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**Project Acronym:** ESTABLISH  
**Project Title:** European Science and Technology in Action:  
 Building Links with Industry, Schools and Home

## Work Package 5 | Deliverable 4 D5.4 Web-based Teacher Education Programme

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**Name of lead partner for this deliverable:** DCU

**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). It meets the requirements of the Deliverable 5.4 by presenting a report on the web-based IBSE materials selected and adapted by the beneficiaries of ESTABLISH. (See Table 1 below for beneficiary list).

As the materials are applicable to both in-service and pre-service teacher education, it was agreed that this Deliverable 5.4 would focus on the web-based teacher education programme developed as part of the project. These web-based materials are more appropriate for pre-service teachers and those little or no prior experience with IBSE. A parallel report, D4.4, will focus on the web-based materials more appropriate for in-service teachers and those with greater experience of IBSE. The development of the materials presented here have been informed by discussions of small working groups at each of the General Assembly Meetings over the period 2012-2013.

This document, published in October 2013, has been produced within the scope of the ESTABLISH Project. The utilisation and release of this document is subject to the conditions of the contract within the Seven<sup>th</sup> Framework Programme, project reference FP7-SIS-2009-1-244749.

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**B. The ESTABLISH consortium**

<b>Beneficiary short name</b>	<b>Beneficiary name</b>	<b>Country</b>	<b>Abbreviation</b>
DCU	DUBLIN CITY UNIVERSITY	Ireland	IE
AGES	AG EDUCATION SERVICES	Ireland	IE
UmU	UMEÅ UNIVERSITET	Sweden	SE
JU	UNIwersytet Jagielloński	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 UNIVERSITÄT OLDENBURG	Germany	DE
UTARTU	TARTU ÜLIKOOL	Estonia	EE
UNIPA	UNIVERSITÀ DEGLI STUDI DI PALERMO	Italy	IT
MaH	MALMÖ UNIVERSITY	Sweden	SE
IPN	LEIBNIZ-INSTITUT FÜR DIE PAEDAGOGIK DER NATURWISSENSCHAFTEN UND MATHEMATIK AN DER UNIVERSITÄT KIEL	Germany	DE
CMA	CENTRE FOR MICROCOMPUTER APPLICATIONS	Netherlands	NL
MLU	MARTIN LUTHER UNIVERSITÄT HALLE-WITTENBERG	Germany	DE
FU	FREDERICK UNIVERSITY	Cyprus	CY

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## 1. Introduction

This report describes the process of development and access mechanism for the web-based materials selected and adapted by the beneficiaries of ESTABLISH to facilitate online teacher education in Inquiry Based Science Education (IBSE). As the materials are applicable to both in-service and pre-service teacher education, this report will focus on the web-based Teacher Education Programme as it will be the main starting point for both pre-service teachers or those with little or no prior experience with IBSE. A parallel report, D4.4, will focus on the web-based materials which are more appropriate for in-service teachers and those with at least some experience of IBSE. It is noted though, that all web-based materials and resources are made freely available for all teachers without distinction.

## 2. Objective of the web-based Teacher Education Programme

The provision of teacher education in IBSE is the core objective of the ESTABLISH project to promote and extend the implementation of this teaching methodology across Europe. The delivery of teacher education has mainly been facilitated by all ESTABLISH partners through face-to-face interactive sessions (workshops, summer-schools, etc.) which align with the criteria for ESTABLISH IBSE education programmes, as outlined in the milestone reports MS11<sup>1</sup> and MS16<sup>2</sup>. It is acknowledged that this criteria represents the minimum, albeit realistic, rather than an optimum, number of hours recommended for engagement in teacher education, to effect change in the classroom. Thus, in order to support and extend the implementation of IBSE as a teaching methodology, both at pre-service and in-service level, the consortium agreed it was desirable and necessary to create online support and web-based materials, identified in the previous report on the web-based materials (D4.2<sup>3</sup>). In this way, this web-based teacher education programme can extend the use and dissemination of IBSE, both at national and international level, during and after the lifetime of the ESTABLISH project.

The main objective of these web-based materials is to provide a self-instructive online resource that teachers can access at their own convenience and at their own pace. Also identified in a previous ESTABLISH report (MS2<sup>4</sup>), an e-platform constructed in Moodle was determined to be the appropriate place to facilitate these web-based materials.

