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Learners' conceptions about astronomical concepts related to the sun and the earth

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2006-11-16T10:18:48Z
http://hdl.handle.net/10539/1791

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CHAPTER 1

INTRODUCTION

This chapter gives an introduction to the research report. It gives a general idea of how the study was conducted, including the approach used, the instrument used to collect data, and how the data was analysed. The chapter also gives the outline of the report, *i.e.* it shows the contents of each chapter.

1.1. STATEMENT OF THE PROBLEM

The basis for this research project is the poor performance of students in science, a problem revealed by results of external examinations. Research shows that this is related with learners having many scientifically unacceptable concepts. The following discussion shows that learners in many parts of the world, from primary, through high school learners, to university students, have scientifically unacceptable ideas about day and night, and seasons.

1.1.1. Day and Night

In a study in the U.K. only 32% of 31 B.Ed. students and 56% of 41 PGCE students correctly explained the cause of day and night, *i.e.* spherical Earth spinning on its axis once in 24 hours (Parker & Heywood, 1998). In other studies, 60% of 42 ten-and-eleven year old children in the U.K. (Sharp, 1996), 62% of 76 university students in Israel (Trumper, 2000), 50% of 448 junior high school students (Trumper, 2001a) and 64% of 378 senior high school students (Trumper, 2001b) in Israel gave the same response.

Two percent of 102 secondary students in Greece (Bakas & Mikropolous, 2003) and 5% of children in the U.K. (Sharp, 1996) gave responses that imply that the Sun behaves like an animal. Examples of this animate conception are that the Sun goes behind hills and/or inside clouds at night. A misconception given by 13% of B.Ed. students (Parker &

Heywood, 1998) and 2% of children in the U.K. (Sharp, 1996) is that the Moon and the Sun obscure each other at night, and separate during the day. A misconception revealed by 35% of secondary students (Bakas & Mikropolous, 2003), 13% of B.Ed. students and 17% of PGCE students (Parker & Heywood, 1998), and 30% of senior high school students (Trumper, 2001b) is that the revolution of the Earth around the Sun causes day and night; while 17% of children in the U.K. (Sharp, 1996), 11% of junior high school students (Trumper, 2001a), and 6.5% of B.Ed. students (Parker & Heywood, 1998) said that the revolution of the Sun around the Earth causes day and night.

1.1.2. Seasons

Only 2% of 49 pre-service elementary teachers in Kentucky (Atwood & Atwood, 1996), 19% of children in the U.K. (Sharp, 1996), and 14% of junior high school students (Trumper, 2001a) correctly explained the cause of seasons, that is, Earth's tilted axis as it revolves around the Sun once a year. A misconception revealed by 37% of pre-service teachers (Atwood & Atwood, 1996), 18% of secondary school students (Bakas & Mikropolous, 2003), and 5% of children in the U.K. (Sharp, 1996) is that the Sun moves closer to the Earth in summer and away from the Earth in winter. A misconception of 12% pre-service teachers (Atwood & Atwood, 1996) is that the Earth's axis changes direction, that is, the axis tilts towards the Sun in summer and away from the Sun in winter. One of the 26 seven-to-seventeen year old deaf pupils in Norway (Roald & Mikalsen, 2001) said that the Sun has a summer side and a winter side, and that it spins once a year to make summer and winter on Earth. Twelve percent of children in the U.K. (Sharp, 1996) said that different seasons are caused by the stationary Sun, which heats up in summer and cools down in winter.

These studies show some alternative conceptions that learners have about day and night, and seasons. However, relatively little has been published about the conceptions of South African learners about these concepts.

1.2. AIM OF THE STUDY

The aim of this study is to find the conceptions of grade-10 learners about simple astronomical concepts related to the Sun and the Earth after instruction.

1.3. RESEARCH QUESTIONS

The study aims to answer the following questions

- What are grade-10 learners' conceptions about day-and-night?
- What are grade-10 learners' conceptions about seasons?

1.4. CONTEXT OF THE STUDY

This research project is based on the content area: **Planet Earth and Beyond**, which "... focuses on the structure of the planet [Earth]... and on the Earth as a small planet in a vast universe" (National Department of Education, 2001:61). The South African national curriculum requires intermediate phase learners to learn that day and night are caused by rotation of the Earth on its axis, and that the motion of the Moon relative to the Sun and the Earth can be used to explain apparent changes in the Moon's shape. In the senior phase, learners learn the positions of members of the solar system, and use motions of the Earth and the Moon to explain day and night, year (including seasons), phases of the Moon and eclipses. Data for this research was obtained from senior phase (Grade-10) learners.

