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D5.2 Framework for Teacher Education Programme

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A. Background to this report

This report is a deliverable of Work Package 5 (WP5) of the European FP7-funded project "European Science and Technology in Action: Building Links with Industry, Schools and Home" (ESTABLISH; 244749, 2010-2013). D5.2 was intended to be a report regarding interim web-based IBSE materials for only pre-service teacher education. However, as the web-based materials for pre-service and in-service teacher education are very similar, a combined deliverable has been prepared for both of these cohorts and submitted as D4.2. However, all ESTABLISH science teacher education should happen within a guiding framework, which was not provided by the original list of deliverables. Therefore it was deemed necessary to revise and refocus this deliverable to present an agreed framework for teacher professional development programmes as developed and provided by the beneficiaries of ESTABLISH. (See Table 1 below for beneficiary list).

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B. The ESTABLISH consortium

Beneficiary short name	Beneficiary name	Country	Abbreviation
DCU	DUBLIN CITY UNIVERSITY	Ireland	IE
AGES	AG EDUCATION SERVICES	Ireland	IE
UCY	UNIVERSITY OF CYPRUS	Cyprus	CY
UmU	UMEA UNIVERSITET	Sweden	SE
JU	UNIWERSYTET JAGIELLONSKI	Poland	PL
CUNI	UNIVERZITA KARLOVA V PRAZE	Czech Republic	CZ
AL	ACROSSLIMITS LIMITED	Malta	MT
UPJS	UNIVERZITA PAVLA JOZEFA ŠAFÁRIKA V KOŠICIACH	Slovakia	SK
COUO	CARL VON OSSIETZKY UNIVERSITAET OLDENBURG	Germany	DE
UTARTU	TARTU ULIKOOL	Estonia	EE
UNIPA	UNIVERSITA DEGLI STUDI DI PALERMO	Italy	IT
MaH	MALMÖ UNIVERSITY	Sweden	SE
IPN	LEIBNIZ-INSTITUT FUER DIE PAEDAGOGIK DER NATURWISSENSCHAFTEN UND MATHEMATIK AN DER UNIVERSITAT KIEL	Germany	DE
CMA	CENTRE FOR MICROCOMPUTER APPLICATIONS	Netherlands	NL
MLU	MARTIN LUTHER UNIVERSITAET HALLE-WITTENBERG	Germany	DE

ESTABLISH Framework for Teacher Education

Introduction

The aim of ESTABLISH is to facilitate and implement an inquiry based-approach in the teaching and learning of science and technology across Europe with second level students (age 12-18 years). To facilitate the adoption of an Inquiry Based Science Education (IBSE) methodology in the classroom, ESTABLISH has developed appropriate teaching and learning IBSE units (informed by scientific and industrial communities), together with appropriate supports for both in-service and pre-service teachers. The provision of IBSE units alone will not change classroom practice, so teachers must be given the opportunity to attend inquiry workshops, where they will be provided opportunities to develop a deeper understanding of the inquiry process. Teachers across all the beneficiary countries in ESTABLISH will thus participate in workshops – either as continued professional development for in-service teachers or as training workshops for pre-service teachers embedded in their methods course. The purpose of these workshops is to accordingly educate the teachers in IBSE. The background knowledge of inquiry varies greatly among teachers, as does the role of inquiry within the national curricula. Therefore, it is important to develop a framework for the ESTABLISH science teacher education workshops that is flexible to suit individual and contextual needs across the participating countries and beyond.

In terms of defining IBSE and scientific inquiry the ESTABLISH definition is based on the definition of inquiry (Marcia C. Linn, Elizabeth A. Davis, & Philip Bell, 2004)

"Inquiry is the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments."

Purpose of framework

A framework for teacher education is required to set out the overall structure, content and implementation plan of ESTABLISH science teacher education programmes in IBSE. This framework is developed for both in-service and pre-service science teacher education programmes and is designed with a large degree of flexibility to accommodate national and local differences. This document outlines the overall content of the teacher education programme, identifying core and supplementary elements. It includes the implementation guidelines for both in-service and pre-service teachers.

Key aspects of the framework relate to the way it has been designed to accommodate and address the following areas:

- **Cultural variation** - From an earlier study within ESTABLISH (D2.1), it is clear that some inquiry skills are explicitly or implicitly stated in curriculum and in national assessment criteria of all the beneficiary countries in ESTABLISH. Many new national curricula in these countries also include additional elements of inquiry. Therefore, there is a need to recognize the varied background and cultural differences within the educational systems of the participating countries.
- **Challenges faced by teachers** - From an earlier study within ESTABLISH (D4.1), the challenges that teachers may face in implementing IBSE were identified under three areas - *Teachers beliefs, Classroom Management* and *Pedagogical and scientific knowledge.* These areas are addressed within the elements of the science teacher education programmes.

