Study visit group report

Group	452
Title	Encouraging enjoyment of science education
Theme	Making science education more attractive
City, Country	Glasgow, Scotland, UK
Type of visit	General education
Group reporter	Dr. Ali ERYIMAZ

I. **Findings**

This section summarises the findings that the group makes while visiting host institutions, discussing issues with the hosts and in the group. You will be reflecting about the things you have learnt every day, however, in order to put them together and give an overall picture, you need to devote special session to preparing the final report on the last day of the visit.

It is important that you describe in this part not only things you learnt about the host country but also what you learnt about the countries which you represent.

1. Summarising your impressions, please describe 3 most important, in your opinion, things you learned about during the visit.

1.1. Differences and similarities in the participants' country education system.

Motivation of pupils:

It is remarkable that all participating countries face the same problem in school, the lack of motivation of the pupils. It is a trend of today's teen society in the Western world. Although students are very keen to enter university in Turkey, with a shortage of universities and a growing population, only 20 to 30% of the students have a chance to study at a university.

In addition, most teens are not working up to their potential and are lacking the desire to continue school. Since quitting school before the age of 16 (or 18 in some countries) is for most pupils not an option, a lot of them go to school to socialize. Plenty of teens are underachievers; they are capable of work, intelligent enough but lack of motivation to succeed. They are either not challenged enough in schools, have some learning disabilities that are not diagnosed or are not stimulated from home.

Another tendency which is seen in some of the participating countries is the so-called 'Waterfall effect', meaning that a great number of pupils follow what is considered the most 'superior' type of education level, even if this is not the best choice. They are not able to complete it and have to continue at an 'inferior' level or even drop out. This gives early adolescents reason to believe that they simply do not possess abilities what it takes creating a decline in self-esteem. A lower self-esteem has a great

influence on the career choices of the students. Without knowing their true potential they face a life of dissatisfaction.

The unwillingness to learn and the lack of motivation can decrease the overall level of students' achievements. These lower the critical knowledge of the students.

What seem to work in every participating country are supportive, enthusiastic and passionate teachers, proactive teaching methods, hands-on work, and use of varied resources. Whether a pupil or student is supported and stimulated by his/her family is also a very important factor in the motivation.

Funding and facilities:
There seems to be a big difference in the funding of formal and non-formal educational activities for science education in all participating countries. Percentages of the private and public schools, their facilities, and number of students in each class are different for each participant country. While most countries have made the popularisation of science, technology and innovation as one of their priorities, in some countries it is still hard to find enough funding for science projects. Moreover, government funding is barely enough for ultimate science classes in most countries.

Without proper funding it is more difficult to encourage science education inside and outside the classroom.

Science and technology in the curriculum:
At primary level, science and technology are for most participating countries embedded in the different courses. Sometimes as a general science course and sometimes separate courses as physics, chemistry, biology, astronomy and so on. But all are mandatory in the primary schools. But teachers seem to be poorly trained to teach these subjects. In secondary schools, the education system differs for every country, resulting in a different amount of science and technology in the curricula. While science is mandatory in Poland, Germany, Sweden, and the Czech Republic from the age of 12 all the way to approximately 18, it is an optional subject in Flanders, Scotland, Italy, Bulgaria, Turkey, and Hungary depending on the age of the pupils.
Regardless of the fact that science courses are mandatory or not, schools in most countries complain about insufficient amount of experimental sets and insufficient number of specialised laboratories.

Science curricula have been or will be changed in the participant countries. For example in Poland, the curriculum is stated for all the subjects at all levels of education by the Ministry of Education, but the new and more specified one is expected next year. On the other hand, science curriculum for primary level in Turkey had been completely changed since 2003. Now they have an integrated science and technology course instead of the science course. Furthermore, science curricula for secondary schools in Turkey are being changed at the very moment.

