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Exploring the Astronomical Knowledge of Italian Students: Surveying Middle Schools and Informal Courses

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Abstract

Kids receive most of their astronomical knowledge through three fonts: formal educations (schools), informal education (laboratories,scientific festivals and other out-school activities) and from TV, cinema movies and documentaries. In the first case, students have to learn astronomy from certified fonts (school books and others teaching tools) and their knowledge is verified by teachers. However, for younger students, deep competence of teachers in a specific topics of science is not usually requested. In the second case the situation is less homogeneous. Informal education is located in scientific structures (Universities, Planetarium, Observatories), scientific festivals or dedicated structures for science outreach and it is lead by researchers (with little if any educational preparation) or by members of associations for scientific popularization.The skills of these members vary a lot since one can find teachers, university or high school students or experts, that in the case of Astronomy are in numerous cases amateur astronomers. Moreover, an important source of informal education is found on internet, where one can found numerous science outreach blogs, facebook and web site. In this latter case the quality of fonts is very hard to evaluate. The aim of this work is to explore the astronomy knowledge and misconceptions in students of age range of about 10-13 and to compare two types of students: one attending only regular school lessons and the others attending also informal education. We tested the hypothesis that latter students are more motivated to go deeply in their astronomical education and should have a more precise astronomical knowledge. Data have been collected form 2014 to 2017 and the final sample regarded 1017 students.We proposed questionnaires with questions about Black Holes, Star life, Seasons and Moon phases.

Keywords: *Astronomy, Misconceptions, Informal Education,School;*

1. Introduction

Kids receive most of their astronomical knowledge through three fonts: formal educations (schools), informal education (laboratories, scientific festivals and other out-school activities) and from TV, cinema movies and documentaries. In the first case, students have to learn astronomy from certified fonts (school books and others teaching tools) and their knowledge is verified by teachers. For younger students, deep competence in a specific topic of science of teachers is not usually requested. The second case the situation is less homogeneous. Informal education is located in scientific structures (Universities, Planetarium, Observatories), scientific festival or dedicated structures for science outreach and it is lead by researchers (with little if any educational preparation) or by members of associations for scientific popularization. The skills of these members vary a lot since one can find teachers, university or high school students or experts, which in the case of Astronomy are in numerous cases amateur astronomers. Moreover, an important source of informal education is found on internet, where one can find numerous science outreach blogs, facebook and web sites. In this latter case the quality of fonts is very hard to evaluate. The third case is far most critical. In fact, one spans from rigorous to low level products as in the case of documentaries. Moreover, part of the information is driven by newcasts, by science-fiction movies or cartoons (f.i. the recent The Martian or Interstellar movies), that are not thought to be educational tools. Educators tend to underestimate this source of information that is on the contrary widespread, emotional driven and easy to remember. A general problem of the education is whether the astronomical concepts are correctly exposed and subsequently understood by students. A number surveys took on this question and the origins, persistence and time evolution of misconceptions in astronomy (see f.i. Favia et al. [1], Favia et al [2], Calvente et al. [3] , Sadler[4]) The aim of this work is to explore the astronomy knowledge and misconceptions in students of age range of about 10-13 and to compare two types of students: one attending only regular school lessons and the other attending also informal education. With this classification we made the hypothesis that latter students are likely using fonts outside the school to approach astronomical concepts. In order to avoid biases, the questions are not related to the

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rgument of the lectures we gave during the survey. In this paper we present the first results of this survey, that is ongoing, and regard three questions related to arguments present in the school curriculum. This means every student should have heard at school the topics proposed.

