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SCIENCE ON STAGE – TOWARDS A REJUVENATED SCIENCE TEACHING IN EUROPE

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Abstract

Several studies, such as the SAS and ROSE studies, as well as every-day experience of many science teachers suggest a 'disconnect' between the tenants of traditional, formal science teaching and contemporary youth culture. Clearly formal science teaching fails to stimulate the interest in science and technology among wider groups of youth. This has led to numerous proposals on how to improve science teaching at school and how to make it more attractive to pupils. Suggestions include the involvement of extra-curricular activities, e.g. in science centres, engagement by the media and by the scientific community itself. However, while functioning well on an individual basis, many of these proposals are hard to implement in a formal way and on a large scale because of 'systemic' or institutional barriers. This paper describes a practical approach, led by the European Intergovernmental Research Organisations (in the EIROforum partnership), to foster innovative science teaching in a bottom-up approach across the European Union, while trying to embed this in a larger framework involving education administrators and policy-makers.

1. Introduction

Over the last couple of decases activities to stimulate public understanding of science have blossomed in Europe. A new communication-friendly culture is emerging amongst young scientists. Academic studies of science communication have led to the formation of a new discipline, which is now taught at many universities across the continent. Indeed science communication has become professionalized and its practitioners have obtained considerable insights into communication processes, both at the theoretical and at the practical level.

For the public, excellent science programmes on TV with impressive animations and fascinating images, hands-on experiences in science centres, planetaria, popular science magazines etc. offer great tools for informal science learning, capitalising on the continued, strong public interest in science and technology. While many of these activities must be understood as long-term, with the real effects becoming visible at a later stage, it is nonetheless troubling that most surveys of science literacy in the public fail to show real improvements.

It is however noteworthy that while much effort has gone into developing new (extra-curricular) activities for young people, the pace of change of class-room teaching is quite different from that of the surrounding society and indeed also from the state-of-the-art of science itself. This means that what is arguably the single-most important element of the science education offered to our youth is out of step with many efforts to improve public awareness and understanding of science. These findings are borne out by results from several studies regarding public interest in science and technology. According to the latest Eurobarometer survey carried out in 2005 in the 25 member-states of the EU, 78 % of the respondees declared themselves 'very' or 'moderately' interested in new scientific discoveries (the scores for sports and politics were 68 % and 71 % respectively). At the same time, however, the survey revealed that 50 % strongly agreed with the statement that 'science classes at school are not sufficiently appealing', while 19 % were undecided. With 15 % replying 'I don't know', this leaves about 15 % who seem to find formal science teaching at school 'appealing' (numbers are rounded). Eurobarometer covers all age groups, but the Science and Scientists Study (SaS), which focussed on 13-year olds showed similar results. A full 80 % of the surveyed boys and 59 % of girls in the UK agreed with the statement that 'science is interesting!' The similar number for Sweden was 81 % for boys and 68 % for girls. Clearly, there is a declared interest in science in the public, also among young people. But again, the first results of the ROSE survey deliver a stinging indictment of science teaching in secondary schools. The survey covers 15-year old boys and girls in a large number of countries.

While gender differences are obvious and in line with those in the SaS study, for all developed countries the survey shows a strong disenchantment with science teaching. Sjøberg has argued that on practically all accounts science teaching at school is out of tune with contemporary youth culture. It therefore seems clear that the current teaching delivered to Europe's youth fails to exploit the potential interest in science and technology for which several studies provide evidence. [1] [2] [3]

These general findings mask a number of initiatives to rejuvenate science education in Europe. Amongst these are efforts to strengthen links between science centres and the school system and undertakings at national and regional level with respect to curriculum development. At the same time, dedicated teachers have developed novel and innovative solutions, which are implemented with great success at the level of individual school classes. It is clear that there are many ideas about how to improve science teaching and make it more attractive to pupils; what is lacking is coordination and mechanisms for development and implementation of these ideas in a more general way. Science is the same everywhere and should constitute a formidable unifier in our efforts to reform science teaching. But the decision mechanisms remain disparate, embedded in national systems and subject to national policies and priorities.

