Space&Astronomy education programs in Israel National Science-Educational Center "Blossoms of Sciences" and Project "ASTROTOP" in Israel

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ABSTRACT

We present 12 year experience of educational project in Space/Astrophysics/Environment field, realized on the base of National Science- Educational Center "Blossoms of Science" of the Jordan Valley College. Our approach is based on the natural curiosity of children as driver of their self-development from the first minutes of their life and even in adult state. This approach shift center of the weight in educational process from direct lectures, sermons, explanation from teacher to children on own attempts of children to investigate problem, what is interesting for them, by themselves (individually or in group). Our approach includes four levels of the projects: "nano-projects" for children garden and basic school (up to 10-12 years), "micro-projects" for intermediate school (12-16 years), "mini-projects" for high school (16-18 years), and "macro-projects" for the best graduates high schools and students of colleges (17-22 years). These levels and projects are interconnected one with another and sometimes participants, started on the micro-projects level in intermediate school, continue their activity up to macro-projects of the graduate's diploma level. For each level we organize courses for preparation of the teachers and instructors, interested in the using of our receipts, and published books and brochures for them.

The content of our activity for different levels:

a) Level of kinder gardens/basic schools– special software with interactive movie -nano-projects; b) Level of intermediate school: "Days of Science" in tens schools of Israel– first contact with astronomy; c) Summer astronomy camps (4–5 of one week camps on 200-300 pupils from all country) with introduce to astronomy and with preparation of micro-projects on themes - first successful experience of research in real science fields (hundreds projects); d) ASTROTOP –

one year program of preparation of short projects, with solution on the quality level of chosen astrophysical problem – mini-projects with first experience of data acquisition, collection, critical analysis and comparison with alternative explanation (many tens projects); e) Graduate Diploma – 1.5 year real participation of students-graduates of high school in astrophysical projects in national observatories and research space centers.

Introduction.

Last years science education in the world meets with serious problems what leads to slow permanent decreasing of level of graduates in this field. This negative process has several reasons from defeat in competition with TV and Internet, deprived school of unique role as monopole source of knowledge, necessary for succesfull existence in the addult world, up to conflict between hard conservative system of school education (based on the principle "follow me" like to soldiers preparation in army) and evident liberalisation of school and society, errosied monopole role of the teacher as undoubted source of "truth". This degradation of the school level of science education is source of potential dangerous for next steps in technological progress of our society in the nearest future. Worry about this future stimulates different initiative groups to develop original projects of an alternative approaches to science education, what may shange situation radically to progress.

Part of these alternatives is based on creative education approach, what change role of the pupil from function like to soldier in army (with hard programs of study, with hard and apriory determined ways of comprehension of knowledge and proficiency) to role of reseacher-scientist. In this role pupil is like to child, gamed in sandbox (with large freedom in choice of the ways for solution of the task, based on the deep inner motivation and intuition). In some mean difference in this two approaches (conservative and creative) is like to difference in approach to help to famished peaople: first is equal to distribution of the food ("fish")= knowledge, second – to teach them to technology of production of this food ("fish rod") =art of substantive generation of question and discovery of the answer. Evidently, that second (creative) approach to education process demand serious modernisation of educational technology, but on the long time scale it is much more efficient then the first one. It gives to pupils not only knowledge, but technology of production of the knowledge.

Main change in thansition to creative approache is change of the basic unit of the educational process from "knowledge" to "project/research", from study of facts and relations as given by God (or by Newton, Faradey, Einstein, ...) to obtaining of these laws and correspondent conclusions in result of research of the pupil/student himself. Transition to this technology is

based on three basic element: demonstration in real laboratory or in virtual Internet space of the processes and provocative facts, conflicted with standard expectations and stimulated intuitive questions from pupil/student; open tools in laboratory or in the Internet virtual space, what supply attempts of the pupil/student to find answer on their question and to test their suggestions; set of scenarious/receipts, what help and direct of pupils/students in their research.

Evidently, that necessity of open and friendly organised databases of experimental or observational data, necessary for research activity of pupils, limits list of possible field of scientific activity very hard and select from them astronomy and space sciences as high priority direction.