Two major target groups were identified as the primary users of these web-based materials:

- Teachers who have **little or no experience of IBSE** and require information on how they can incorporate aspects into their teaching practice;
- Teachers who are **aware of and have varied experience of IBSE** and require examples of activities around scientific topics to extend their use of IBSE in their teaching practice.

With this in mind, the web-based materials were categorised resulting in two major sections on the ESTABLISH e-platform; a section which focused on presenting **Teacher Education Programme Elements**, appropriate to support those with lesser experience of IBSE, and a section which focused on presenting teaching and learning materials (**IBSE Units**) on particular scientific topics, appropriate for those with some experience of IBSE.

As pre-service teachers also tend to have no or lesser experience of IBSE, this section of the e-platform will be addressed in this report (D5.4) with a parallel report (D4.4<sup>5</sup>), focusing on the web-based materials (IBSE units). It is noted though, that both sections of the e-platform will be made available for both cohorts of teachers without distinction.

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<sup>1</sup> MS11: Agreed criteria for in-service science teacher education

<sup>2</sup> MS16: Agreed criteria for pre-service science teacher education

<sup>3</sup> D4.2: Interim web-based materials of teacher education

<sup>4</sup> MS2: Selection of suitable e-platform for the project

<sup>5</sup> D4.4: Web-based materials for in-service teacher education

### 3. Developing the web-based Teacher Education Programme

The provision of teacher education in IBSE is the core objective of the ESTABLISH project. As referred to within the interim report (D4.2<sup>3</sup>), ESTABLISH teacher education programmes have been developed around an agreed framework for Teacher Education consisting of four core and four supporting elements (Table 1), as shown in Figure 1. Collectively these eight elements address the key aspects of implementing IBSE in the classroom as identified from the experiences from across eleven beneficiary countries (Ireland, Germany, Sweden, Cyprus, Czech Republic, Poland, Slovakia, Malta, Netherlands, Estonia and Italy).

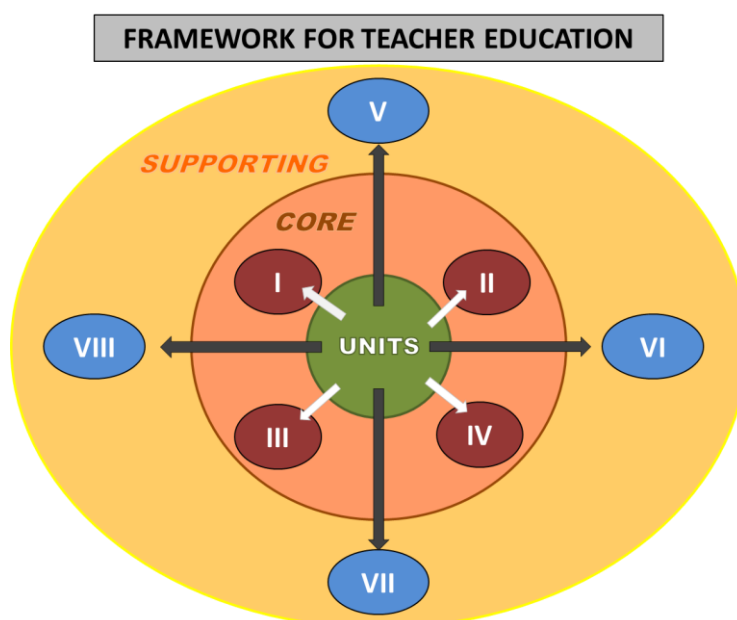


Figure 1. Framework for ESTABLISH Teacher Education

The key learning objectives for each of these elements (given in Appendix 1) were discussed and agreed through group-work sessions at several ESTABLISH General Assembly meetings<sup>6</sup> and inform the scope of the finalised web-based teacher education programme developed. The development of the framework for teacher education and the focus of these elements have also been informed by independent input from members of the ESTABLISH External Advisory Panel<sup>7,8</sup>.