- **Flexibility in delivery -** While each beneficiary country in ESTABLISH will run science teacher education workshops, the timing within each country may differ, e.g., short evening sessions, day long sessions, summer courses, face to face, or web-based teaching/learning. National provision of opportunities for in-service teachers to participate in inquiry based programmes is diverse across the participating countries, ranging from national programmes to local initiatives. Therefore, the framework is flexible to accommodate such variations and cater for local needs.
- **Suitability for all teachers -** Science teachers within each country have varied experiences of IBSE, varied backgrounds, teaching experience, qualifications and they teach at different levels. However, the issues faced by both in-service and pre-service teachers in implementing inquiry based science teaching/learning are somehow similar and interrelated. Therefore, the framework provides for a core content that is suitable for both pre- and in-service science teachers across differing national contexts. The specific needs of either pre-service teachers or group of in-service teachers can also be addressed thorough provision of additional and supplementary elements.

Teacher Education Programme

The overall model of the ESTABLISH teacher education programme has been designed to accommodate cultural variations among beneficiary countries and to be adaptable to facilitate both the timing of science teacher education workshops and to also cater for the varied experiences of the teacher participants. It is specifically built around the IBSE units that have been developed within the ESTABLISH project and consists of a common core supported by additional materials and resources to address aspects of implementation of IBSE within real classrooms.

Teachers' professional development includes development of both their understanding of IBSE and their ability to develop students' skills in IBSE. The aim of the programme is that the teachers develop general skills and competences to implement IBSE and to also be able develop their own materials aligned with the IBSE framework. The overall structure is shown in Figure 1.

The model proposed for teacher education is built on the documents already provided through the ESTABLISH project. i.e., "Framework for developing ESTABLISH IBSE units" (D1.1), the "Guide for developing ESTABLISH Teaching and Learning Units" (D3.0) and the IBSE units developed (D3.1)

The model involves a core number of elements; say four elements that form the backbone of all ESTABLISH teacher education programmes. The core is then supported by a number of other elements (V to X11) that can be implemented as required to suit local teachers, environment, curriculum etc. At the very centre of all science teacher education programmes are the exemplary inquiry units that have been developed by ESTABLISH. These units will be used as exemplars of good inquiry practices.

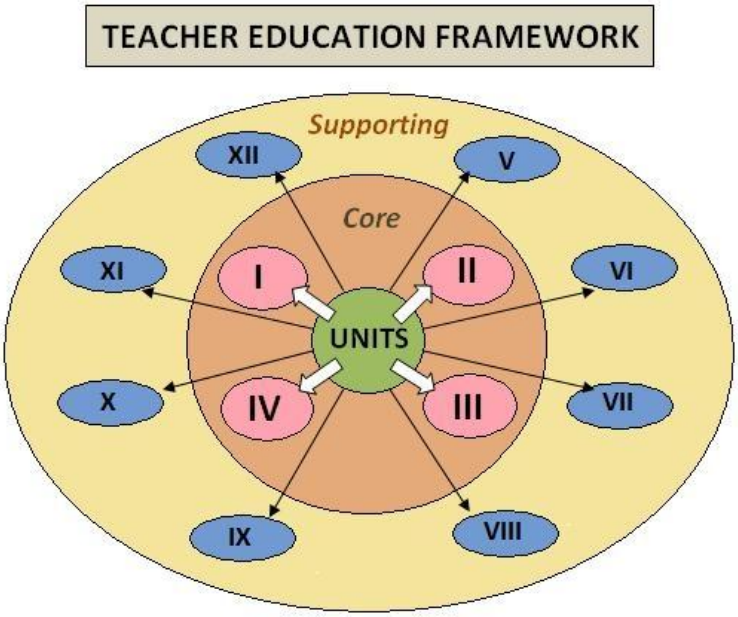

Figure 1: Framework for ESTABLISH Teacher Education

Each element is not necessarily of the same extent and duration during implementation. Each element addresses a different topic and forms the basis of background information for some science teachers or can be a component of the science teacher education programme in other cases. The length of time devoted to each element is at the discretion of the science teacher education programme providers, based on the experiences and background in IBSE of the particular teacher group.