The European Union does not possess legislative competence in the field of education. Nor do the EIROforum partner organisations*, whose remits are confined to support cutting-edge research in Europe. Even so, both take a strong interest in the field. Firstly, the issue of science literacy is deeply intertwined with the objective, set out by the EU, to build the world's strongest knowledge-based economy. Secondly, building a European Research and Innovation Area requires initiatives at a European level to complement national efforts. It is difficult to see that science education can remain insulated from this process and it is hard to justify that it should, given the universality of the subject. Thirdly, the long-term success of the EIROforum organisations is intimately linked to their ability to keep recruiting a satisfactory number of the brightest young people in Europe. Whilst they do not carry any responsibility for education, they must live with the results of the education system.

Conversely, much knowledge that is generated within these organisations can be put to use at school in the effort to make science teaching more appealing, relevant and 'modern'. Reducing the gap between modern scientific research and contemporary science teaching is clearly an important element to support a rejuvenated science teaching.

Indeed, real science is fascinating and can serve as an attractor for young people. Real science means the latest discoveries but it also means real-time application of the scientific method, it introduces the realities of the lab, uncertainty, the difficulty of making and interpreting measurements, it involves questions of philosophy of science, etc. Bringing real science and real scientists into mainstream science education can provide also role models for pupils.

But reform of science teaching can only be successful if it is carried out together with the teachers themselves – if they are part of the process and able to provide input in terms of specifying the operational and institutional requirements for the future. Progress will therefore not be achieved without recognising the need to support Europe's teachers in meeting the didactic and cognitive challenges of science teaching in the new century and to help them to bring contemporary science into the classroom. In short: The primary key to increase the scientific literacy in children and young people remains the professional science teachers. If they fail, the wide spectrum of complementary activities may be to little avail. This calls for a sustained effort in the field of teacher training, both of young teachers and teachers who are well established within their national environments.

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* EIROforum is a partnership of the seven major intergovernmental research organisations (CERN, EFDA, EMBL, ESA, ESO, ESRF and ILL) in Europe that operate large research infrastructures. Together they cover a wide spectrum of the natural sciences, from particle- and astrophysics to molecular biology, fusion research and materials science.

This is the background for the EIROforum Science Teachers' Initiative, which comprises two activities, the Science on Stage Programme (SoS) and 'Science in School' (SiS), a European science education journal that was launched on 28 March 2006. The initiative is managed by the EIROforum, which also pays the lion's share of the cost but with significant, indeed critical, additional funding provided by the European Commission. Further partners of the programme include the European Physical Society (EPS) and the European Association for Astronomy Education (EAAE). SoS is the continuation of the successful Physics on Stage (PoS) activity that ran from 2000-2004, in itself the development of 'embryonic' activities in this field undertaken at Eso in the mid-nineties*. The name change of course signifies that SoS covers a much wider spectrum of the natural sciences than 'just' physics. At the same time ESTI is part of the Nucleus programme, a three-year activity funded mainly by the European Commission and the outcome of the Commission's European Science Education Initiative.

2. The Science on Stage Programme

Science on Stage (SoS), which is thus the flagship educational activity for the EIROforum, seeks to

- identify innovative science teaching and –teachers from all over Europe,
- bring them together and facilitate exchange of best practice,
- provide a forum where science teachers and scientists can meet,
- expose science teachers to cutting-edge research as it is carried out at the EIROforum facilities,
- foster a dialogue between teachers, education administrators and policy makers at the national level, based on the outcome of workshops and other interaction at the Science on Stage Festival.

The programme involves national activities and a 'central' European Science on Stage Festival.

3. The Science on Stage Festival

The Festival itself, which usually has around 500 participants, comprises a 'fair', on-stage presentations (which can be full-fledged drama pieces or more modest presentations), workshops and seminars, visits to the research facilities of the host organisation and the awarding of the European Science Teaching Prizes for the best projects or ideas presented at the Festival.

