

Analyzing the upper secondary school students' view of the universe

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Abstract. In this work we analyze preinstructional ideas about the Universe that students (enrolled in physics courses) of last year of upper secondary school have. We have focused on the beginning and the later behavior of the universe. In order to accomplish that, we have designed a questionnaire with open questions to detect the way students think about the universe. The answers have been analyzed using phenomenography, a method that enabled us to perform a qualitative-quantitative mixed study. The results show that the majority of the students have misconceptions about the Big Bang and the evolution of the Universe.

1 Introduction

The study of the universe, in general, and the cosmology in particular, usually begins in primary school. Moreover, the amount of information received from TV, internet and other surrounding media is broader than in other more specific and not so popular science subjects. Taking into account the above arguments, the preconceptions and the ideas that students' have about the universe are relevant [1]. It is well known that sometimes these ideas persist after instruction and the detection of them is essential for the future meaningful learning of the students [2].

There exists a variety of studies on the students' ideas on astronomy (solar system, moon phased, seasons...), but with an evident lack of studies about Big Bang and the evolution of the universe [3]. Given the above, we have developed a research to analyze the ideas of the upper secondary school students' about the universe, paying attention to a) how they understand the Big Bang and the birth and evolution of the universe; b) how they describe the nature of the universe and c) how they explain the solar system into the universe.

2 The study

In order to answer those research questions, we designed an open-ended questionnaire for last year upper secondary school students (17-18 years old), who choose physics as subject. The aim of the questionnaire was to focus on the explanations more than in the correctness of the answers. Four secondary schools from different towns of Gipuzkoa (Basque Country) were selected. There are no statistical differences in the answers of the schools so we are presenting all the data together, 122 students at all. The questionnaire was validated in two different ways. First, experts in cosmology stated that the questions are well related with the objectives of the survey. Second, the questionnaire was given to 26 students as a pilot probe and one question was split in two and some wording changes were done due to that trial.

The analysis of the questionnaire was performed using phenomenography [4] and made independently by two researches. Besides, several cycles of refinement were considered so as to define the categories and to classify the students' answers. Cohen's kappa was measured to confirm the reliability of the analysis of the data.

3 Results

In this work we are going to present the results of two questions from a broader questionnaire. The first question, categorization and percentages of answer in each category are presented in table 1.

Question 1: What is the Big Bang?		
Category		Percentages of answers
A	The birth of the universe. There was nothing before.	5%
B	There was materia before the Big Bang	19%
B1	Materia was spread in the Big Bang	38%
B2	Big velocity, pressure, temperature... generated Big Bang	5.8%
B3	Cyclical universe	6.6%
C	Bag Bang doesn't exit	2.5%
E	No answer/no coherence	23.1%

Table1. Resume of the question 1of the questionnaire. Reliability: Cohen's kappa 0.95.

Only 5% of the students answer that the Big Bang was the birth of everything and that there was nothing before it, neither materia nor space/time. Around 75% of the students think that there was materia before the Big Bang and represent that moment as a conventional explosion where the materia is spread in the space. There are also answers without coherence or without explanations.

Regarding to the second question, we asked the students if their answer to the first question is demonstrated by science. There is only a 10% of students speaking about evidences as the microwave background or the redshift of the galaxies (Cohen's kappa was 0.83).

4 Conclusions

In this work we studied the ideas of the upper secondary school students about the formation and evolution of the universe. We found that there are important misconceptions in the model of the universe they have. Most of the students incorrectly relate the Big Bang with a conventional explosion and think that there was materia before it [5]. Although the students in general do not have a correct scientific model for the Big Bang, they assume that nowadays the universe is in expansion. However, near the 90% of students are not able to present any evidence related with the Big Bang or with the expansion.

These results show what are students' conceptions on some fundamental aspects of the universe. Nevertheless, they also evidence the need of more and deeper researches in the topic. Furthermore, the need of research based Teaching Learning Sequences to help students to overcome these difficulties also arises.

References

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