, defined it thus:

Phenomenography is the empirical study of the differing ways in which people experience, perceive, apprehend, understand, conceptualize various phenomena in and aspects of the world around us.

Phenomenographic analysis does not look for pre-determined patterns but extracts emergent patterns from the data.

Other approaches

Two well-known approaches to the analysis of qualitative data are grounded theory and phenomenology. Although the approaches have diverse uses, the aim of grounded theory is to generate theory from the gathered data while phenomenology provides a philosophical stance for studying people's understanding of phenomena. Each approach has a selection of data collection and analysis tools. The perspective adopted by a researcher determines the approach and an associated set of data collection and analysis tools.

We have chosen phenomenography because we are interested in identifying variations in the data. Multiple researchers and iterations are used to identify the variations. In contrast phenomenology identifies themes and a structure for each theme while grounded theory obtains data from multiple sources and considers multiple views of the data.

PHENOMENOGRAPHY

Historical overview

Phenomenography was originally developed by a research group in the Department of Education, University of Gothenburg, Sweden. The word phenomenography was used for the first time in 1981 for describing a method for analysing interview transcripts.[7] Marton [8] argues that research such as that by Piaget in its earlier phases is phenomenographic in nature. Such research aims at providing a detailed description and analysis of the qualitatively different views of aspects of the world and human experiences.

Methodology

We use phenomenography as a way of learning about the different ways students think about things, by asking questions and categorising the answers. The initial categorisation is done independently by several researchers who read the answers and place them into categories according to a pattern, or structure that they perceive. The researchers may choose to use differences or similarities between responses or any other criteria that they perceive as being

significant. These initial categorisations are often made using only a sample of the full set of available responses. After the initial categorisations, the researchers meet to discuss their categories and, more importantly, their interpretations of the answers. It is interesting to note that different members of the team quite often place the same subset of answers in a category, yet give quite different names and descriptions to that category. It is also quite normal for a researcher to identify a category that the others had not identified and for the others to then realise that the category does exist. At this level the categories are used to simply describe what students are saying. Following the initial categorisation, the team of researchers discusses and revises the categories, re-examining the original data and including larger samples, until they reach a consensus about the final set of categories.

Thus, using phenomenography we can get a broad picture of the range of students' ways of thinking. If we look only at content and correctness, we can miss the range of different ideas that students have, simply because they are 'wrong'. If we use predetermined categories we may fail to identify important conceptions and ways of thinking.

The following process was used for analysing data for the two studies presented in this paper. The process involves several stages of independent categorisations by a team of researchers, meetings to deliberate on category definitions and names, and further meetings to establish the boundaries of the categories.

Three researchers independently categorised the same sample of 20 to 30 responses. We met to compare our categories and decide on broad category definitions. The researchers again independently categorised the same 20 to 30 responses into the broad categories. The process was repeated till we were confident about the categories and some finer subcategories had emerged. Then we categorised an additional 50 responses and

established definitions and boundaries for the categories. If we could place the responses into the categories with an agreement of about 70% or better, the definitions were tested with a person who was not previously involved in the project. That person was asked to place 20 to 30 responses into the categories which we had defined and if that categorisation had about 70% or better agreement with that of the research team we accepted the definitions. One of the researchers now placed the remaining responses into the categories. Additional meetings were held to discuss responses that were difficult to categorise, possible changes to category definitions and the possibility of new categories.

AN INVESTIGATION OF STUDENTS UNDERSTANDINGS OF GRAVITY

The study

We categorised 200 answers to the following qualitative problem from a first year examination.

In a spaceship orbiting the earth, an astronaut tries to weigh himself on bathroom scales and finds that the scale indicates a zero reading. However, he is also aware that his mass hasn't changed since he left the earth. Using physics principles, explain this apparent contradiction.

The aim of the study was to determine the variety of answers and structure in the answers. The results are being used to investigate (1) whether students who had studied senior high-school physics had performed differently from those who had not and (2) if repeating the same question three years in a row in final examinations influenced students' answers.

Results

We obtained a three-tiered structure in student responses. Most student responses contained a comment regarding the existence or absence of gravity at the space ship. These comments formed the first tier of categories. The second tier contained

answers that tried to justify the absence of gravity and/or explain freefall. The third tier either used mass and scales, or scales and normal force to explain the absence of a reading on the scales. We have mapped the tiers to show how students understand and link concepts.[9]

STUDENTS' AWARENESS OF PHYSICS

The study

We have been studying differences in perceptions of physics for two successive intakes, during 2001 & 2002, of first-year university students who had experienced two substantially different high-school physics syllabuses. An important feature of the new syllabus is that it emphasises the importance of context for learning subject matter. Student responses from the two intakes to two open-ended survey questions have been analysed using phenomenography. The two questions, I and II are as follows.

I: Much of physics is about the way things move and change in motion. What do you know about the physics of motion?

II: There is a lot of Physics that relates to the way people communicate with each other. What do you know about this?

Question I refers to mechanics that is covered in depth in both syllabuses while question II was designed to probe the significance of context in the new syllabus. We expected that qualitative differences and similarities in responses would give a measure of students' awareness of the utility of physics in communications.

Results

The major phenomenographic categories are shown in Table 1. We stress that there were four different independent sequences of categorisations for each question and each year allowing new categories to emerge. The original categories and category definitions have subtle differences. However, if there are enough similarities to justify comparisons we have done so in Table 1. In some cases, categories have not been identified, indicated by a dash in Table 1.

Question	Question I		Question II	
	2001	2002	2001	2002
A. Little or no information	18.8%	19.5%	50.4%	36.3%
B. Lists or list like information	50.8%	53.1%	25.6%	24.9%
C. Linking of physics ideas and concepts	19%	15.2%	11.1%	-
D1. Linking of physics with communication or development of technology, or explicitly with real life examples	5.2%	5.5%	-	24%
D2. Highly coherent and outward looking	-	-	1.3%	0.9%
U. Uncategorizable	6.2%	6.7%	11.6%	13.9%
Total number analysed	325	420	234	237

Table 1: A comparison of phenomenographic categories of student responses.

We note several trends.

* Question I has prompted about 50% list like responses. Overall the percentages of student responses in each category for question I are similar for 2001 and 2002.

* Question II has prompted more responses that don't provide much information. In fact students not exposed to the contextual syllabus had difficulties interpreting the question. Different categories have been identified in 2001 and 2002. The distributions for the two years are quite different.

* In comparing the 2001 cohort with the 2002 cohort, students' awareness of physics as measured by question I is not different. However, their awareness of the utility of physics as measured by question II is quite different.

Students have had to choose the manner in which they answer the questions. The dimensions they choose reveal aspects of the students' relevance structure. Hence students exposed to the contextual syllabus are more tuned to the utility of physics.

SUMMARY

We have discussed the use of phenomenography in analysing written responses to open-ended questions. In the first study the results have provided a methodology for mapping how students understand and link concepts. In the second study we have made comparisons of students awareness of physics. Advantages of such a method are that the categories are derived from patterns in the data, allowing for different patterns to emerge and that each student is exposed to the same intervention. Disadvantages are that the method requires several researchers and that students are not thoroughly questioned, although that can often be done in follow up interviews.

We have deliberately chosen phenomenography because we are interested in identifying the variations in students' responses.

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