2. Data

We collected questionnaries during talks and lectures given at the last year of "Scuole secondaria di primo grado" (broadly correspondents to middle schools) here, the students are 12-13 years old and have received basic astronomy concepts during their scholastic year. However, astronomy have been studied also at the last year of "Scuola Primaria" (when they were aged 10). Unijunior is a brand concerning a series of lectures held inside the spaces of the Bologna University. The lectures are organized by Marzia Govoni and Fulvia Farabegoli (Departement of Experimental Pathology, Bologna University) and managed by Leo Scienza. The teachers are professional researchers of the University or of the other research Institutes and the participation of students is free. Tipically, students attend at two lectures, whose arguments span from science to history, from economics to psicology. The age range is 8-14 with 45 % are 10-11, while ˜39 % are 8-9 with small gender bias (male are 56 +/- 5 %) (M. Govoni private communication) This data are to be compared to those of students attending only at the astronomy lectures where the 10-11 years old are 41 % and those aged 8-9 are 37 % with the remaining in the age range 12-14.
Data are collected during three years from 2014 to 2017 and regard about 1074 students (567 Unijunior and 507 Schools). In this paper we present results on ~600 students and on three questions. Hereafter we divided the sample as “Uniju” and “School”. Sample sizes are reported in Table 1.

3. The Questions

We started with three basic questions, that concern arguments part of the standard school curricola.

1. *Lunar phases are due to: a) Earth’s shadow projected on the moon; b) different illumination of the Moon along its orbit; c) a real change in the Moon shape*

This question is a classical test for astronomical misconceptions. The first answer is related to lunar eclipses
and reveals whether the students understand correctly the difference between eclipse and moon phases

2. *A) Do different regions of the Earth see the same Lunar phase? : a) yes b) no c) It depends on the hour of observation*
   B) Lunar Phases are due to the Earth shadow projected on the Moon: a) yes b) no c)I do not know

The first question is considered difficult for students because is not in a form normally presented as a verification test in school.
Unfortunately it was not possible to test both Unijunior and School samples with the same question. Question A) was done only in School.
The second question is more standard for schools and has been asked only to Unijunior students in order to test their indoor preparation.

3. *In winter, Earth is: a) nearer to the Sun b) further c) no difference in distance with Summer*

This question is related to the cause of seasons. Although this topic is present in school starting from early years, it is one of the most common misconceptions found also among adults. This is probably due
to the fact that one has a intuitive concept that farther form a heat source you one receives
less energy, while the actual explanation o seasons is the inclination of Earth axis.

Table 1: samples data

Question	a	b	c	NR	Tot
Q1 Total	235	334	47	13	629
Q1 Uniju.	40	74	26	12	152
Q1 School	195	260	21	1	477
Q2A School	61	173	85	1	320
Q2B Uniju	20	33	28	5	86
Q3 Total	96	235	97	1	429
Q3 Uniju	6	80	25	0	111
Q3 School	90	155	72	1	318

4. Discussion

First, we asked to the two samples the reason of Moon phases. At face value only a small fraction of students (7%) think that this phenomenon is due a real change of the satellite's shape.
The different illumination of the moon has been chosen by about 53%, while the "eclipse"explanation has been indicated by ~37% of students. This means, although with similar percentages, the right explanation is in mind of half of the students. By analyzing the difference between Uniju and School samples it seems that a larger fraction of School students significantly preferred the eclipse explanation (41 % vs 26 % of Uniju), while a larger fraction of the Uniju sample (17 % vs 4%) think that phases are due to real shape change. It is interesting to know that the same test given to younger school students (aged 10) give consistent results to the School sample.
Second question is dived in two: the first is in some way difficult and has been proposed toteh School alone.
The success of the (b) answer (different phases are seen by different sites on the Earth) means a difficulty to extrapolate the concepts of question 1. More surprising is the case of question 2B, that is actually only a rephrase of question 1, where we find a flat distribution of answers.
For what concerns question 3, as expected, the most indicated question (54%) says that the Earth is further from Sun in winter. However note that the right answer (a) added to (c), which says "no difference"and that could be roughly considered acceptable, equals the b answers.
Uniju sample indicate more clearly the (b) answer (72%) than School (48%) .
As a tentative conclusion of these initial results of our ongoing survey we can propose a working hypothesis: it seems that, although we presume that students attending informal lectures are more motivated to extend their knowledge, they do not have a more precise concepts of astronomical phenomena than the general School population.
This statement will drive our next questionnaires: in fact we asked deliberately questions about arguments like seasons and moon phases that are not usually at the top of the outreach lists where Black Holes and space exploration are more common. Moreover, we do not touch that points in the lectures we did at school and at Unijunior. Therefore we presume that the student's knowledge is not biased by our presence.

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