1.5. THEORETICAL FRAMEWORK OF THE STUDY

The concepts that have been used to analyze the results in this study are border crossing, collateral learning, mechanistic and organistic worldviews. These concepts are described below.

Aikenhead (1996) says that when students learn science at school, they move from their home culture to the school-science culture, *i.e.* they cross borders from one culture to another. He says that border crossing is **smooth** for some students and almost **impossible** for others. Jegede (1995) has given a *cognitive experience* of border crossing, which is called collateral learning. This is "the process whereby a learner in a non-western classroom constructs, side by side and with minimal interference and interaction, Western and traditional meanings of a simple concept" (Jegede, 1995:117). Learners who resolve a conflict between the two cultures experience ***secured*** collateral learning while those who do not experience disequilibrium having acquired knowledge from the two cultures experience ***parallel*** collateral learning (Jegede, 1995).

In a study conducted in two **South African** universities, Lemmer, Lemmer and Smit (2003) classified responses of first-year students about special objects into two categories: **mechanistic** views, which involve "formal … reasoning and … operational definition of concepts" (Lemmer *et al*., 2003:564), and **organistic** views, which fall in the following categories: animism, holism**,** teleology and egocentrism**.**

1.6. METHODS

1.6.1. The Sample

Data for this study was collected from two schools. Convenience sampling was used, *i.e.* one convenient school was used to pilot the instrument, and another school used to gather the research data. Forty one learners participated in the pilot study while 60 participated in the main study. A limitation that has to be acknowledged is that learners differ from

one school to another (in their backgrounds and abilities) and therefore the findings from the two schools may not be truly representative of conceptions of all grade-10 learners in South Africa, and hence the problem of making generalizations.

1.6.2. The Diagnostic Questionnaire

A diagnostic questionnaire was used to collect data in this study. The first step taken when designing the questionnaire was to define the content, that is, writing propositional knowledge statements and relating them with a concept map. The concept map shows the relationships between the concepts in the propositional knowledge statements. The second step was to review literature to find misconceptions that are already documented. This gave a broad scope about what to expect from the study. The last step was to set the questions. Open-ended questions were constructed, and learners were asked to use diagrams in their explanations. Also, a specification grid was constructed. The purpose of this grid was to check whether the test questions match the propositional knowledge statements. This grid shows that the questions are evenly distributed, *i.e.* they have not addressed too few concepts. The completed test was taken to experts to check both content and face validity. The checking ensured that there were no leading questions, and that the instructions and the language used were clear. The specification grid was also checked to ensure that all the test content has been covered.

1.6.3. Piloting the Instrument

The diagnostic questionnaire was administered to a pilot group. The pilot group consisted of grade-10 learners in a school near the school whose students were later used for the final study. The pilot group was asked to report difficulties encountered when answering the questionnaire. The purpose of piloting was to determine whether the time given was enough to finish the test, and to check ambiguity in the instructions and question wording, as suggested by Bell (1987) and Anderson (1990).

1.7. ANALYSIS OF RESULTS

Open coding was used to identify patterns of responses given by learners. An item-by-item analysis was made from the questionnaire and it shows that very few learners had scientifically acceptable ideas about day and night, and seasons. Direct quotes from learners' responses have been reported to give an essence of how they responded. Patterns of their diagrams have also been reported. It is hoped that results obtained from this study will enable learners' conceptions to be better understood.

1.8. IMPORTANCE OF THE STUDY

Findings from this study can be helpful to educators and researchers. If educators know the conceptions that learners have after instruction, they will be able to modify their lessons so as to give better instruction in future. Analysis of the results indicates that some learners did not move from their cultural to a scientific knowledge, and this may help educators when planning their lessons. Researchers may investigate ways of remedying misconceptions that persist even after instruction

1.9. ETHICAL CONSIDERATIONS

The study was carried out in two Gauteng Department of Education (GDE) schools. As a requirement, permission to conduct research in these schools was sought from the GDE. Also, names of the schools and the learners who participated in the study remain confidential.

1.10. OUTLINE OF THE REPORT

Introduction to this research report has been given in this chapter. The next chapter (Chapter 2) gives a detailed review of the literature, *i.e.* documented conceptions of learners about day and night, and seasons, and also describes a theoretical framework used to analyze the results. Chapter 3 is a methods chapter. It describes how the instrument was constructed, piloted, and administered in the main study. Chapter 4 presents analysis of pilot and main study results. Chapter 5 discusses main study results, gives conclusions, and makes some recommendations.