Elements of Teacher Education Programme

The science teacher education programme focusses on the IBSE units that have been already developed by ESTABLISH. These IBSE can be used as exemplary materials for teachers during the science teacher education programmes and can be used to inform all the other elements within the programme. As shown in Fig 1, the ESTABLISH science teacher education programme consists of core elements that will be included in all training programmes and additional supporting elements that can be used as required, depending on the experiences of teachers or local situations. It is envisaged that these elements may be provided through face to face workshops or will be available on line. In this way, individual teachers may be supported and their concerns and needs can be catered.

Informed by the ESTABLISH report "Main obstacles to implementation IBSE" (D4.1), which identified the main obstacles that teachers usually face in implementing IBSE in their classrooms, and informed by the group discussions by the science teacher educators within the ESTABLISH project, the following core elements (I – IV) for teacher education have been identified.

I. ESTABLISH view of IBSE – outline ESTABLISH view of inquiry, benefits to learning, role of inquiry in curriculum, provide direct experience of inquiry, ethical issues

(Completion of profile questionnaire)

II. Industrial Content Knowledge (ICK) – industrial linking – provision of authentic experiences informed by industry or real applications, while this connection may be accomplished study visits in several cases that such a thing seems appropriate

III. Science Teacher as Implementer - followed by implementation in classroom – key area here is for the science teachers to be prepared for implementing inquiry teaching/learning in their own classroom, identifying challenges.

IV. Science Teacher as Developer – evaluation of classroom experience; identification of further needs – teachers should have experience and be equipped to implementing IBSE and start on the process of changing their own materials into inquiry based materials.

(Completion of profile questionnaire)

Additionally, the science teacher education programme must support teachers to overcome the challenges and barriers that have been identified and discussed in report D4.1, and milestone document M4.1. Therefore, a number of supporting workshops will be developed in the following areas to address these needs.

V. Classroom Management – address issues of developing and managing a student-centred classroom, where students may be carrying out different activities and also where the noise level may be higher than in a 'traditional' classroom as group discussions may be taking place. Also addressing time constraints within a predefined and packed curriculum.

VI. ICT – develop confidence and competence in the effective use of ICT in teaching and learning of science and appropriate use in inquiry-based teaching/learning in inquiry.

VII. Argumentation in the classroom – address skills to develop and manage effective argumentation in the classroom.

VIII. Questioning Skills for Inquiry – address the posing of questions that lead to inquiry activities and also to develop skills to ask appropriate questions to guide the inquiry process.

IX. Research and design projects for students – providing authentic experiences – address the development of these ideas, what aspects provide authenticity, student ownership and endorsement.

X. Assessment of IBSE – address assessment of many aspects of inquiry; how assessments can be changed to provide value to the skills (cognitive, affective etc.) linked to IBSE.

XI. Critiquing activities for IBSE – key area to be addressed is to critique activities to identify the areas of inquiry that are connected with particular activities.

XII. Evaluating evidence – address the evidence from scientific experiments to determine the conclusions that can be made from the data, and how these can lead to further investigations.

It is envisaged that each country will implement elements I – IV in their in-service and pre-service science teacher education programmes but will incorporate elements V-XII as these will be required. The list of elements V to XII is not exhaustive and may be added to, particularly for pre-service teachers, following experience of running these programmes. Each element I – XII is not necessarily of the same length and some elements may be considerably shorter than others. Additionally, it is envisaged that web-based elements will be freely available to complement any additional issues or concerns.

Agreed criteria for in-service science teacher education

The following are the minimum criteria adopted for in-service science teacher education.

- Minimum total time for in-service: 10 hours
- Training is delivered over a minimum of three stages;
- Strongly encouraged that the materials are trialled in real classrooms.
- Recommended that a minimum of two teachers per school attend the workshops.
- Recommended that the workshops are hosted in the schools.
- Suggested that a workshop take place in a relevant industrial setting (e.g., industry learning centre)

Agreed criteria for pre-service science teacher education

While minimum criteria could be agreed for in-service teacher education (M4.1), the consortium felt that the criteria for pre-service teacher training were difficult to identify, because of existing timetables for pre-service. It was recommended that partners include ESTABLISH materials and work with links to industry, but they have to develop their own national plans for implementing pre-service teacher training. IBSE teacher training at pre-service level may only be introduced as ESTABLISH related. The "Guide for developing ESTABLISH teaching and learning units" (D3.0) is suggested to be used as teaching materials at pre-service level. Each beneficiary has to list the local constraints, and examine the possibility of discussing with departments of education within their institutions to see where overlaps occur with teaching modules on methodology, so as to bring the focus towards the objectives of ESTABLISH science teacher education at the pre-service level. It is envisaged that a particular module of their pre-service programme will be exclusively devoted to IBSE teaching and appropriate support or encouragement will be provided for them to implement IBSE in their own teaching practice in the classrooms, or in microteaching sessions depending on their local conditions.