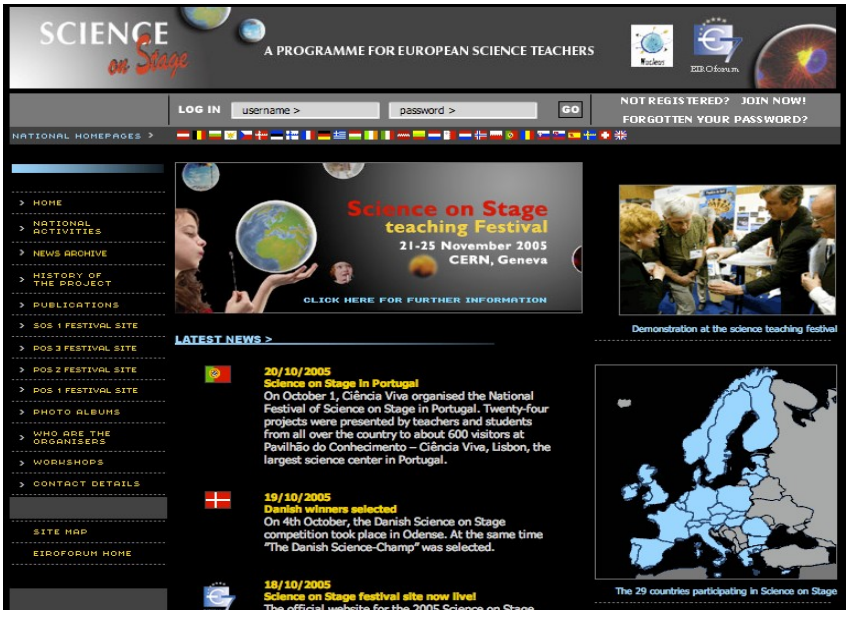

Fig. 1. The Science on Stage website at www.scienceonstage.int

*The first transnational teachers' meeting took place at the Eso Headquarters in 1994 under the title: 'Astronomy – Science, Technology, Culture'. It was part of the second European Week of Scientific Culture, an initiative of the European Commission.

The latest Festival, which took place at CERN over five days in November 2005, had the title Science for Humanity. Participants from 27 countries took part. The scientific programme contained presentations and workshops, e.g. 'The prospects to find Earth-like extrasolar planets', 'What do we know about the evolution of the early Universe'?, 'Particle physics, medical diagnostics and therapy', etc. It also provided the opportunity for discussing scientific aspects of the interdisciplinary teaching projects centred around major science projects such as the astronomical ALMA project.

Figure 2. The first winner of the EIROforum European Science Teaching Award was Miguel Cabrerizo from Spain, here seen at the award ceremony with Philippe Busquin, then European Commissioner for Research.

Figure 3. On-stage performance by the *Fysikshow* from Denmark.

Figure 4. A late-afternoon ‘wrap-up’ with the highlights of the day at the Science on Stage Festival at Cern.

The Fair, which in many ways forms the core element of the Festival, offers the possibility for every participant to showcase activities, exercises and projects and thus also for other participants to learn about new ideas that could be used ‘back home’ in the class-room.

The workshops at PoS and SoS have covered topics such as

- Multiple Intelligences Approach to Education in Physics
- University-High School Interface
- Science Education in Primary School and Kindergarten
- Physics in Secondary Education
- Physics and Public Understanding
- The Role of History and Philosophy in Physics Education
- Women and Physics
- Better education with Cinema and Science
- Moving Biology (sports and biology)
- The Theatre of Science (science drama/class-room activities)
- Physics Education Networks in the Enlarged European Union
- Curriculum Developments
- Teacher Training Courses and the Role of the Associations
- Medical Applications: from radiation to image

Descriptions of the individual events can be found in the Eso Messenger (Madsen and West, Bacher and West, Mackowiak and West, Pierce-Price *et al.*). [4] [5] [6] [7]

Attending the Science on Stage Festival has come to be seen as a coveted reward for many science teachers. It has introduced the notion of ‘excellence’ and competition into the teaching world, a world that has traditionally shunned competition. At the same time, transnational gatherings – quite normal for scientists – are truly exceptional for teach- ers. Aside from the great experience of participation in such a gathering, simply being invited (with essentially all costs covered) has interesting sociological effects: It clearly enhances the standing of the invitees in their local environment and thus also sends a signal to society: Science education is an important activity and the work of its skilled practition- ers deserves public recognition.
The next Science on Stage Festival will take place in Grenoble (France) between 2-6 April 2007.

4. Science on Stage in the participating countries

National activities include identification of teachers who may participate in the programme and follow-up activities to disseminate the results of the Festival. More often than not, the selection process involves a national contest and a national meeting or ‘mini festival’. This not only functions to identify the ‘best’ science educators but also serves as an important multiplication factor. In this respect there are still substantial variations between the participating countries, but a conservative estimate suggests that SoS has at least 10 to 20 times more participants than those that ultimately attend the §European festival. We expect this number to grow significantly with the publication of the Science in School journal, launched earlier this year and appearing in a printed and an on-line version.