<sup>6</sup> General Assembly Meetings: GA 6, Prague; GA 7, Palermo and GA 8, Krakow

<sup>7</sup> MS30: Evaluation of Teacher Education – Part 1

<sup>8</sup> MS31: Evaluation of Teacher Education – Part 2

Table 1 List of ESTABLISH Teacher Education Programmes

No.	Core/Supporting	Element Title	Element short title (visible on e-platform)
1 (I)	Core	Establish view of IBSE	Intro to IBSE
2 (II)	Core	Industrial content knowledge	ICK
3 (III)	Core	Science teacher as implementer- Management	Implementer
4 (IV)	Core	Science teacher as Developer - Feedback, Evaluation	Developer
5 (V)	Supporting	ICT	ICT
6 (VI)	Supporting	Argumentation in the classroom	Argumentation
7 (VII)	Supporting	Research and design projects for students - Evaluating evidence	Research & design
8 (VIII)	Supporting	Assessment of IBSE	Assessment

### Presenting the web-based materials

The main objective of these web-based materials is to provide a self-instructive online resource that individual teachers can access at their own convenience, and use to self-direct their own professional development. To assist with navigation of the web-based Teacher Education Programmes the following template for the presentation of each element was agreed and adopted.

#### Template for e-platform content for ELEMENTS

##### Element Heading

- **Introduction** - *this presents an overview description of the element*

##### Element Sections

- **Background** - *purpose and scope of short programme*
- **Learning objectives**
- **Activities**
- **Narrative** – *some details about how to use the activity*
- **Evidence** – *some details of how this activity is useful to teachers; e.g. videos, presentations or other materials*
- **Reference/ Further reading** - *series of FILES as links to documents, presentations or references*

The selection of content for the web-based teacher education programmes has been conducted as a cumulative and collaborative effort of the project, as informed by project beneficiaries based on evidence from their own workshop implementation. The structure of this programme builds on previous discussions about the learning objectives of each element within the Framework for Teacher education (see reports on implementing models for science teacher training in IBSE<sup>9,10</sup>), and draws on their experiences of facilitating workshops with teachers (pre-service and in-service). The content of the programme builds on previously reported Interim web-based materials, available in Appendix 2, as well as IBSE activities available within

<sup>9</sup> D4.6: Effective models for in-service science teacher training in IBSE

<sup>10</sup> D5.6: Effective models for pre-service science teacher training in IBSE

the 18 ESTABLISH units (D3.1<sup>11</sup>, D3.2<sup>12</sup>, D3.3<sup>13</sup>) that were reviewed for suitability, as listed in Appendix 3. Where a particular Teacher Education Element was not explicitly covered in the workshop material previously developed (e.g. Argumentation), external activities and materials are proposed and referenced.

Thus, all eight elements of this web-based Teacher Education Programme present exemplary workshop activities in a clear sequence so that the user may achieve the learning objectives of each Teacher Education Programme element.

#### 4. Accessing ESTABLISH Teacher Education resources

The web-based materials developed and adapted for teacher education are made available through a Moodle e-platform at: <http://ibse.establish-fp7.eu/index.php?>, as shown in screenshot, Figure 2 and will have open access for all users from 1<sup>st</sup> November 2013.