First of all, astronomy and space science have unique open databases of observational data, collected in Internet from tens telescopes and space observatories, largest in the world. This giant database is basis of Virtual Observatories, what allow obtaining necessary images of sky objects in numerous spectral band with help of friendly interfaces. Another part of databases includes thousands of catalogs, integrated data on different kind of samples of sky objects from sunspot numbers during hundreds years up to parameters of quasars and far galaxies.

Second priority of the astronomy, as field for application of creatrive methods of education is unique place, what astronomy as science on Unverse around us, occupy in our mind from child years up to the last days Here may be cited well known remark of great European philosopher Immanuel Kant: “Two things fill me with wonder: the starry sky above and the moral law within.”

How can we stimulate students to be exited about learning? How can we get them to feel that they are learning something relevant and will generate enthusiasm and eagerness to know? In which ways are we to allow students to build their understanding? How to combine their personal experiences on the one hand, and their human scientific knowledge on the other hand? The Blossoms of Science group at Jordan Valley College was founded to address these questions. Through years of intensive work of trial and error we tried to combine theory and practice. We were not alone. We did this with groups of: students, young scientific guides, science teachers in various levels, experts in science education, and scientists that are doing science in scientific communities. We are trying to create a bridge between the naïve ideas of children and kids with the well developed, and quite often the unintuitive ideas that are accepted by the scientific community.

In this paper we would like do describe briefly some projects we are doing with students ranging from kindergartens to high-school students. In the last part we will describe in greater

detail the ASROTOP – an astronomy project that allows high school students to choose a subject from the almost infinite astronomy subjects, a project that enables students who are curious enough to expand their understanding from the geocentric world to the celestial one.

The Mission of the "Blossom of Science" Center

Our group was founded in 1993 with the goal to stimulate the study in the Exact and Natural Sciences in accordance with a new educational Paradigm: "Study as you play, enjoy it as a scientist!" The Hebrew term for "Blossoms of Science is "Perhey Mada" which admits of an untranslatable duality: "Blossoms of Science" and "Cadets of Science". This duality reflects the center's aims and approach.

Fig 1: Main observational sites used by the "Blossoms of Science" as sources of observational data for students activity: Emilio Segre Cosmic Ray observatory on the Mount Hermon and comples from 2.5 m radiotelescope and 16-inch optical telescope at Jordan Valley, on the south bank of See of Galilee.

This approach sees the natural curiosity of children as the driving force of their self-development from the first minutes of their lives through their adulthood. This approach shifts the center of weight in the educational process from direct lectures, sermons, and explanation provided by teachers to their children, to the children's own attempts to investigate problems, what interests them, either when studying individually or in groups.

Evidently, this paradigm transition forces us to change our educational tools. Instead of frontal teaching, when teachers formulate problems and their solutions, describing the field of knowledge in their own terms and from their own standpoints, in our approach students obtain from the teachers many tools and options for exploring the same knowledge as the students' own discovery. The main instrument in our approach is the Research Project, where students act as researchers. Certainly, this Research Project approach must be well adapted to the level of the

pupils; it must stimulate creativity in the students and help them on their way to learn as researchers.

As the main field of our activity we focus on Astronomy/Space/Environment, partly because these subjects are highly regarded by the young students, (and in general, by adults as well). Terms such as "black holes", "solar storms", "hidden mass" and "dark matter", or the "ozone hole" and "global warming", stimulate attention immediately in pupils, making them ripe for discussion with a strong desire to understand the mystery of such phenomena.

Science as a Way of Life

Our approach includes four levels of projects: "nano-projects" for kindergartens and elementary school children (up to 12 years); "micro-projects" for Junior Highs Schools (12-16 years); "mini-projects" for High School students (16-18 years); and "macro-projects" for the best High School graduates and those beginning their university studies (17-22 years). Evidently, these levels and projects are interconnected with one another and sometimes participants, starting on the micro-projects level in elementary schools, continue their activity to the macro-projects level. For each level we organize courses in order to prepare the teachers and instructors that will conduct the above-mentioned projects. Below is a more detailed description of each level:

A. **Nano-Projects**: Level of kindergartens and elementary schools – special software with interactive movies or games such as "Touch the Sky"; formulated questions of children to the surrounding world; special books and booklets with prepared activities, games, and hand made experiments for different levels.