Technological education is in most countries not compulsory, apart from Belgium where it is a subject in the first two years of the first grade (12-14). To give an answer to the increasing market demand for certain skills, the curriculum of secondary and higher education needs to respond with more technological subjects. It does that quite slowly, while countries need a lot of highly educated and skilled people to sustain their economy.

The wider the choice of subjects, the less likely pupils will choose science and technological subjects, which are considered more difficult. Therefore we all should ask ourselves the question if it is important to make science and technology compulsory in all education levels.

1.2. Science teaching methods in all participants' countries**.**

Science has been taught more similarly in most participant countries. This hasn't been changed for a long time. Teachers are active and students are passive. Teachers teach and students memorize or mimic the teachers' acts. Teachers usually use chalk and blackboards in teaching science. Although there are some rival teachers in all countries to change the way that science is taught. This is the way most teachers follow in all countries. Because of the new technologies and changes in the psychological perspectives of learning, the science curricula and science teachers emphasize different ways of learning and teaching. This new approach wants students to be mentally active always and physically active most of the time. Students should be responsible for their learning. Therefore, developing students' metacognition is a new and vital objective for most of the new science curricula. Teachers shouldn't teach the subjects to the students. Instead they should create a social learning environment that students become mentally and physically active, receive prompt feedback, and improve themselves conceptually in science classes. Integration of technology in science classes and new approaches to increase students' motivation towards science are also very important.

Use of media:
The school computer era has started the last fifteen years in Europe but computers are not yet a common mode of instruction in every school. Schools, who attempt to keep up with the technological innovation, need to invest a lot in computers and software. It takes time and money to replace the entire infrastructure. Without proper funding of the government or the local industry, it is impossible.

Even though the number of computers in the schools is growing faster, the teachers' ability to learn how to use them is lagging behind. It is necessary to integrate streaming video, social-networking tools, and internet resources into everyday classroom lessons. New learning styles and educational software are required. Mostly young and enthusiastic teachers are computer literate and use computers more effectively.

Real-life context-based approach:
What should we teach in science classes (content) and to what extent (details)? This is a vital question in an educational setting. In most cases the curricula developers answer these questions, hoping that students and teachers like it. What we know right now is that most students don't like science classes and think that science is more theoretical and one can not apply it to the everyday life. These show us that the decisions (the answers of the curricula developers) were not satisfactory for most of the students. To overcome this problem, context-based approach has been developed. In this approach, learning is situated in a real-life context. These contexts are chosen from the contexts that students want to learn. Therefore, real-life contexts (students) determine what to teach and in what extent to teach a specific concept. This is not a new teaching method. This is a teaching approach that can be used with all teaching methods even with the explanatory teaching. The literature shows that students, who learn science with context-based approach, achieve the course objectives as much as

the students who learn science with traditional approach. However, their attitudes towards and motivation to learning science are higher than the students who learn science with the traditional approach. High school physics curricula have been developed based on the context-based approach in Turkey.

Spiral structure:
Most science curricula have sandwich structure. It means that when the curriculum starts to teach a specific concept, it finishes the details of the concept. In this way for example, you study kinematics in 6th grade and you finish it. You don't study it again. After that year you forget it. In spiral structure, the curricula teach kinematics in every year in different details. You start with the simple concepts and principles in the first grades then increase the complexity to more advanced concepts and principles in the last grades. Therefore in every grade, students remember what they have learned on this strand before and build the new knowledge on the previous ones. By this way, students may transfer the knowledge in short term memory to long term memory. New Turkish high school physics curriculum has spiral structure.

1.3. What the Scottish institutions do for encouraging science and technological education.

Competitions, events and projects:
Scotland has a lot of activities, clubs and centres where pupils can taste from science and engineering outside the regular lessons. Placing these subjects in a challenging environment changes the perception of science and technology and stimulates the development of skills and knowledge. Non-formal activities take sciences and technology out of school and place them in the day-to-day life of the pupils. This is an important condition for generating interest in young people.

