Energy Education Science and Technology Part B: Social and Educational Studies
2012 Volume (issue) 4**(4):** 2327-2338

Developing experiment-based science teaching skills: A lifelong learning opportunity for teachers in a rural area of Turkey

M. Erol[1,*], U. Boyuk[2], R. Sahingoz[1], T.G. Harrison[3], M. F. Costa[4]

[1]*Bozok University, Faculty of Education, Department of Science Education, 66200, Yozgat, Turkey*
[2]*Erciyes University, Faculty of Education, Department of Science Education, 38039, Kayseri, Turkey*
[3]*Bristol University, School of Chemistry, Cantock's Close, BS8 1TS, Bristol, United Kingdom*
[4]*Minho University, Department of Physics, 4710-057, Braga, Portugal*

Received: 16 August 2011; accepted: 05 November 2011

Abstract

Modular Mobile Education: Science Experiments (MOBILIM) is an innovative pilot project for the vocational training of science teachers in rural regions of central Turkey supported by the European Commission in the frames of the Leonardo da Vinci program. In this project, a mobile science laboratory (MSL) was established in order to cope with the great disparities in opportunities between science teaching in urban and rural areas. Teacher training both in what concerns practical competencies and subject knowledge is one of the main reasons for these disparities in the standards of science teaching. Teacher training via MOBILIM is based on hands-on and demonstration practical activities. At the end of the MSL based phase a two-day conference was organized to provide an opportunity for discussion with and among teachers and also to make it possible to exchange ideas and experiences with European partners of the project. Results indicate that in order to improve teachers' practice in the classroom, experimental vocational education via mobile laboratories is advisable and allow good results. The majority of the teachers were delighted with the participation in both the training phase and the subsequent project conference. All of the teachers involved want to become a better and more active teaching force. There is a high expectation to carry on with similar courses in the future.

Keywords: *MOBILIM;* LLP; Leonardo da Vinci; Science teaching; Rural; Mobile science laboratory; MSL; Experimental vocational education; Hands-on; Turkey; Yozgat

1. Introduction

Mobile science laboratories have become an invaluable resource for educational applications. These *labs-on-wheels* come in different sizes and configurations, some are offered as a service, some are off-the-shelf versions, while others are heavily customized [1].

*Corresponding author. Tel: +90-354-242-1021; fax: +90-354-242-1022.
E-mail address: mustafa.erol@bozok.edu.tr (M. Erol).

In June 1980 UNESCO undertook the preparation of a study on the development of science and technology within the framework of societies and cultures with the help of mobile science exhibitions [2]. The study was based on the experience of developing countries in general and India in particular and contains some suggestions and recommendations for UNESCO's action in this field. In recent years many MSLs were prepared for outreach activities especially in the UK and USA. Some of them are listed in Table 1.

Table 1. Some examples of MSLs in the world

MSL Project	Foundation	Web Site
Lab in a Lorry	Institute of Physics, London, UK	http://www.labinalorry.org.uk
AIMS CETL	University of Bristol, Bristol, UK	http://www.bris.ac.uk/cetl/aims/mobile_lab
Helmsdale II	West London Floating Classroom Ltd., Middlesex, UK	http://www.elsdale.co.uk/
SCI-FUN	University of Edinburgh, Scotland, UK	http://www.scifun.ed.ac.uk/
GB4FUN	Radio Society of Great Britain, Bedford, UK	http://www.gb4fun.org.uk/
AGUM	Natur-und umweltschutz-akademie nrw, Recklinghausen, DE	http://www.umweltmobile.de
Galieo Science Mobil	Flad & Flad, Luxemburg, LU	http://www.science-mobil.lu
Cell Motion BioBus	Cell Motion Laboratories, Inc., NY, USA	http://biobus.org/
Agastya	Agastya International Foundation, Gudivanka, IN	http://www.agastya.org/
Shell Questacon Science Circus	The National Science and Tech. Centre, Kingston, AU	http://sciencecircus.questacon.edu.au/
CityLab	Boston University, Boston, USA	http://www.bumc.bu.edu/citylab/
BioBus	CURE, Inc., Connecticut, USA	http://www.ctbiobus.org/
Science on the Move	CAMSE, South Dakota, USA	http://www.camse.org/scienceonthemove/
MdBioLab	Tech Council of Maryland, Rockville, USA	http://techcouncilmd.com/mdbiolab/
Bio-Bus	Georgia State University, Atlanta, USA	http://www.biobus.gsu.edu/
Venter's Discover Genomics!	The J. Craig Venter Institute, San Diego, USA	http://www.jcvi.org/cms/education/
DESTINY	Morehead Planetarium and Sci. Center, N. Carolina, USA	http://www.moreheadplanetarium.org
Vidnyanvahini	Dialogue and Action Group (DAG), Maharashtra, IN	http://www.vidnyanvahini.org/
SERC's Mobile Ecol. Lab.	Smithsonian Env. R. Center, Maryland, USA	http://www.serc.si.edu/education/outreach/mobile.aspx
Mobile Science Labor.	Science & Discovery Center, NY, USA	http://www.sdcsciencecenter.org/mobile-lab.htm
Salk Mobile Sci. Labor.	Salk Institute for Biological Studies, CA, USA	http://www.salk.edu/support/mobile_lab.html
Mobile Family Sci. Lab.	University of East Anglia, Norwich, UK	http://biobis.bio.uea.ac.uk/family/index.html
Illinois Physics Van	University of Illinois, Illinois, USA	http://van.physics.uiuc.edu
Science on the Go	University of Illinois, Illinois, USA	http://urbanext.illinois.edu/scienceonthego/
Rhodes Mobile Biol. Lab.	University of Rhodes, Grahamstown, South Africa	http://www.mobilelab.co.za/
Mobile Science Center	University of Namik Kemal, Tekirdag, TR	http://www.gezicibilimmerkezi.org/
MOBİLİM	University of Bozok, TR	http://mobilim.bozok.edu.tr/