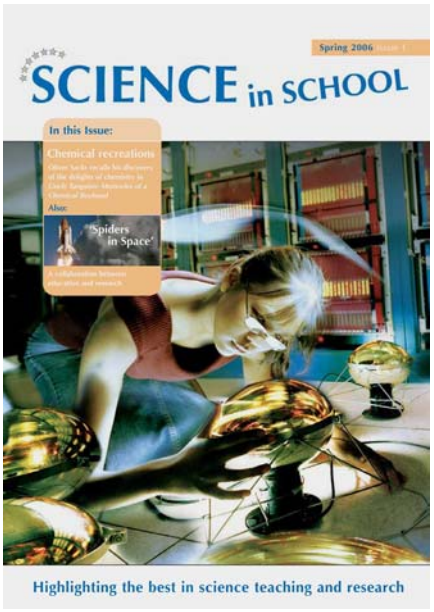

Figure 5. The first issue of Science in School.

The post-festival activities are of the highest importance to the programme. Participants from the European event discuss the experience with teachers, education administrators and policy-makers in their respective countries. It is in these encounters that the thoughts and ideas developed at the central event are introduced in the national debate and become 'visible' to curriculum developers and decision-makers in the field.

The national activities are organised by National Steering Committees (NSCs) and are by and large funded by national contributions. Since sufficient funding is a requirement for the countries to fully exploit the programme, it is gratifying to note that increasingly strong national committees have been established with satisfactory funding, either directly by governments, academies of science or from industry. The willingness to provide national support, however, did not occur overnight. Rather did it take years and the early attempts were greatly hampered by the fact that the programme 'survived' on short-term funding so that its continuation remained uncertain for a long time.

5. Next step

Science on Stage and its precursor must be regarded as highly successful programmes, but they must also be seen as pilot and catalytic activities. Indeed, given the magnitude and the degree of complexity involved in the issue of raising scientific literacy and stimulate young people to pursue careers in science and engineering, it has become clear that there is no simple – and no single – solution to the problems facing us.

The initiatives carried out in the context of the EU Framework Programme have enabled us to obtain an overview of the principal actors in the 'European science education scene'. The various calls for proposals have also led to definition of a variety of interesting projects, only some of which could finally be financed.
While the problem has been recognised and a number of actors have tried to develop promising schemes (such as the activities bundled under the Nucleus umbrella), it becomes clear that there is a need for concerted action at a level and a degree of integration that has previously not been seen in Europe. Simply put, there is no lack of interesting and promising ideas, but most initiatives fail to reach critical mass, suffer from lack of coordination and do not enjoy sufficient financial support to operate on longer time-scales.

This is the reason for EIROforum's proposal for the establishment of a Pan-European Partnership for Science Education . It should involve all major stakeholders, such as the national education administrations, teachers' networks, teachers' training establishments, centres of informal science learning, media, the learned societies, industry and the main public research facilities. It should also comprise the European Commission and might possibly exploit the policy instrument of 'open coordination' that has been used for other purposes in the EU. [8]

The Partnership would facilitate dialogue between the actors, would enable exchange of best practice, coordina- tion of activities and serve as an incubator for possible new activities. Clearly it should provide a forum for exchange and for developing concerted actions. Since these actions must be of significant scale and reach the individual partners should, however, be involved not just at the level of developing ideas, but also in funding them.

Importantly, while the Partnership may foster new initiatives, it may usefully explore the uncharted terrain of possible collaboration within education among member states and advise the European Commission in its efforts to develop accompanying measures, as it did under FP-6 with the European Science Education Initiative.

6. Conclusion

Science on Stage and its associated journal are relatively new activities in the area of science education. They mark a serious attempt on the part of some of the world's leading research organisations to make a contribution to improving the quality and attraction of formal science teaching in Europe's primary and secondary schools. This contribution is unique, because it exploits the particular expertise and knowledge contained in these organisations as well as their pan- European orientation. For the organisers it is an expression of their commitment to the European societies and at the same time it has enabled a new partnership between the European intergovernmental organisations and the European Union. It has introduced new ideas and the notion of excellence and competition as a means to raise the overall standard in education and it has enabled fruitful dialogue between educators across Europe. Even so, this programme can only be but one of many activities undertaken by the various stakeholders, either individually or in partnerships. What is needed is coordination between countries and stakeholders, activities with critical mass and with sufficiently long funding perspectives to make a real, and lasting, difference.

7. Acknowledgements

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