Involving the industry:
Several high quality education projects have been developed to engage pupils in science research and engineering with input and support from local business. It enables pupils to get to know the industry, possible professions, discover interests and to work with state of the art equipment.

Teachers are also stimulated to stay in contact with the industry. In Scotland teachers and professionals or scientists are brought together through speed dating sessions or company visits. Schools welcome often guest speakers in class.

Career advice:
Scotland has a strong focus on careers orientation. They provide structural measures such as career advisors in every school to follow-up the students and several projects to help pupils choosing the best possible profession.

They use a number of key-moments in the study orientation of pupils; between 9 and 13 they grow interest in certain subjects like science and technology; in the early adolescent years (13-16) it is important to keep them stimulated; at the end of secondary school (16-18) pupils should be informed about the possibilities and careers before they make a definite choice. The role of media, parents, and the peer

group is however a determining factor in the process of choosing a career. Pupils who know their potential are better off in deciding what they will and can do. It is therefore encouraged to study more than one science subject at standard grade to keep changes open.

2. One of the objectives of the study visits programmes is exchange of good practices among the hosts and participants. Cedefop will select examples of good practices and disseminate them among former participants and wider public, including potential partners for future projects.

Describe each of the good practices you learn about during the visit (both from the hosts and from each other) indicating the following:

title of the project/programme/initiative/...	name of the institution that implements it (website)	contact person (if possible), who presented the programme to the group	whom the project/programme/initiative addresses	what features of the project/programme/initiative make it an example of good practice
School visits	Scottish Engineering (http://www.scottishengineering.org.uk)	Dr. Peter Hughes, Chief Executive	Pupils of age from 11 to 18	• Motivating pupils to choose more science subjects • Increase the communication between engineers and pupils.
'Skills for work' program	Scottish Qualifications Authority (http://www.sqa.org.uk)	Dr. John Allan	Pupils of age from 14 to 16	• Discover possible potential of the pupils • Improve pupils' skills for a possible vocational career • Prepare pupils for real life
The path is green – Green jobs	Careers Scotland (http://www.careers-scotland.org.uk)	Mr. Nigel Akam	Pupils of age from 14 to 18	• Encouraging pupils to choose green jobs • Giving information about green jobs
Year in industry	Scottish Engineering (http://www.scottishengineering.org.uk)	Dr. Peter Hughes	Pupils of age 18	• Help students gain work experience before university
Early stimulation in technical subjects	Comprehensive Primary and Secondary School Hoechstaedt	Georg Brenner	Pupils of age from 7 to 17	• Increasing pupils motivation towards science and technology • Developing psycho-motor skills
Science Week and Weekend	Flanders Ministry of Science, Economics and Technological Innovation	Evy Copejans	Wide audience (from 7 to 77)	• Contact between scientists and general public • Informing public about current scientific research • Parents and children can participate in experiments

Planet Ocean; e-learning project about the ocean	Flanders Marine Institute (http://www.planeetzee.org/www.planetocean.eu)	Evy Copejans	Pupils from 15 to 19	• Extending knowledge about the ocean with practical exercises • Interdisciplinary learning: integrating all science subjects in one context, the ocean;
Glasgow science centre	Glasgow science centre (http://www.glasgowsciencecentre.org)	Tara Gibson	All age groups	• Increasing pupils motivation towards science and technology
Science days with lab in a lorry	Science and technology matters for Scotland (http://www.careers-scotland.org.uk)	Mr. Nigel Akam	Schools without lab-facilities	• Increasing pupils motivation towards science and technology
Competition About "The Magician Experimenter's Hat"	Club AMAVET Gymnasium Pisnicka, Prague (CZ)	Julius Kolín	Pupils of age from 11 to 15	• Motivating pupils through competition • Comparison knowledge and skills of pupils
Science and technical tours	Club AMAVET Gymnasium Pisnicka, Prague (CZ)	Julius Kolín	Pupils of age from 12 to 18	• Introduce pupils with technical sights in various countries (mostly EU) • Motivating pupils to choose more science subjects through visits of science museums in various towns
Real-life context based approach	Turkish ministry of education (http://www.fizikprogrami.info)	Dr. Ali ERYILMAZ	Pupils of age from 15 to 18	• Prepare pupils for real life • Increasing pupils motivation towards science and technology
Spiral structure	Turkish ministry of education (http://www.fizikprogrami.info)	Dr. Ali ERYILMAZ	Pupils of age from 12 to 18	• To transfer knowledge from short term memory to long term memory