Lab in a Lorry is an initiative set up by the Institute of Physics and the Schlumberger Foundation in the UK [3]. Each mobile laboratory contains hands-on experiments with which people can interact. Each lorry has one permanent member of staff who looks after the experimental apparatus, and also by volunteers that offer to demonstrate the experiments to the young visitors/users. Lab in a Lorry aims to encourage positive attitudes towards science, and make science and engineering more attractive to 11 to 14 year-old children. The perceptions of pupils in the science subjects of biology, chemistry and physics are discussed for UK [4]. The declining number of students choosing to take physics during their further studies continues to be a cause for concern for scientific and educational communities around the world. [5]. The Lab in a Lorry activities are being investigated on the impact the attitudes of the pupils towards science [6].

The Mobile Teaching Unit (MTU) of the AIMS and Bristol ChemLabS project provides a great platform for outreach activities: a lorry that expands to turn into a seminar room capable of accommodating groups of 20 students at a time. The well planned series of outreach engagements, organized by a School Teacher Fellow [7] and medical scientists at the Bristol University, can deliver a high quality, age-relevant event to large numbers of school students of all ages at low per capital cost through using a small, well trained team. Sessions are tailored to cover various aspects of the science curriculum. The results of the outreach works are published in a number of publications [8-14].

Elsdale II is a mobile science education project that gives the chance to pupils to discover and explore science by using creative hands on science experiment kits [15]. Elsdale II, the west London floating classroom, is considered a unique venue for a range of educational and private events in UK. It can accommodate up to 60 pupils for a variety of activities on the Grand Union Canal. The education modules provide a creative and hands-on experience for pupils to discover and explore the inland waterways. Elsdale II is also available for private hire and corporate conferences. The versatility makes it the ideal venue for many occasions. Another organization, *The Scottish Science & Technology Roadshow (SCI-FUN)* prepares shows, displays and hands-on exhibits in some science disciplines like physics, chemistry, and biology in Scotland [16]. *GB4FUN* is another active centre. *It* is a mobile and fully self-contained communications centre that is already visiting schools and colleges up and down the countryside of UK [17].

Galileo Science Mobil is a MSL in Luxembourg. The hands-on and interactive exhibition in it changes approximately every three years [18].

The main issues of the *Association of Mobile Environmental Education Projects (AGUM)* in Deutschland are sharing ideas and experiences to support and motivate existing projects, conceptual support to the building up of new projects, advanced training of the staff with new focus ever year- and public relations/outreach. [19].

In the USA there are many mobile laboratories. In 2006, DeRosa and others established the Mobile Laboratory Coalition, a partnership of traveling laboratory programs, institutions of higher education, and K–12 schools and other school systems in the USA. The organization has grown to include almost 80 members. Some of these programs are Boston University School of Medicine's MobileLab, the University of North Carolina at Chapel Hill's DESTINY Program, University of Texas-Pan American's Regional Biotech Program, Connecticut's BioBus, South Dakota's Science on the Move, Maryland's MdBioLab, Venter's Discover Genomics!, Georgia State's Bio-Bus, etc [20].

"Dee Enae, a pun on DNA" is the quick-thinking sidekick in this popular science education module for high school students, created by Boston University School of Medicine's CityLab program [21]. In the *Cell Motion BioBus*, the students explore the world around them with research-grade microscopes, and make their own discoveries under the guidance of professional scientists. SEAS mobile laboratory seeks to improve ocean literacy by exposing students to the tools and techniques used by marine scientists [22].

Agastya is a large science outreach programs in India. They travel thousands of miles every year, engaging children, teachers and communities in hands-on learning [23].

The Shell Questacon Science Circus tours around regional Australia for 18—20 weeks each year. Enthusiastic science graduates staff the Circus as it travels, bringing lively presentations of science to towns and schools [24].

2. Science education and EU programs

Improving students' experience of science education across Europe is a major goal. The presidential conclusions of the Lisbon meeting of the European Council in March 2000 talked about 'a new strategic goal' for the EU for the first decade of the twenty-first century 'to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion' [25].

