A TEACHER TRAINING PROGRAM TO IMPROVE ASTRONOMY AND SPACE SCIENCE EDUCATION WITH INTERNATIONAL COOPERATION

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Abstract

It is a continuation of our earlier studies regarding Astronomy and Space Science Education in Pakistan. Reviewing pre-university level curricula in Pakistan it was found that the ratio of Astronomy (A) and Space Science (SS) topics to the other topics is very low. Several proposals were given to improve the situation. The Space Science curriculum as suggested by Higher Education Commission of Pakistan also contains proposals for developing programs for general awareness and programs for enhancing the technical and professional human resource in the field of Space Science. I t is much stressed on catering for the current/future needs of the academic and research institutions of the country. It is found that the immediate implementation of such suggestion will not be possible unless personnel trained in A & SS are available. At university level the problem is not such severe. But at Pre University level an increase in the number of trained personnel is a matter of urgent attention. This study proposes a comprehensive training program for the existing teaching staff of schools and colleges. Such programs should be able to clearly explain the objectives, to give knowledge of teaching material, to create acquaintance with necessary observational techniques, instruments and software. To include historical development and future prospects will be an additional advantage. For the program to be successful it also stresses upon the need and line of action for international cooperation.

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1. Introduction

Rahim, Yousufzai and Ansari in their study (Rahim I , Yousufzai M A K and Ansari M R K) pointed out that unlike the developed countries of the world, in Pakistan, at pre-university level the ratio of Astronomy (A) and Space Science (SS) topics to the other topics is very low. Corresponding textbooks and curricula at these levels are also deficient in this regard. In developed countries either these subjects are part of the curricula as independent subjects or selected topics from these areas are frequently included in the curricula of other related subjects. Developed countries on one hand give stress to include A and SS in their curricula for updating the scientific knowledge and on the other hand they consider it necessary for enhancing the knowledge of history and culture. While teaching the historical development of A and SS in different eras of humanity, the development in those eras can be easily discussed. Similarly, because of their versatility, A and SS have wider connections with human sphere as compared to other single subjects falling in the realm of natural or social sciences. Recall that in the ancient past, among the seven liberal arts subjects **Quadrivium** (Lundy M., Ashton A) of astronomy, arithmetic, geometry and music was considered to be the advanced level of education. Whereas, the remaining subjects, grammar (the art of inventing symbols and combining them to express thought), logic (the art of thinking), and rhetoric (the art of communicating thought from one mind to another) forming Trivium were used to prepare students for the Quadrivium. These subjects were considered a must for the intellectual development. Rahim, Yousufzai and Ansari listed many proposals to improve the situation. One of the suggestions was to add some material related to observational astronomy including the observation using student telescopes in 8^{th} grade. The other one was to add at the secondary level, specific chapters on A & SS in the Physics curriculum and some material related to geometry of spheres and spherical trigonometry in Mathematics curriculum. In fact, a full scheme to enhance the proportion of A & SS in the curricula from lower secondary level to pre university level was provided there. It was also stressed upon providing hands on training on astronomical telescopes and other astronomical instruments and software. They hoped that if we push up any process to initiate a system for the training of teachers of pre university classes, it will lead to self sufficiency.

The Space Science curriculum as suggested by Higher Education Commission of Pakistan (www.hec.gov.pk) also contains proposals for general awareness and developing technical and professional manpower in the field of Space Science to cater for the current/future needs of the

academic and research institutions of the country. Among a number of suggestions, the most prominent suggestion was regarding the enhancement of A & SS contents at all levels of education, increasing the number of personnel trained in A & SS.

Comparing the proposals (Rahim I, Yousufzai M A K and Ansari M R K) and (www.hec.gov.pk) it is clear that (Rahim I, Yousufzai M A K and Ansari M R K) is concerned with pre-university education whereas [www.hec.gov.pk] is mostly related to university education. Considering the spirit of the two as same we preferably stress upon (Rahim I, Yousufzai M A K and Ansari M R K) for its higher level of urgency, importance and wider scope. It is noticeable that in underdeveloped countries like Pakistan most of the students do not continue education after matriculation. However, it does not mean that the proposals in (www.hec.gov.pk) be left for some future. A simultaneous push to both is the imperatively needed.

To accommodate all these proposals an increase in the personnel trained in A & SS will be required. This communication proposes a comprehensive training program that should be conducted for the existing teaching staff of schools and colleges. This may be in the form of a short course covering necessary theoretical, practical and observational knowledge. Launching such a program will involve financial obligations as well as technical support. Such requirements cannot be met without international cooperation. In the following we elaborate the consequences of an increase in A and SS contents.