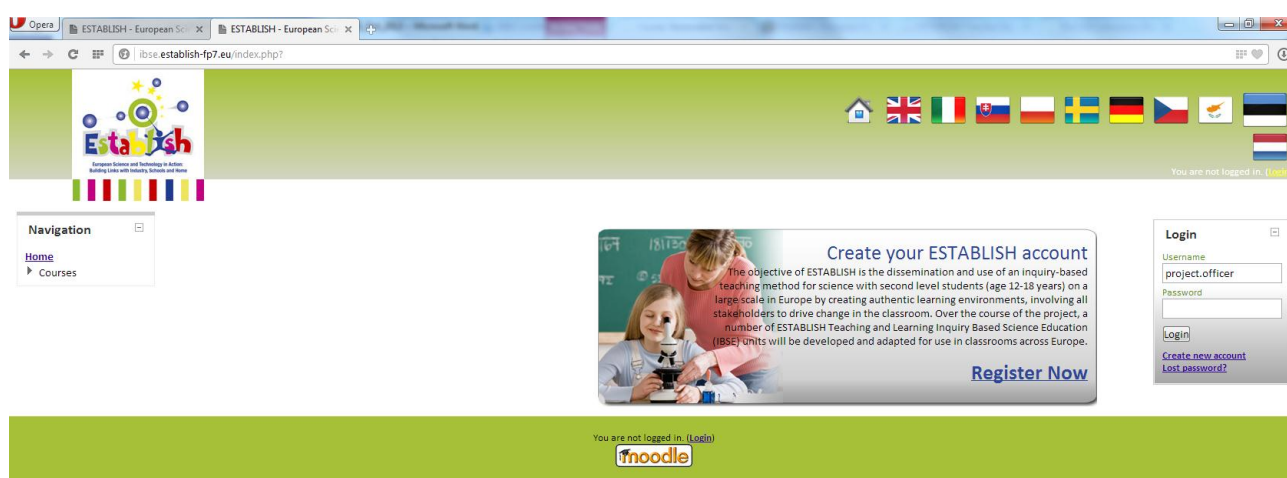


Figure 2 Screenshot of ESTABLISH e-platform

On entering the e-platform the user is introduced to the project and invited to explore the developed and adapted TEACHING AND LEARNING UNITS, for those who have greater experience in IBSE, or the teacher education TEACHER EDUCATION SHORT PROGRAMMES, for those who have lesser experience in IBSE, as shown in screenshot, Figure 3.

<sup>11</sup> D3.1: Piloted, culturally adapted, teaching and learning units – Part 1

<sup>12</sup> D3.2: Piloted, culturally adapted, teaching and learning units – Part 2

<sup>13</sup> D3.3: Piloted, culturally adapted, teaching and learning units – Part 3





Figure 3 Screenshot of ESTABLISH e-platform landing page

By clicking on the TEACHER EDUCATION SHORT PROGRAMMES, the user is introduced to shortened versions of the ESTABLISH Teacher Education Programmes, Figure 4, which are presented as four core and four additional elements, as listed in Table 1.

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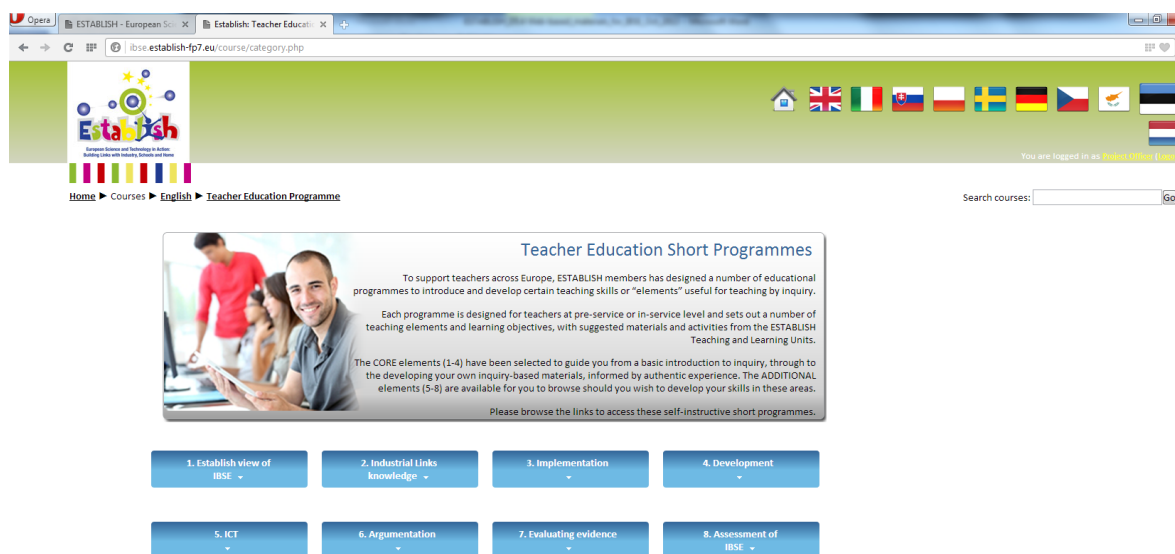


Figure 4 Screenshot of ESTABLISH Teaching and Learning Units

It was agreed to populate the e-platform with only English content during the project and subsequently beneficiaries may translate this resource into other European languages, so as to extend the impact and usefulness of this e-platform.

The resulting product, thus, presents exemplar web-based materials and activities as a self-instructive online resource that users, mainly science teachers can access at their own convenience to support them in incorporating IBSE into their own teaching practices.