In 2004 the report 'Europe Needs More Scientists' [26] Professor José Mariano Gago and his committee analyzed many of the problems found with science teaching and commented on practical work in science that 'Done well, practical work can both inspire and instruct pupils: done badly, it is a standard subject of complaint by uncomprehending, disaffected students….' and 'SET (Science, Engineering and Technology) laboratories and equipment are vital to pupils' education in these subjects – both in directly educating pupils about areas of science and technology and in interesting and enthusing them to study these subjects further.

In 2007, Rocard Report [27] of the EU High Level Group on Science Education identified 'elements of know-how and good practice that could bring about a radical change in young people's interest in science studies'. Among their findings were the realization that teachers are 'key players in the renewal of science education' and that being in networks of teachers improves both teaching and motivation.

3. Science teaching in Turkey

The Program for International Student Assessment (PISA) is an international assessment that measures the performance of 15-year-olds in reading literacy, mathematics literacy, and science literacy every 3 years. First implemented in 2000, PISA is coordinated by the Organization for Economic Cooperation and Development (OECD), an intergovernmental organization of 34 member countries.

More than 400 000 students from 57 countries (including Turkey) encompassing 90% of the world' economy took part in PISA 2006. The focus was on science but the assessment also included reading and mathematics and collected data on student, family and institutional factors that could help to explain differences in performance. Among 57 countries evaluated in 2006's test, Turkey ranks the 44th in science [28].

In all, 60 countries and 5 other education systems (located in non-national entities, such as Shanghai-China) participated as partners in PISA 2009. Among 65 countries evaluated in 2009's test, Turkey ranks the 43rd in science. From the PISA 2009 reports, for each country, students' overall performance in science can be summarized by mean score as in Table 2 [29].

The Trends in International Mathematics and Science Study (TIMSS) provides reliable and timely data on the comparison of the students' mathematics and science achievement of 4th- and 8th-grade students from many countries. Table 3 shows the TIMSS2007 science scores for eight-grade students [30].

It is understood that the success of the Turkish students in science lessons is seriously low and behind most of the other countries. This is due to many different reasons. Among the most important factors for the failure of the science teaching, teacher related ones are perhaps the most conspicuous [31]. Students' success during laboratory sessions is directly proportional to the teachers' attitude towards laboratory courses. Teachers' attitudes will definitely affect the students' interest and success in the course. According to this research, the main reason of teachers' ignoring laboratory work during the lessons is connected with the shortcomings of their own training. That is, they may have not been educated for practical science teaching, applying secondary school level experiments, initiating and developing an experiment and managing the class in a laboratory. Furthermore, a research on the effects of the in-service training which are organized for teachers on the use of laboratories effectively brought out that there are not enough in-service training courses on practical science teaching and also distance-learning training is not preferred by teachers [32].

One of the important reasons for the great disparities between science teaching in urban and rural regions in Turkey is the gap in the pedagogical and vocational knowledge of the

Table 2. PISA2009 mean scores in science [29]

Range	Country / Economy	Science Scale	Range	Country / Economy	Science Scale	Range	Country / Economy	Science Scale
1	Shanghai-China	575	23	United States	502	44	Chile	447
2	Finland	554	x	**OECD Average**	**501**	45	Serbia	443
3	Hong Kong-China	549	24	Norway	500	46	Bulgaria	439
4	Singapore	542	25	Czech Republic	500	47	Romania	428
5	Japan	539	26	Denmark	499	48	Uruguay	427
6	Korea	538	27	France	498	49	Thailand	425
7	New Zeland	532	28	Iceland	496	50	Mexico	416
8	Canada	529	29	Sweden	495	51	Jordan	415
9	Estonia	528	30	Latvia	494	52	Trinidad and Tob.	410
10	Australia	527	31	Austria	494	53	Brazil	405
11	Netherlands	522	32	Portugal	493	54	Colombia	402
12	Liechtenstein	520	33	Lithuania	491	55	Montenegro	401
13	Germany	520	34	Slovak Republic	490	56	Tunisia	401
14	Chinese Taipei	520	35	Italy	489	57	Argentina	401
15	Switzerland	517	36	Spain	488	58	Kazakhstan	400
16	United Kingdom	514	37	Croatia	486	59	Albania	391
17	Slovenia	512	38	Luxembourg	484	60	İndonesia	383
18	Macao-China	511	39	Russian Fed.	478	61	Qatar	379
19	Poland	508	40	Greece	470	62	Panama	376
20	Ireland	508	41	Dubai (UAE)	466	63	Azerbaijan	373
21	Belgium	507	42	Israel	455	64	Peru	369
22	Hungary	503	43	**Turkey**	**454**	65	Kyrgyzstan	330

science teachers. New educational, social and economic approaches in many areas like environment, energy and technology are going to encourage both the teachers and students and have vital importance for continued economic growth and social cohesion in the country [33-39].