B. **Micro-Projects**: Level of Intermediate schools -

- "Science Days" in dozens of schools in Israel based on the Blossoms of Science Mobile Astronomical Laboratory, which includes 3 telescopes (2*20 cm +1*10 cm) with solar filters, set of rockets, inflatable planetarium, presentations on current issues in astronomy ("Asteroid attack", "Solar flare impact") – for many pupils this is usually the first contact with astronomy. This also includes contact with the Blossoms of Science Internet web site and with other programs
- Summer astronomy camps: 4 – 5 weeks with 200-300 pupils from all over Israel. These camps focus on an introduction to astronomy as students work on their mini-projects stimulated by "The Astronomy Pictures of the Day". These micro-projects are the students' first successful experience of research in real science fields. The Internet Astronomy School lists hundreds of such students' mini-projects.

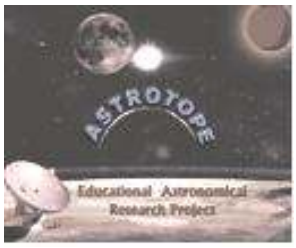
C. **Mini-Projects**: ASTROTOP- A one-year program focused on a chosen astrophysical problem, enabling students to gain first experience in data acquisition, collection, critical

analysis and comparison with alternative explanations. Dozens of such projects have been done in the past.

D. **Macro-Projects**: Matriculation points: A year and a half of real participation of High School graduates in astrophysical projects using telescopes and data-bases of national observatories and Research Centers: Wise Observatory, Israel Space Weather and Cosmic Ray Center, our Sea of Galilee Observatory with a 40-cm optical telescope and 2.5-m solar radio telescope.

Here we will describe in more details ATROTOP program with answer on the questions: For whom is it intended?, What are stages in the ASTROTOP project realization?, How student selects objects for research? What proposals for research (scenarios) are prepared already in our program for students?

ASTROTOP - Project for High Scholl Students 11-12 grades



An ASTROTOP is an Astronomical research project run by High School students (years 11 & 12) in the Physics class.
The ASTROTOP can take the place of the Laboratory Matriculation Exam and be developed further to cover another exam unit.
The ASTROTOP is supervised by a physics teacher and supported by scientists from National Observatories (Wise Observatory on Mitspe Ramon and Cosmic Ray Observatory on Hermon)

ASTROTOP Stages:

A. Selection of Subject.
B. Background Research.
C. Preparation of Research Proposal
D. Focus on the Research Question
E. Hypothesis and its Criteria
F. Planning of Methodology and Data Collection.
G. Data Collection from Internet and our Data Base
H. Data Processing and Analysis of Result
I. Conclusions
J. Final discussion with attention to new questions that arise from the Research.

Selection of subject

1. Principles for selection of subject:

- The subject must be of interest to the students.
- There should be a reasonable chance that the student can acquire a fair background to be able to understand the subject.
- The teacher or specialist assigned for each student can supervise the assignment.
- The student can analyze the data and draw conclusions.

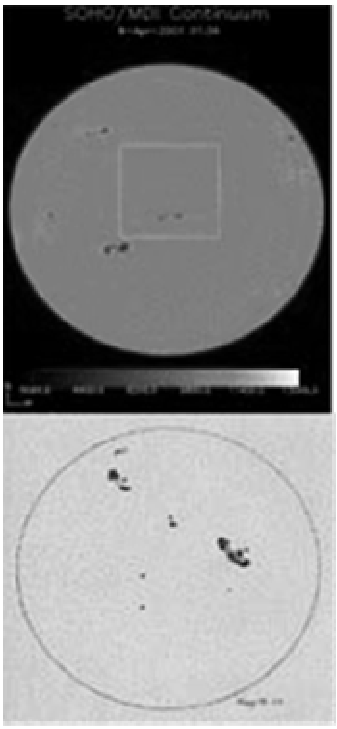
2. **How to choose a subject?**

- "Astronomy Picture of the Day" – breath taking "bank" of picture that include over 1800 photos with relevant links and a professional explanation of what is shown in the photo.
- Pool of students' projects – includes 400 high school projects organized by subject.
- Pool of Astronomy resources – the pool includes 150 different Astronomical concepts and is linked to additional explanations on the net.