## Appendix 1 – Learning objectives

The following learning objectives have been articulated for each of the ESTABLISH Teacher Education Programme and will be addressed in the web-based Teacher Education Programme. On completion of each Teacher Education Programme the teacher will be able to:

Element Title	Learning Objectives
I. ESTABLISH view of IBSE	Recognise and replicate direct experiences of inquiry into the teaching of science
	Outline ESTABLISH view of inquiry
	Understand the benefits of learning by inquiry
	Identify & discuss the role of inquiry in curriculum
	Understand the role of the teacher (and other students) when teaching by inquiry
	Understand the ethical issues pertinent to teaching science
	Become effective in asking questions that raise curiosity in students; generating (productive) questions that can be investigated
	Elicit students' creative/intelligent/investigative questions
	Adapt and turn questions into those that can be investigated
II. Industrial Content Knowledge (ICK)	Acknowledge the relevance and benefits of ICK in IBSE
	Identify and appreciate variations of ICK experiences
	Develop and integrate ICK experiences into their inquiry teaching.
III. Science Teacher as Implementer - Manager	Reflect on practice of inquiry within the classroom
	Become effective in asking / owning ; managing / encouraging questions that can be investigated
	Design investigations that support analysing and interpreting data
	Find ways to help students to support their claims by generating / searching out evidence
	Manage and encourage communication within the classroom
	Discuss different ways to perform an IBSE lesson
	Support the curiosity of students within the classroom
IV. Science Teacher as Developer	Encourage, assist and develop inquiry lessons
	Reflect and evaluate resources from multiple sources (including online and print media) to find possible topics, scientific background, etc.
	Become effective in managing and evaluating the scientific content and additional information from these resources
	Reflect and report back on self-developed inquiry lessons
	Identify classroom issues when teaching by inquiry and provide constructive comments on how to resolve these issues
	Engage actively in a community of practice to share experiences

	Understand and appreciate the criteria for inquiry activities
	Demonstrate how to turn activities into inquiry
V. Information Communications Technology (ICT)	Understand the role of constructional ICT tools (Data-logging, Image/Video measurement, Data processing and analysis, Dynamical modelling, Simulations and Animations) in IBSE
	Identify and practice the integration of appropriate ICT tools to enhance and augment scientific inquiry and teaching
	Discuss the educational benefits of these tools and multiple ways of using them in IBSE teaching
	Develop their own ICT supported IBSE activities
VI. Argumentation in the classroom	Describe what an argument in science is, and why argumentation is important in the science classroom;
	Give examples of different argumentation activities and supporting materials (for example web links to resources)
	Interpret and integrate argumentation in the classroom with activities and resources are produced within the ESTABLISH-project but other well-known resources are also presented.
VII. Research & Design projects for students - Evaluating Evidence	Organise and manage the development of suitable research and design projects for students
	Describe the role, reasoning and operative procedures of project work in IBSE
	Evaluate evidence
	Recommend how to apply scientific rigour when collecting and analysing evidence
	Explain and demonstrate how to implement instructional elements into the classroom
VIII. Assessment of Inquiry	Recognise and appreciate the different levels and expectations of IBSE and its assessment
	Identify how to assess skills and attitudes as well as knowledge (general guidelines for successful formative and summative assessment in inquiry)
	Become efficient in delivering feedback through multiple strategies
	Practise the use of various assessment tools

## Appendix 2 - Update to accessing Interim web-based materials

The interim web-based materials were agreed to remain on the project's website. These materials, outlined as four workshops are presented online available on the project's website at TEACHER PROFESSIONAL DEVELOPMENT: <http://www.establish-fp7.eu/teacher-professional-development-en>, as shown in the screenshot, Figure 5 and have informed the finalised web-based Teacher Education Programmes.

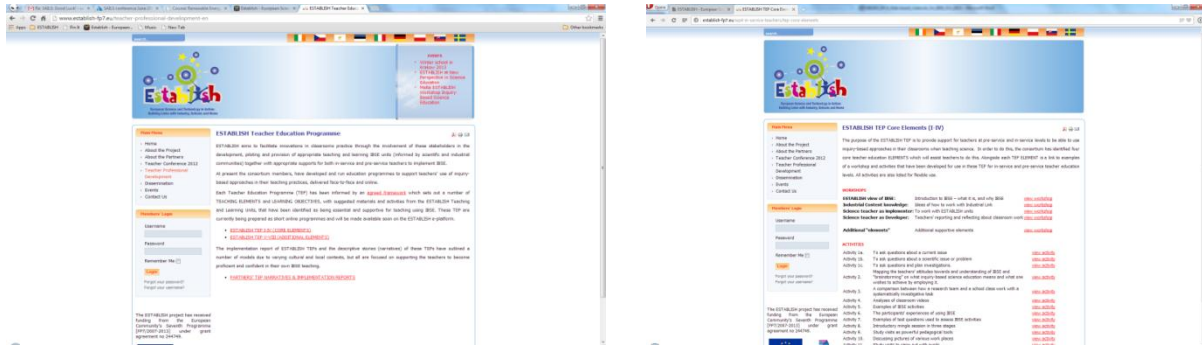


Figure 5 Screenshots of ESTABLISH Teacher Professional Development webpages showing interim web-based materials