Table 3. TIMMS average science scores of eighth-grade students, by country: 2007 [30]

Range	Country/ Economy	Score	Range	Country/ Economy	Score	Range	Country/ Economy	Score
1	Singapore	567	17	Armenia	488	33	Cyprus	452
2	Chinese Taipei	561	18	Norway	487	34	Tunisia	445
3	Japan	554	19	Ukraine	485	35	Indonesia	427
4	Korea, (Rep. of)	553	20	Jordan	482	36	Oman	423
5	England3	542	21	Malaysia	471	37	Georgia	421
6	Hungary	539	22	Thailand	471	38	Kuwait	418
7	Czech Republic	539	23	Serbia	470	39	Colombia	417
8	Slovenia	538	24	Bulgaria	470	40	Lebanon	414
9	Hong Kong SAR	530	25	Israel	468	41	Egypt	408
10	Russian Federation	530	26	Bahrain	467	42	Algeria	408
11	United States	520	27	Bosnia and Her.	466	43	Palestinian Nat'l Auth.	404
12	Lithuania	519	28	Romania	462	44	Saudi Arabia	403
13	Australia	515	29	Iran	459	45	El Salvador	387
14	Sweden	511	30	Malta	457	46	Botswana	355
15	Scotland	496	**31**	**Turkey**	**454**	47	Qatar	319
16	Italy	495	32	Syrian Arab Republic	452	48	Ghana	303

The flexibility and accessibility of MSLs will provide better opportunities for the support of all teachers in vocational education and will raise their own pedagogical skills too. With MSL-based activities, it is easy to reach out to teachers in rural schools who have no laboratory facilities and to offer them experience in science teaching through laboratory experiments. Likewise performing face-to-face training courses which focus on the recent experimental paradigms in science teaching and to approach teachers with the relevant supporting pedagogical principles is facilitated.

At the end of our project we aimed to gather accurate information on science fairs, workshops, meetings, science museums, national and international symposiums and conferences for science teachers, particularly for those in Yozgat, Turkey.

4. MOBILIM Project

Modular Mobile Education: Science Experiments (MOBILIM) is a Transfer of Innovation project of the Leonardo da Vinci programme (LdV) (see Appendix), funded by the Center for European Union Education and Youth Programmes grant. Eleven institutions from five different European countries (Italy, United Kingdom, Portugal, Greece and Turkey) came together to create an international consortium for the project [40]. The aim of the consortium was to contribute to the body of knowledge of the use of mobile laboratories and the introduction of the new techniques in the area of science and technology teaching. The objectives of the project also include; the provision of a forum for discussion to exchange ideas and experiences, to gather new ideas for science fairs, to develop internet supported training courses to be used by science teachers in rural regions, to reach out to the teachers in rural schools who have no laboratory facilities and to offer them the means of teaching practical science, through the use of the MSL to hold training courses. The training courses held in the mobile laboratory focused on all aspects of practical work in science teaching.

Mobilim is based on the experiences of several other innovative projects: The Bristol *ChemLabS* outreach project is intended for outreach activities partially delivered by a *Mobile Teaching Unit in the UK* [7-14]. *Lab in a Lorry* [4-6] is an interactive mobile physics laboratory staffed by volunteer practicing scientists and engineers and organized by the Institute of Physics [41] also in the UK. The *H-Sci* project was developed in the action framework of Socrates - Comenius 3 networks program to establish the *Hands-on Science Network* initially with twenty-eight institutions from ten European countries [42]. The Affordable and Efficient Science Teacher In-service Training **(**AESTIT) project is a formal project for face-to-face training courses within the framework of Socrates - Comenius 2.1 European Union program [43]. *OIKOS* is an innovation project for distant learning in the field of earth sciences [44]. These projects were researched thoroughly to identify examples of good practice that could be applied to the MOBILIM project.

5. The profile of the science teachers engaged

The target group of the MOBİLİM project is science and technology teachers for 6^{th} to 8^{th} grade students (12-14 ages). The majority of the participant teachers work out of the city center, that is, in the towns or villages in rural areas in central Turkey as shown in Fig. 1.

The profile of the cohort, shown in Figs. 2 and 3 is of fairly inexperienced young teachers. A large fraction of these young teachers have up to date subject knowledge although they lack sufficient experience in teaching practical work in laboratories. The rest of the group have more experience but were not eager to use their new laboratory facilities or reported that they had no time to train themselves in the use the laboratory equipment.

The backgrounds of the science teachers involved in this project differed considerably as shown in Fig. 4. Most graduated from education faculties as primary school science teachers. Graduates from chemistry and biology education departments are trained as teachers for high schools. Graduates from physics, chemistry and biology departments have no training in education at all. It is now obligatory for teachers in Turkey to have followed a teacher training education course.

The reason for the high concentration of younger, less experienced teachers is due to the adoption of a new curriculum system since 2004. These teachers are mostly graduated from Science Education Departments of Education Faculties with a knowledge of current pedagogy. On the other hand older teachers feel more challenged in because generally they graduated from the Physics, Biology and Chemistry Departments of Science and Arts Faculties. These teachers may only know their specific science subject and do not tend to have a good grounding in all the sciences [45].