** You can describe as many good practices as you find necessary. You can add rows to the table.*

3. The study visits programme aims at promoting and supporting policy development and cooperation in the field of lifelong learning. That is why it is important to know what you learnt about such policies and their implementation during your visit. You are invited to describe your findings of the following:

3.1. Common approaches, if any, that are met in all or some countries (both host and participants') regarding the theme of the visit:

- teaching methods: motivating and interactive, pupil presentations, working in group, hands-on, experiment kits/boxes, use of IT, and video in class
- context based learning: making science and technology part of the real life
- science and technology projects with a competition, main event and award
- exchange programs between different countries
- informing pupils about possible careers in science, technology, engineering and mathematics (STEM)
- government funding: grant for certain jobs, funding science projects
- teacher training: updating teachers' knowledge and skills, and increasing enthusiasm
- involving industry: funding by local industry, apprenticeship programs, company visits
- involving parents and grand-parents: science and technology centres, shows and events: science week, technology day
- involving scientists and universities: lectures, visits
- special science/engineer clubs with motivated youngsters after school time

3.2. Common challenges that are faced by all or some countries (both host and participants') in their effort to implement policies related to the theme of the visit:

* **Declining interest**: The proportion of students choosing science subjects at university is decreasing. Pupils find science too difficult and choose less difficult subjects in secondary school and later new university courses such as communication, journalism, forensic sciences and etc.

* How to **motivate pupils**?

* The **proportion of girls** for physics and mathematics is low.

* **Waterfall-effect**: students start a course that is not within their capacity (because of family pressure or to get better salary) and are unsuccessful. They waste valuable time without discovering their true talents. How to **find their potential**?

* **Shortage of skilled engineers**. How to encourage pupils to become an engineer?

* **Replacing qualified science teachers** that will retire within the next few years. And how to make the profession of a science teacher more attractive to graduates?

* **Continuous Professional Development**: How to motivate teachers to develop themselves?

* **Transition problems** between primary and secondary school. Enthusiastic pupils lose their interest in science because when they have to start from scratch again the first year, they get bored.

* If **parents and media** are a big influence on the choice of a career. How can we involve them more?

* **Finding the necessary funds** for projects to promote science education on a long term.

3.3. Effective and innovative solutions you have identified that the countries (both host and participants') apply to meet the challenges you mentioned in question 3.2:

* **Declining interest in science subjects and courses**, and how to **motivate pupils**?
- Giving them a reward: Dr. Peter Hughes uses instruments to reach the pupils' attention and gives them 5 GB pounds if they get a good answer. Another type of reward are the competitions, for instance The Planet Ocean-project gives the winning class a week's expedition in the North Sea.
- Enthusiastic teachers and role models and motivating and varied teaching methods: Teachers of the St. Thomas Aquinas School
- Baccalaureates in curriculum : Scottish Science Baccalaureate for pupils in the fifth and sixth years of secondary education that will allow them to build a significant body of knowledge, skills and qualifications in science which will enhance progression opportunities in related disciplines to Further and Higher Education and to employment.
- Streaming: forming groups of pupils that have more or less equal competences.
- Explaining science and engineering in a more comprehensive way (linked to a day-to-day life) to all students, as compulsory subjects until the age of 16. As in Scotland motivated pupils can then choose freely 2 years of higher education (16 to 18) before they start university.
- Developing motivating science curricula based on real-life context-based approach as in Turkey.