These interim web-based materials focus on the following elements:

1. Introduction to IBSE – what it is, and why IBSE (*ESTABLISH view of IBSE*)
2. Ideas of how to work with Industrial Links (*Industrial Content Knowledge (ICK)*)
3. To work with ESTABLISH units (Science Teacher as Implementer)
4. Teachers' reporting and reflecting about classroom work (*Science Teacher as Developer*)

### Appendix 3 – List of exemplar unit activities related to ESTABLISH Teacher Education Elements

<b>Unit Activities</b>	<b>Teacher Education Element</b>								
<b>Unit Title</b>	<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>	<b>VI</b>	<b>VII</b>	<b>VIII</b>	<b>Total</b>
<b>Blood Donation</b>									
Blood as a transporter							•	•	2
Blood preservation				•	•				2
Determining blood types	•						•		2
Interview						•			1
Is it possible to produce artificial blood?		•					•		2
Is Pavol the father?				•	•				2
Looking up information			•						1
Scientific conference			•						1
Separation of blood constituents				•					1
Study visit at a transfusion center		•							1
<b>Blood Donation Total</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>15</b>
<b>Chemical Care</b>									
Carrying out experiments	•								1
Formulating hypotheses	•								1
Formulating questions	•								1
Further applications I								•	1
Further applications II		•							1
How much acid do we find in a household product?		•							1
Planning an investigation	•								1
Production processes of textile fibres		•							1
The dream fibre/plant		•							1
Transfer of knowledge	•								1
Which household products contain acids?		•							1
<b>Chemical Care Total</b>	<b>5</b>	<b>5</b>						<b>1</b>	<b>11</b>
<b>Chitosan</b>									
Chitin from Crab Shells			•	•					2
Chitosan binding Fat			•	•					2
Chitosan from Chitin			•	•					2
Clarification of Fruit Juices			•	•					2
Preparation of Chitosan Films			•	•					2

Solubility of Chitosan			•	•						2
Chitosan Total			6	6						12
<b>Cosmetics</b>										
Analysis of the cosmetic cream			•							1
Experiment: making the product									•	1
Making the decision							•			1
Preparations for making an emulsion cream									•	1
Presenting the product									•	1
Testing the product									•	1
Cosmetics Total			1				1		4	6
<b>DC Electricity</b>										
Batteries and their reasonable use		•	•							2
Bulb		•						•		2
Does human body obey Ohm's Law?									•	1
Fuel cell			•							1
How electric eel kills its prey		•								1
How is it connected inside the black box?				•						1
Other elements in a dc circuit (diode)		•						•		2
Photovoltaic cell			•							1
Power transfer efficiency								•		1
Power transfer to the load								•		1
Resistor		•						•		2
Terminal voltage								•		1
Thermistor		•						•		2
Two different bulbs in series				•				•		2
Two identical bulbs in series								•		1
What element is hidden in the black box?								•		1
DC Electricity Total		6	3	2		1		9		1
<b>Designing a Low Energy Home (DLEH)</b>										
An open Inquiry about Infrared thermography			•	•	•	•	•	•	•	7
Analysis of the cooling processes of an hot body in different conditions. Cooling in air and in a vacuum environment.			•	•	•	•	•	•	•	7
Build and use home-made radiometers			•	•	•	•	•			5
Experimenting different kinds of convection			•	•	•	•	•	•	•	7
How is the temperature distributed inside your house model ?		•		•		•	•			4
How to maintain warm your house model		•		•		•	•			4