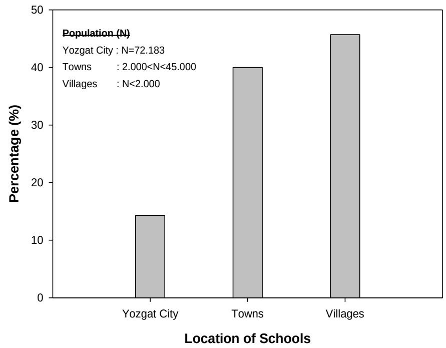

Fig. 1. Location of the schools of the participating teachers.

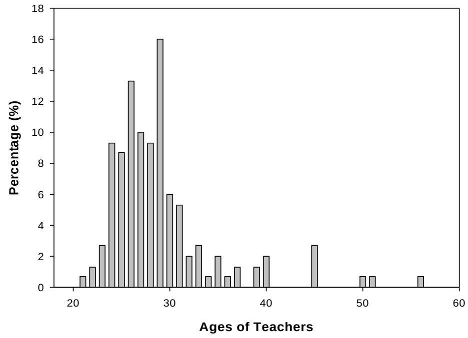

Fig. 2. Age profile of the participating teachers.

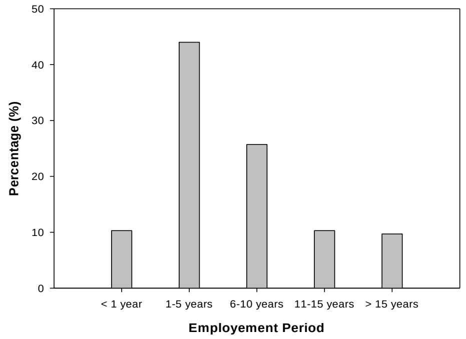

Fig. 3. Work experience of the participating teachers.

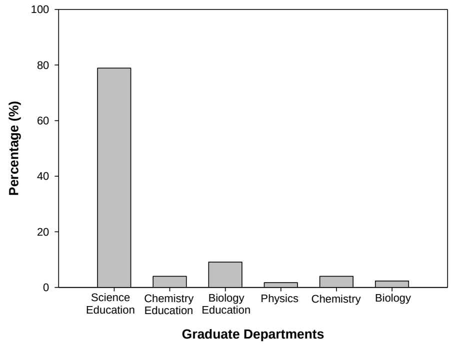

Fig. 4. Graduation subjects of participating teachers.

The status of the teachers, according to their participation in in-service training, is shown in Fig. 5. From the reported data we can note that 142 (81.1%) of the project participant teachers had not participated in in-service training. This result was not surprising as in-service training is rarely delivered in the region that Yozgat is situated.

In order to question teachers about their qualification in laboratory experiments a Likert-scale questionnaire was created. The participant teachers were requested to mark for each question one of the options; (1) I am very unqualified, (2) I am unqualified, (3) I am partly qualified, (4) I am qualified, (5) I am very qualified.

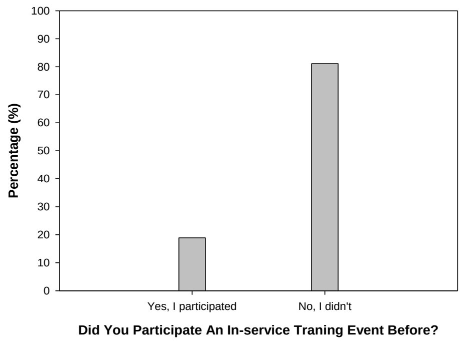

Fig. 5. Teachers' distribution according to their status about participating in in-service training

It is seen from the results that after the activities, science teachers feel that they have a positive attitude towards and they are highly qualified in using laboratories. None of the teachers felt unqualified, or they hesitated to give such an answer. They generally felt unqualified or partly qualified. Especially "being aware of the importance of laboratory in science teaching" (94.8 %), "being willing to integrate laboratory work into courses" (90.8 %), "deciding the appropriate equipment for an experiment" (93.1 %), "interpreting experiment results" (100 %) and "combining the experimental results with theoretical data to find new results" (90.8 %) are the topics in which teachers feel content.

These results indicate that teachers have a positive attitude towards the importance of laboratory usage in science teaching. But, "knowing and being able to use all the equipment and utensils in the science laboratory" (36.6 %) and "being able and skillful to do the basic renovations of the equipment and utensils in the science laboratory" (47.4 %) are the problematic areas for teachers. These results tell us that the in-service training courses should include instructions and practice on using and renovating the laboratory equipment.

Through the MOBILIM project, as with the Science on Wheels project [46], we successfully tried to close the gap in the background knowledge that causes problems in science teaching and not just the differences in science teaching experience.

6. The MSL of Mobilim

An articulated lorry was rented and modified as a comfortable mobile science teaching laboratory with the funds from the Center for European Union Education and Youth Programmes (see Appendix) for the Mobilim project. The MSL provides space to prepare and perform experiments for a group of 12 teachers at the same time. It has three sections: the main laboratory (14.30 m^2), an experiment preparatory room (9.88 m^2) and a staff lounge (11.18 m^2) as shown in Fig. 6. Electricity, heating, lighting, ventilation, water, computer and projection systems were masterfully constructed and installed in the vehicle by experts before the MSL was used to deliver outreach activities.