Proposals for Research:

More than 30 "skeleton proposals" already prepared by the "Blossoms of Science" team. Here a list for getting an impression:

- **The Earth and it's surroundings**
- **Cosmic Rays**
  - The interaction between Cosmic Rays and the Earth's Atmosphere.
  - The interaction between Cosmic Rays, the Earth's Magnetosphere and Solar activity.
- **From Solar Storms to Magnetic Storms**
  - From Solar Storms in the sun to Magnetic storms on Earth.
  - The Northern Lights: Are they dangerous?
  - Solar eruptions and their shock waves impact on earth



- **The Sun**
- **Sunspots**
  - Sunspots and the Solar Magnetic Field
  - Proof of the solar rotation through sunspots
  - The Rotation of the Sun: from Galileo to present day
  - Solar cycle activity and the effect on the Earth

- **The Solar System**

- Eclipses in the solar System
- Lunar eclipses and measuring the radius of the moon
- Solar eclipses on other planets
- Eclipses of Jovian moons and measurement of the velocity of light
- Kepler's Laws in the Solar System
- Kepler's Laws and the definition of the masses of the planets
- High and Low Tides and Cannibalism in the Universe

- **Stars**

- The colors of the Stars
- What does the Star's color tell us
- Populations in the world of the stars
- Spectroscopy of the Stars
- The Continual Spectrum of the Stars
- The Line Spectrum of the Stars
- Eclipses in the world of the Stars: Measurement of the Physical Size of the Stars through their eclipses

- **Galaxies and Quasars**

- Measuring the Mass of the Quasars in the Universe
- What is the weight of the Black Hole in the Galaxy Center
- Populations of the stars and nebulae in our Galaxy
- Milky Way.

- **The Universe**

- The Evolution of the Universe – Hubble's Law
- Run-away of galaxies from Supernova observations
- Manifestation of dark energy
- Measuring the distances and run-away velocity for spiral galaxies
- Hubble's law discovery
- Searching for the structure of the universe on a global scale using deep survey of the galaxies in polar strip.
- Gamma bursts, their position in the sky and their possible nature

Example of Research Proposal:

The Rotation of the Sun, from Galileo to the present time

- **Aims**
  - To compare Galileo's observations of the sun's rotation from 400 years ago to recent observations
  - To check any changes during the 400 years and describe them, if found
  - To explain the reasons for these changes, if found.
- **Objective:** To understand the relationship between sunspots and the solar rotation.
- **The Research Question:** What are the changes in the sun's rotation over the 400 years from Galileo to the present?
- **General Knowledge**
  - Historical Background: The history of science in Galileo's time.
- **Background in Physics:**
  - Mechanics
  - Rotation, angular motion and rotation period, conserving of angular momentum
  - Electricity and Magnetism: Electric fields and currents, magnetic fields, Ohm's Law.
- **Astronomical Background:**
  - The structure of the sun
  - The origin of solar energy
  - The propagation of solar energy outwards from the center
  - The origin of magnetic fields in the sun
- **Mathematics and computer background:** Algebra, Geometry, trigonometry, EXCEL.
- **Required information**
  - Data from observations of sunspots in the optical light from Galileo and in the present time
  - Sunspots images from the Internet
  - The data can be found in the recommended links.
- **Stages of Project**
  - Measurement of coordinates of the sunspots in Galileo's sketches by Microsoft PhotoEditor or Photoshop and estimation of the rotation period of the sun in his time
  - Measurement of coordinates of the sunspots for current observations
  - Comparison of the rotation periods and the predominant sunspots position from Galileo's observation till now
  - The differential rotation should be taken into consideration
  - Summary of the project

Discussion.

Program ASTROTOP was created 5 years ago and during this years it show as effective way of intending of pupils and students in the science as researcher, especially in astrophysics and Space Science. First places of our students and teachers with ASTROTOP projects in Pan-European Competitions in Science Education field shows that our approach is effective in really and high competitive. We are open for collaboration in development of our approach in cooperation with other groups and science educational centers.