illuminating objects of different colours.			•	•	•	•	•		5
Measuring insulation properties of different materials	•	•	•	•	•	•	•	•	7
Observing convection currents		•	•			•			3
Observing ice melting in plates of different materials	•	•	•	•	•				5
Radiation from hot and cool bodies		•	•	•	•	•			5
What is the effect of sunlight on the temperature inside your house model?	•	•	•		•	•		•	6
<b>Designing a Low Energy Home (DLEH) Total</b>	<b>3</b>	<b>7</b>	<b>12</b>	<b>9</b>	<b>11</b>	<b>12</b>	<b>6</b>	<b>5</b>	<b>65</b>
<b>Disability</b>									
Disability aids		•							1
Discussion about body fixation, disabilities and handicaps						•			1
Fitness training	•							•	2
How is the pulse and respiratory rate affected by different activities?	•							•	2
Receptors, nerves and nerve impulses	•								1
Study visit to disability aid centre		•							1
Text in teacher materials									
What does the future hold for the development of disability aids?		•							1
Why do we breathe?	•					•			2
<b>Disability Total</b>	<b>4</b>	<b>3</b>				<b>2</b>		<b>2</b>	<b>11</b>
<b>Eco Biology</b>									
Estimating the density of an endangered plant species in a named ecosystem	•	•	•				•	•	5
Flowering plant reproduction	•	•					•	•	4
Plant adaptations and effects of global warming on endangered and/or farmed plant species	•	•			•		•	•	5
Plant extracts and antibiotics	•	•	•				•	•	5
The science of taxonomy	•	•	•				•	•	5
<b>Eco Biology Total</b>	<b>5</b>	<b>5</b>	<b>3</b>		<b>1</b>		<b>5</b>	<b>5</b>	<b>24</b>
<b>Exploring Holes</b>									
Assessment activity								•	1
Investigations of properties and factors affecting SAP	•								1
Properties and applications of cyclodextrines		•							1
Transfer and Extension/Assessment: Dialysis								•	1
Use of filters in industry		•							1
What is the best wrapping material?		•							1
<b>Exploring Holes Total</b>	<b>1</b>	<b>3</b>						<b>2</b>	<b>6</b>

<b>Forensic Science</b>								
Awareness test and change blindness.				•				1
Can you use footprints to determine if a person was running or walking?				•				1
Fingerprints as a way to identify persons.				•				1
Historical Trials	•							1
How can fingerprints be categorized?	•							1
Measuring on crime-scene pictures					•			1
Modelling the ballpoint case					•			1
Solve another crime.						•		1
Take fingerprints from an object							•	1
The trial								• 1
Traces in the snow						•		1
<b>Forensic Science Total</b>	<b>2</b>	<b>1</b>		<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>11</b>
<b>Medical Imaging</b>								
Are X-rays bad for you?						•		1
CT scans					•			1
Radiation exposure					•			1
Radiation protection					•		•	2
Radioactive decay Guided inquiry					•			1
Tracing substances in the human body		•						1
Ultrasound imaging		•				•		2
X the unknown Guided discovery					•		•	2
$\alpha$ , $\beta$ , and $\gamma$					•		•	2
<b>Medical Imaging Total</b>		<b>2</b>			<b>6</b>	<b>2</b>	<b>3</b>	<b>13</b>
<b>Photosynthesis</b>								
Capturing students' interest	•							1
Designing the model of a space station							•	1
Inquiry on „What factors influence the intensity of photosynthesis?“					•	•		2
<b>Photosynthesis Total</b>	<b>1</b>				<b>1</b>	<b>1</b>	<b>1</b>	<b>4</b>
<b>Renewable Energy</b>								
Designing a wind turbine		•					•	2
Designing a hydroelectric power plant		•					•	2
Cooking with the heat of the sun		•					•	2
Designing a solar collector		•					•	2
Building a dye-sensitized solar cell		•					•	2



The power of a solar powered garden pump	•					•				2
My ipod runs on effluent energy	•					•				2
Designing a hydrogen vehicle	•					•				2
Design an island system!	•					•				2
Renewable Energy Total	9					9				18
Sound										
Analysis of voice sounds	•				•					2
Fundamental frequency, double bass					•					1
Fundamental frequency, guitar					•					1
Hearing sound	•				•					2
How fast sound travel?	•				•					2
How loud is too loud?		•			•			•		3
How sounds are made?	•									1
Human speech analysis	•				•		•			3
Human speech synthesis	•				•		•			3
Make sound visible	•				•					2
Resonance					•					1
Sound graphs	•				•					2
Sound signal analysis	•				•					2
Timbre					•					1
Sound Total	9	1			13		2	1		26
Water in the life of man										
A visit to a dialysis centre		•								1
Water in the life of man Total		•								1
Teacher Education Element										
Unit Activities	I	II	III	IV	V	VI	VII	VIII	Total	
Grand Total	37	43	25	21	45	21	34	19		245