Mem. S.A.It. Suppl. Vol. , 1

Memorie della
Supplementi

The Sky as a Laboratory

Living astrophysics from books to telescopes, using computers and data from space

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Abstract. We briefly review the activities and methodological aspects of "The Sky as a Laboratory", an educational project developed by the Department of Astronomy at the University of Padova. The project is aimed at secondary school students and introduces an innovative hands-on didactic approach to Astrophysics.

1. Introduction

"The Sky as a Laboratory" is an educational project conceived by the Department of Astronomy at the University of Padova in cooperation with a team of astronomers teaching mathematics and physics in the secondary schools. The project was tested during the academic year 2001/2002 in three schools near Padova and was extended to a number of schools throughout Regione Veneto during 2002/2003, thanks to financial support from the Italian MIUR (Ministero dell'Istruzione, dell'Università, e della Ricerca).

2. Aim of the Project

The motivation for the project was to bring students in the final years of secondary school in contact with scientific methodologies of modern astrophysical research. At the end of the program the participants are expected to have acquired sufficient experience to be able to develop a simple research project and extract quantitative information from observational data using physical and mathematical concepts learned at school.

The necessary in depth study of these concepts was accomplished with specific didactical components, seminars, as well as training in data reduction and interpretation.

3. Project Activities

The following secondary schools *Licei* participated in the project: "U. Morin" (Mestre, teachers A. Del Negro and A. Tegon), "G.B. Benedetti" (Venice, teacher C. Forieri), "P. Levi" (S. Pietro in Cariano-Verona, teachers A. Gazzaniga

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and L. Vaona), "G.B. Quadri" (Vicenza, teacher A. Pegoraro), and "E. Curiel" (Padova, teacher M. Scalabrin), and the *Institutes* "G. Renier" (Belluno, teacher M. Guglielmino), and "A. Fogazzaro" (Vicenza, teacher G. Magrelli).

The didactical plan of the project was divided as follows:

- 16 hours of core lectures on astrophysical topics presented by the school teachers including:

    1. the nature of electromagnetic radiation;
    2. physical properties of a Black Body;
    3. structure of the Hydrogen atom;
    4. fundamentals of astronomical spectroscopy;
- participation in seminars given by astronomers;
- search for didactical material on the subjects of the lectures.

The extra-scholastic activities consisted of:

- visit of the Asiago Astrophysical Observatory;
- bibliographical research in the Libraries of the Department of Astronomy in Padova and Asiago;
- collection of the multimedia didactical material in the web site of the project (dipastro.pd.astro.it/progettoeducativo);
- observing experience (3 days) at the 1.22m telescope in Asiago.

All the 220 participants attended the above listed activities. At the end of this didactical phase the preparation of the students was evaluated with a written questionnaire (following Domenici, 2001) and the first 20 students were selected for an observational run of 3 day-nights at the Asiago Observatory.

Two astronomers and a technician assisted the students during the observations at the 1.22m telescope. Tutors were also available for the data reduction and analysis using astronomical software (IRAF) and for preparation of the final report.

Fig. 1. The students at the 1.22m telescope of the Asiago Astrophysical Observatory.

4. Results of the Observational Runs at Asiago

During the two observational runs at the Asiago Astrophysical Observatory, the students worked in pairs at the console of the 1.22 m telescope. Spectroscopic observations involved: 1) an active galaxy MRK6, 2) elliptical and spiral galaxies NGC 4254, NGC 2768, NGC 1569, NGC 2798, NGC 3227, NGC 3310 and NGC 4775, 3) a planetary nebula NGC 2371 and 4) a number of standard calibration stars.

Data analysis was carried out by the students with the help of two tutors, using standard procedures including: bias subtraction, flat-field division, wavelength and flux calibrations, night sky and cosmic rays

Fig. 2. Data reduction in the control-room of the 1.22m telescope.

subtraction. At the end of the data analysis, the students from each school prepared the following final reports:

- AGN and Quasar properties (Liceo "Benedetti");
- Morphology of elliptical and spiral galaxies (Liceo "Curiel");
- Physical condition of the gas in the planetary nebulae (Istituto "Renier");
- Mass determination of spiral galaxies from their rotation curves (Istituto "Fogazzaro" and Liceo "Quadri");
- Star formation rate of disk galaxies (Liceo "Morin");
- Electronic density of ionized gas in disk galaxies (Liceo "Levi").

This material will be published in a forthcoming issue of the "Giornale di Astronomia", edited by the Italian Astronomical Society.

5. Pedagogic Evaluation

The didactical methodology of "The Sky as a Laboratory" has focused on:

- building Didactical Units based on problem-solving techniques;
- promoting teamwork and cooperative learning;
- increasing student responsibility in the learning process;
- stressing a quantitative approach to scientific problems;
- using a telescope as a research instrument;
- emphasizing the link between observations and theoretical concepts.

During the project we carried out a pedagogic evaluation by means of both:

- qualitative measures of student satisfaction and teacher activities;
- a statistical test given to the students that included questions about their motivation to be a part of the project, their favorite topics, their previous astrophysical knowledge and the problems encountered during all the phases of the project.

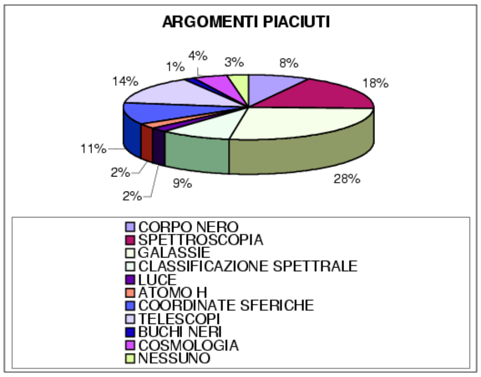
The teachers have also been asked to complete a questionnaire concerning:

- their teaching experiences;
- their empathy with the students;
- their preferences for a particular didactic approach to the subjects;
- their methods of evaluations.

All the activities and pedagogic considerations have been assembled in a general report that was sent to MIUR. In Fig.3 we plot student preferences and problems they encountered in understanding the content of the lectures. The new mathematical and physical concepts were considered rather difficult to assimilate however their use in a practical setting partially overcame this problem. Photographs and notes were recorded during all phases of "The Sky as a Laboratory". In Fig.1 and Fig.2 we see, for example, two moments from an observing run at the Asiago Astrophysical Observatory.

6. Conclusions

We are pleased to say that most of the didactic and educational goals of the



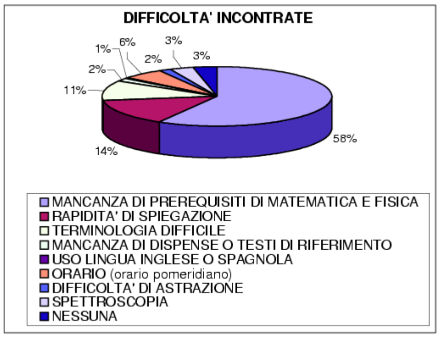


Fig. 3. Up: students' favorite topics. Down: problems encountered during the lectures

project were reached. The novelty of this approach and the advantage of building a "learning environment" (Tessaro, 2002) certainly enhanced the interest, the collaborative activities among the students and the teachers that contributed to this didactic experience. All the details of the project can be found at the web address: http://dipastro.pd.astro.it/progettoeducativo.

7. Aknowledgements

We are grateful to S. Sacchetti, G. Umbriaco, M. Dalle Ave, L. Di Giorgio and R. Baù for their availability and collaboration during all the phases of the project.

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