Educational materials such as the experimental vocational education course syllabus, manuals for the demonstrations or show experiments for biology, chemistry and physics courses were also prepared.

7. Experimental vocational education in the MSL

An in-service training program for science teachers in Yozgat was planned in conjunction with local authorities and was centered on experimental outreach activities delivered in our MSL.

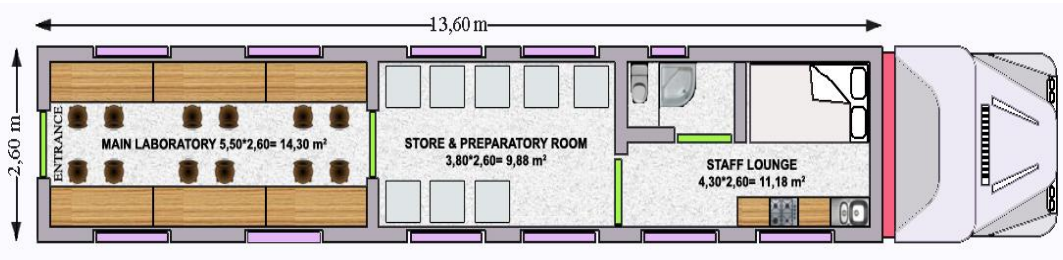

Fig. 6. The plan of the MSL of Mobilim.

The MOBILIM project has reached out and benefited 223 science teachers (130 male, 93 female) in Yozgat, a rural city in the middle of the Anatolia, Turkey, via the MSL to give experimental vocational education. The target group was categorized into 15 groups in 10 different rural towns (Yozgat, Sorgun, Akdagmadeni, Saraykent, Kadısehri, Cekerek, Sarıkaya, Bogazlıyan, Yerkoy, Sefaatli) as shown in Fig. 7. Each teacher was permitted to participate for one week by their local education authority.

Fig. 7. Itinerary of the Mobilim experimental vocational education visits.

When the MSL reaches a town, it deploys in a school grounds for a week. Academic staff from Bozok University led the vocational education sessions. A four day education program was delivered to all participating groups.

In the first day a ‘science is fun’ set of 30 demonstrations were introduced. In the other three days 25 physics, 27 chemistry and 18 biology experiments were introduced to the teachers. The vocational education was applied in three stages: (i) To emphasize the ‘science is fun’ aspect; (ii) Performing experiments in the MSL; (iii) The reorganization of the participant teachers’ own school laboratories with the help of academics to make them more efficient.

Among the objectives of this vocational education project were to construct a network of teachers interested in new science teaching techniques, to provide a vehicle for discussion so as to make it possible to exchange ideas and experiences, to create an opportunity for the teachers to obtain some new ideas for science fairs and other informal or non-formal learning activities and to develop internet resources for the use of other science teachers in rural regions. http://mobilim.bozok.edu.tr/ is used to communicate with teachers and exchange ideas and experiences between the different participants.

7. 1. Students in MSL

When the schedules allowed, the training coordinator created the opportunity for teachers to bring their own students to the MSL. In total 982 students experienced practical sessions in the MSL for themselves with the collaboration of their own teachers under the supervision of the MSL academic staff.

7. 2. The MOBILIM conference

The final conference of the MOBILIM was held in the city of Yozgat, Turkey on 7-8th October 2009. The aim of this conference was to bring the teachers to exchange ideas with several teachers academic and researchers from European institutions and evaluate the training and outreach activities developed within the project. The teachers engaged in the course had chance to discuss with and question the international EU project partners who gave 11 presentations, 2 experimental shows and participated in a discussion panel about science education policies and strategies. The Turkish teachers learned of the opportunities, benefits and limitations of the science teachers in other EU countries. They learned that similar teacher and teaching problems exist elsewhere. The conference ended with a certificate ceremony.

7. 3. Project evaluation

Two hundred and twenty-three science teachers, each, attended a four day training session in the MSL and also attended the two-day conference. Questionnaires and observation notebooks were used to evaluate the project. These consisted of 12 Likert-style and 2 open response questions. Out of 223 teachers all questionnaires that were incomplete or statistically found to be of low reliability were excluded. The 175 questionnaires remaining (100 responders were males and 75 were females) were evaluated. The results obtained from the teachers' responses are summarized in Table 4. Statistical Program for the Social Science (SPSS 16.0) was used for the analysis of the questionnaires and reliability statistics. Cronbach's Alpha (α) was found to be 0.832. Cronbach's Alpha is commonly used as an indicator of the internal consistency reliability of a psychometric instrument. If the value of α approaches 1, it means higher reliability.

One participant Mrs Huriye Acikel reported, "*When I was invited to in-service training within the Mobilim Project, I thought that it would be just a boring lecture, so I was unwilling to participate in it. I changed my mind when I saw the MSL. It was really a comfortable atmosphere to work in. At first, I participated in a four–day practical training that the experiments carried out were wonderful. I tackled my shortcomings. I also had the opportunity to learn what's happening in science education in Europe during the two-day conference. [As a result of the training] I organized a mini science fair in my school in order to put into practice the demonstrations and experiments that I gathered during the Mobilim course. I hope to repeat this fair every year. I had a really good time in the course of project, and I think that I gained lots of experience I will use in my lifetime. I would like to thank to all the project staff*".