2. Consequences of Increasing A & SS Contents and Courses

As it is said earlier that a large number of students discontinue education after matriculation and there are millions who have given away education since a long. Due to an increase in the general awareness because of the social media and networks, they have developed zeal to gain further knowledge in A & SS. So efforts to improve pre-university education and general awareness of masses seem to become fruitful earlier. We envisage the following that will need financial support.

(i) Hiring of personnel for the training of teachers to be trained.
(ii) Hiring places to establish training centers
(iii)Equipping the centers with necessary furniture and office accessories
(iv)Providing equipments such as a small observatory telescope
(v) Proving small students' telescopes
(vi)Hiring office, management and observatory staff
(vii) Some stipend for needy trainees
(viii) Organization of seminars, celebration of astronomical events and general awareness programs

As technical support literature, almanacs, training manuals and astronomical charts will be needed.

Training should be implemented through suitable short courses covering necessary theoretical, practical and observational knowledge that can be followed by all natural and social sciences teachers. We are including social science teachers also because in the past, Astronomy as a subject was successfully taught to liberal arts students. It should be noted that most of the teachers of natural and social sciences are not skilled in Physics and Mathematics. Additional efforts to overcome such deficiencies will be required and consequently the additional finances.

3. Features of a Short Course in Astronomy and Space Science

Now we give details of a short course for the training of teachers who will be involved in these A & SS literacy programs.

Main Features

(a) Students should appreciate the value of A and SS as it is applied to other disciplines and how astronomers and space scientists can help in improving quality of life.
(b) Students shall communicate correct A and SS knowledge effectively, both verbally and in writing in English as well as in Urdu
(c) Students shall be able to use technology (packaged software/graphing calculators) to enhance learning of Mathematics among his/ her students
(d) Students shall be able to direct his/her students to collect real-life data and help them analyze the data. Student will also help his /her students for drawing appropriate conclusions orally and in writing.

In view of the above the following Astronomy and Space Science curriculum is proposed for the teachers of grades 8-12 (6-8 weeks, approximately 30 hours). This curriculum is designed to add a semester of science to the existing curriculum or to have these materials integrated into an existing curriculum. Existing teachers of Physical, Biological and Social Sciences can be involved. Contents of such a short course may be the following.

I. A view of the Cosmos

II. History of Astronomy and Early Astronomers

III. The Night Sky

IV. Light and Telescope

V. The Stars

VI. The Sun

VII. Stellar Evolution

VIII. Galaxies

IX. The Universe

X. Our Solar System

XI. The Planets

XII. The Moon

Xiii. Comets, Meteors, Meteorites and Space Junk and Space Debris

XIV. Extra Terrestrial Life

XV. Almanacs, Star Atlases and Observing Guides

XVI. Weather, Atmosphere, Climate and Seasons

XVII. Rockets and Satellites

XVIII. Space Missions

XIX. Remote Sensing and Space Communication

XX. History of Space Exploration

XXI. Use of Robotics, Cameras, Computer Hardware and Software in Astronomy and Space Sciences

XXII. Activities, Projects and Observations

Some supporting astronomical software may be the following.

(i) Skyglobe (*astro4.ast.vill.edu/**skyglobe**.htm*)
(ii) Starry Night (***astronomy**.starrynight.com*)
(iii) Deep Sky Astronomy Software (*www.deepsky2000.com*)
(iv) Red Shift (www.**redshift**)
(v) Astronomy and Astrophysics package for Matlab

We have mentioned these software because of their easy accessibility. Otherwise, there are many more.

In addition to the main training, seminars, celebration of astronomical events and general awareness programs may be organized.

4. Need for International Cooperation

This program will need international cooperation because of two reasons.

(i) Providing technical support
(ii) To fulfill financial obligations

Number of observatories in Pakistan is very low. In fact, there are no astronomical observatories having international connections, only one or two observatories in universities, a few governmental departments equipped with small telescopes and a few planetariums. Though theoretical Astrophysicists and Space Scientist are available but Observational Astronomers are not available. The training program as mentioned above needs the establishment of at least two centers, one in the Northern Pakistan and the other in the Southern Pakistan accommodated with at least one automatic 8"-16" reflector/refractor and 25 small student telescopes (2"/3" refractors) as mentioned in [B Roy L. Bishop]. For the advanced stages one observatory equipped with a larger telescope (and other necessary equipments) should be established. There is a suitable place in Southern Pakistan at Gorakh Hills near Sehwan in the Sindh province of Pakistan [www.sindhpnd.gov.pk]. The place is easy to access from Karachi. Sindh government has already launched programs for the development of Gorakh Hills as a summer camp and resort.

Mentoring programs such as USAID program for computer literacy will be suitable in this regard.

5. Conclusion

The communication proposes a teachers training program for the advancement of Astronomy and Space Science in Pakistan. It stressed on enhancing the contents of pre-university curricula. It also mentioned the need of international cooperation for launching such a program.

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