* **Low proportion of girls in physics and mathematics:**
- There should be new projects like the one as "To study and to work: Entrepreneurship Education" financed by European Found (FSE) is a course for Equal Opportunity between women and men. The course's theme is communication in an entrepreneur and management. The project has had success; now three girls are in Engineering, the other ten girls are in the last year of the secondary school.

* **Waterfall-effect**:
- Program 'Skills for work'; find the potential in a pupil, unlock their talents and ensure employers have access to the skills they need.
- Montessori method of teaching: This teaching method is characterized by an emphasis on self-directed activity on the part of the pupil. It stresses the importance of adapting the child's learning environment to his or her developmental level, and of the role of physical activity in absorbing abstract concepts and practical skills. It is also characterized by the use of autodidactic (self-correcting) equipment for introduction and learning of various concepts.
- Other self-assessment techniques
- Professionally developed placement tests

* **Shortage of skilled engineers**:
- Engineering projects and competitions for pupils
- Compulsory subject 'engineering' in school
- Introducing engineering jobs in formal and informal environment
- Hosting model engineers in science classes

* **Replacing qualified science teachers:**
- Making the profession of a science teacher more attractive to graduates.
- Scholarships for graduates who want to become a teacher.
- A higher salary or less hours of work for the teachers to make this profession more lucrative and to make it possible for teachers to do their jobs better.
- Speed dating between teachers an professionals.
- Study visits, teacher traineeships for 6 or more weeks (as in Flanders)

* **Transition problems**:
- Changing the curriculum with other subjects that are more related to the interests of 12-year old boys and girls.
- Training of primary teachers in science and technology
- Providing motivated teachers with resources for the first two years of secondary schools

* **Involving parents and media:**
- Soap operas with scientists as main characters
- Scientific documentaries such as the Flemish 'Overleven' (in Eng: *About life*) where the Flemish Television broadcasts exciting documentaries about scientific achievements that are closely related to the everyday experiences of the average citizen.
- Increasing science news in the news

* **How to reach teachers**:
- Electronic newsletters, visiting schools, more individual contacts

* **Finding the necessary funds:**
- Government funding: the Flemish government has made it a priority to popularise science, technology and technological innovation. For their Action Plan called

'Science Information and Innovation' they give funding to short term projects and work with structural partners such as science institutes (e.g. Flanders Marine Institute) and science centres (Technopolis and Planetaria) to help them accomplish the objectives of the plan.
- Cooperation with local industry:
- Support of parents: parents voluntarily pay for some expenses for educational activities

3.4. Policies and practices that can be further explored and possibly transferred to other countries:

The following policies and practices could possibly be transferred to other countries. Because they have already been introduced in the report, we only write the titles.

- 'Skills for work' program
- Preparing posters and distributing them to pupils for intended purposes
- The path is green – Green jobs
- Career advisors in schools
- Cooperation with local industry, apprenticeships
- Baccalaureates in curriculum
- Science days with lab in a lorry
- Science in media
- Interactive science centres
- Science and technical tours
- Real-life context based approach
- Year in industry
- One year gap

4. Creating networks of experts, building partnerships for future projects is another important objective of the study visit programme.

Please describe if any ideas for future cooperation evolve during meetings and discussions.

- Exchange programs: visiting science centres like 'Technopolis' and 'Eurospacecentre' in Belgium
- Comparing and contrasting curricula of different science courses for the participant countries
- Developing networks that include info about Baccalaureates in different countries.
- Initialize school cooperation: making science teachers exchange good practices.
- Cooperating for developing science curricula.
- Exchange students and their teacher to participate in interesting activities in another country. e.g., take pupils with their science teachers to the Marine Biology ship in Belgium.