8. Conclusion

The conclusion obtained using evidence from the observation notebooks showing the teachers' views on MOBILIM approach are very positive: the flexibility and accessibility of MSL provided opportunities for support for teachers and to raise their pedagogical skills.

More than 93.3 % of the participating teachers enjoyed visiting Mobilim and 96.7% of them impressed that visiting Mobilim has made them want more experiments in lessons.

Table 4. Teachers' responses to whether they enjoyed vocational education in Mobilim Lorry

	Percentage (%)				
	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Visiting Mobilim has made me want more experiments in lessons	60.7	36.0	2.7	0.7	0.0
Mobilim is a really good way of learning science and technology	25.3	58.8	8.0	7.3	0.7
The experiments on Mobilim were boring	2.0	2.7	6.0	51.3	38.0
Mobilim has helped me with my science lessons	49.3	42.0	4.0	4.0	0.7
Many experiments on Mobilim were new for me	8.7	32.7	16.7	38.0	4.0
I really enjoyed visiting Mobilim	57.3	36.0	4.0	2.0	0.7
I found it difficult to understand what the people on Mobilim were saying	1.3	1.3	5.3	41.3	50.7
I would recommend Mobilim to my teacher friends	50.0	43.3	4.7	1.3	0.7
The experiments on Mobilim were really interesting	31.3	58.7	6.7	3.3	0.0
I would really like to visit Mobilim again	41.3	50.7	4.7	3.3	0.0
I think Mobilim should visit more schools	75.3	22.7	0.7	0.7	0.7
I prefer to teach science on Mobilim than in the classroom	39.3	36.7	11.3	9.3	3.3

MOBILIM aims to impact on the low science grades that have been observed in the PISA and TIMMS studies offered an innovative approach: experiments based vocational in-service training of science and technology teachers in rural areas with mobile science laboratories (MSLs).

This project sought to develop the teaching skills in practical science for a large cohort of teachers. The need for this was not simply to give more job satisfaction to the teachers but by improving their training to impact on the science experience of the many thousands of students that each will influence in their working lives [47-49]. Students are inspired and learn by active practical work and are more likely to carry on studying aspects of the sciences at a higher level. This in turn will help produce a more highly skilled work force desired by the EU for a continued economic growth and social cohesion.

Acknowledgment

This project was funded by Center for European Union Education and Youth Programmes under contract no: LLP-LDV-TOI-2007-TR-038. The authors are grateful to the European Commission and Turkish National Agency for their financial support.

Appendix

The European Commission has integrated its various educational and training initiatives under a single umbrella, the Lifelong Learning Programme (LLP). As a part of LLP, Leonardo da Vinci (LdV) programme enables Vocational Education Training (VET) organizations to work with European partners, exchange best practices, increasing the expertise of their staff and respond to the teaching and learning needs of people.

References

[1] Studt T. Mobile labs in the field. R&D Magazine 2006;48:16–20.
[2] Bose A. Mobile science exhibition, UNESCO, New Delhi, 1983.
[3] http://www.labinalorry.org.uk/, 2006.
[4] Barmby P, Kind PM, Jones K, Bush N. Evaluation of Lab in a Lorry, Final Report, CEM Centre and School of Education, Durham University, 2005.
[5] Barmby P, Defty N. Secondary school pupils' perceptions of physics. Res Sci Technol Edu 2006;24:199–215.
[6] Kind P, Jones K, Barmby P. Developing attitudes towards science measures. Int J Sci Educ 2007;29:871–893.
[7] Shallcross DE, Harrison TG. A secondary school teacher fellow within a university chemistry department: The answer to problems of recruitment and transition from secondary school to university and subsequent retention? Chem Educ Res Practice 2007;8:101–104.
[8] Harrison TG, Shallcross DE. Chemistry outreach opportunities for school students. Sci School 2006;3:48-51.
[9] Shaw AJ, Harrison TG, Medley MI, Sellou L, Shallcross KL, Croker SJ, Williams SJ, Shallcross DE. University-school partnerships: Polymer chemistry days run at a university for 14–15 year olds and their impact on attitudes to science. Acta Didactica Napocensia 2010;3:19–26.
[10] Shallcross DE, Harrison TG, Wallington S, Nicholson H. University and primary school links, the Bristol ChemLabS experience. Primary Sci Rev 2006;94:19–22.