As a minimum, 5 hours will be devoted to ESTABLISH inquiry teaching with pre-service teachers, and all beneficiaries will cover element 1 as outlined above. Additionally, they will cover a minimum of 4 of the elements II to XII during their ESTABLISH training programme.

Table 1: Details of the in-service teacher training targets for the ESTABLISH project.

In-service Teacher Training			
Beneficiary No.	**Beneficiary**	**Number of teachers per year**	**Details on in-service teacher training**
1	DCU	20	Science teachers selected from collaborating schools.
2	AGES	20	Science teachers selected from collaborating schools.
3	UvA	-	*Withdrawn from the project*
4	UCY	20	Science teachers selected from established network of collaborating schools. Online networking and training will be also provided
5	UmU	10	Network of teachers in Umea interested in school development.
6	JU	50	Training will be organised in conjunction with workshops organised each year for secondary school chemistry teachers from south Poland at the Faculty of Chemistry JU.
7	CUNI	80	25 physics teachers, 25 chemistry teachers and 30 biology teachers will participate in training each year.
8	AL	5	Science teachers working in secondary schools (11yrs - 16yrs)
9	UPJS	50	Teachers training activities will be through Clubs of secondary schools Science teachers (Mathematics, Physics I, II, Chemistry, Biology)
10	COUO	20	Science teacher network
11	UTARTU	20	Will involve science teachers associations (3) in Estonia, Baltic network (Latvia, Lithuania Estonia summer schools) , forming expert groups of teachers who currently work in close collaboration with UTARTU.
12	UNIPA	20	High School and Junior High School teachers of Physics and Sciences. Both experienced and new employed teachers will be involved in activities.
13	MaH	20	Network of teachers in Malmo interested in school development.
14	IPN	20	Science teacher network
15	CMA	45	CMA is strongly involved in national science in-service.
16	MLU	20	University of Halle collaborates with in-service-teacher professional development in two German Federal States

Table 2: Details of the pre-service teacher training targets for the ESTABLISH project.

Pre-Service Teacher Training			
Beneficiary No.	**Beneficiary**	**Number of teachers per year**	**Details on Pre-Service Teacher Training**
1	DCU	30	Student teachers at DCU
2	AGES	0	*Not involved in pre-service teacher education*
3	UvA	-	*Withdrawn from the project*
4	UCY	30-40	Student teachers at UCY Online facilities will be also employed
5	UmU	10	Student teachers at Umea
6	JU	60	Workshops in about 8 groups (6-10 students each) in the framework of regular pre-service chemistry teachers training (secondary schools) organised at the JU each year.
7	CUNI	50	8 students of Faculty of Mathematics and Physics (future physics teachers), 42 students of Faculty of Science (17 future chemistry teachers and 25 future biology teachers).
8	AL	5	Student teachers following a Bachelor of Education (BEd)course
9	UPJS	20	Faculty of Science study programs for future science teachers (combination of two subjects: physics, chemistry, biology, mathematics,)
10	COUO	20	Student teachers at COUO
11	UTARTU	20	Students will be involved in the framework by the course "Science Technology-Society" (Prof M. Rannikmae).
12	UNIPA	20	School Teachers of Science will be involved in training workshops organised at UNIPA
13	MaH	20	Teacher education and schools have since about 10 years established well working cooperation concerning the student teachers
14	IPN	30	Student teachers at IPN
15	CMA	0	*Not involved in pre-service teacher education*
16	MLU	60	University of Halle is the only teacher education institution in the Federal State of Saxonia-Anhalt. Courses are regularly held in the field of STEM education. The courses are linked to research in this field.

Conclusion

This report presents the framework for science teacher education as agreed by the ESTABLISH consortium. The framework has been developed for both in-service and pre-service teacher education programmes and designed with a large degree of flexibility to accommodate national and local cultural and educational differences. By outlining the overall content of the teacher education programme, identifying core and supplementary elements, together with implementation guidelines, a realistic model to integrate IBSE into teacher education is presented. Therefore, those directly participating in this project will have a standard reference when conducting science teacher education while those not currently involved in this project can learn from our experiences, thus maximising the impact of this project in the area of science teacher education.