[11] Shallcross DE, Harrison TG. Why bother taking university led chemistry outreach into primary schools? Bristol ChemLabS experience. New Directions 2007;3:41–44.
[12] Harrison TG, Shallcross 'What should be expected of successful engagement between schools, colleges and universities?' Schools Science Review, Association for Science Education, 2009, 91 (335), 97–102.
[13] Harrison TG, Hughes L, Shallcross DE. Jersey schools science week: An outreach case study. New Directions 2009;4:30-33.
[14] Tuah J, Harrison TG, Shallcross DE. The advantages perceived by school teachers in engaging their students in university-based chemistry outreach activities. Acta Didactica Napocensia 2009;2:31–44.
[15] http://www.elsdale.co.uk/, 2008,
[16] http://www.scifun.ed.ac.uk/, 2011.
[17] http://www.gb4fun.org.uk/, 2009.
[18] http://www.science-mobil.lu, 2011.
[19] http://www.umweltmobile.de, 2009.
[20] www.bu.edu/mobilelab, 2006.
[21] Bonetta L. Taking Science Education on the Road: Traveling Laboratories Deliver Engaging Science Lessons to Classrooms Everywhere. National Institutes of Health, National Center for Research Resources Reporter, Bethesda, 2007.
[22] Tankersley RA, Windsor JG. Taking it to the streets: SEAS mobile laboratory exposes students to the excitement of ocean science research. Integrative Comparative Biolog 2009;49:E313–E313.
[23] http://www.agastya.org/, 2009.
[24] http://sciencecircus.questacon.edu.au/, 1988.
[25] http://www.europarl.europa.eu/summits/lis1_en.htm, 2000.
[26] http://europa.eu.int/comm/research/conferences/2004/sciprof/index_en.html, 2009.
[27] Rocard M, Csermely P, Jorde D, Lenzen D, Walberg-Henriksson H, Hemmo V. Science education now: A renewed pedagogy for the future of Europe, European Commission, Directorate-General for Research, Brussels, 2007.
[28] Executive summary PISA 2006: Science competencies for tomorrow's world, OECD, Paris, 2007.
[29] Fleischman HL, Hopstock PJ, Pelczar MP, Shelley BE. Highlights from PISA 2009: Performance of U.S. 15-Year-Old Students in Reading, Mathematics, and Science Literacy in an International Context, National Center for Education Statistics, US Department of Education, Washington, 2010.
[30] Gonzales P, Williams T, Jocelyn L, Roey S, Kastberg D, Brenwald S. Highlights from TIMSS 2007: Mathematics and Science Achievement of US Fourth- and Eighth-Grade Students in an Inter Context. US Depart of Education, 2009.
[31] Kucuk ND. The Evaluation of the Competency Levels of Science and Technology Teachers within the Process of Education and Training in Secondary Stage of Primary Education According to Some Variables. Master Thesis, University of Cukurova, Adana, 2008.
[32] Yildiz E, Aydogdu B, Akpinar E, Ergin O. Attitudes of primary school science teachers towards science experiments. Bogazici Univ J Educ 2009;24:71–86.
[33] Gulay H. Relationship of different variables to depressive symptoms in early childhood: A research from the point of parental acceptance-rejection, social development, social skills and peer relationships. Energy Educ Sci Technol Part B 2011;3:431–440.
[34] Senel Coruhlu T, Calik M, Cepni S. Effect of conceptual change pedagogies on students' alternative conceptions of electricity resistance and electricity current. Energy Educ Sci Technol Part B 2012;4:141–152.
[35] Demirbas A. Energy issues in energy education. Energ Educ Sci Tech-A 2011;27:209–220.
[36] Saka AZ. The effect of the guided discussion method on student success in the teaching of physics. Energy Educ Sci Technol Part B 2011;3:725–738.
[37] Yumurtaci M, Kecebas A. Renewable energy and its university level education in Turkey. Energy Educ Sci Technol Part B 2011;3:143–152.
[38] Tural G. Is an apple act gravitational force on earth? Constructivist approach to understanding gravity and universal law of gravitation. Energy Educ Sci Technol Part B 2012;4:773–784.
[39] Alisinanoglu F, Inan HZ, Ozbey S, Usak M. Early childhood teacher candidates` qualifications in science teaching. Energy Educ Sci Technol Part B 2012;4:373–390.
[40] http://mobilim.bozok.edu.tr/, 2007.
[41] http://www.iop.org/, 2012.
[42] http://www.hsci.info/, 2003.
[43] http://www.clab.edc.uoc.gr/aestit/, 2006.
[44] http://www.e-oikos.net/gmap/oikos.htm. 2007.
[45] Nott M, Wellington J. Probing teachers' views of the nature of science: How should we do it and where should we be looking? Res Sci Educ Europe Current Issues Themes 1996;22:283–293.
[46] López-Garriga J, Muñoz-Solá Y, Torres V, Echevarría Y, Nazario W, Jesus-Bonilla W, Camacho-Zapata R. Science on Wheels: A coherent link between educational perspectives. J Cheml Educ 1997;74:1346–1349
[47] Yimaz B, Kilinc M, Sahan H. Examination of the organizational commitment and the levels of job satisfaction in accordance with specific variables. Energy Educ Sci Technol Part B 2012;4:169–176.
[48] Toros T. Examination of self-esteem, job satisfaction and organizational commitment in employees of sports federations. Energy Educ Sci Technol Part B 2012;4:537–548.
[49] Sirin EF. Job satisfaction and burnout in predicting life satisfaction among elementary physical education teachers in Turkey. Energy Educ Sci Technol Part B 2012;4:695–708.