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D4.4 Web-based IBSE materials for Teacher Education

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A. Background to this report

This report is a deliverable of Work Package 4 (WP4) 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 4.4 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 these web-materials are applicable to both in-service and pre-service teacher education, it was agreed that this report D4.4 would focus on the materials that would be more appropriate for in-service teachers and those with some experience in IBSE, with the parallel report, D5.4, focusing on the web-based Teacher Education Programmes appropriate for pre-service teachers and those with little or no experience in IBSE. The development of the materials presented here have been informed by discussions of small working groups at each of the General Assembly Meetings in 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 Seventh Framework Programme, project reference FP7-SIS-2009-1-244749.

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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
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
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
FU	FREDERICK UNIVERSITY	Cyprus	CY

Contents

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 resources or units, as this will be the likely starting point for in-service teachers or those with some prior experience in IBSE. A parallel report, D5.4, will focus on the web-based Teacher Education Programme more appropriate for pre-service teachers and those with little or no prior experience in IBSE. It is noted though, that all web-based materials and resources are made freely available for all teachers without distinction.

2. Objective of web-based IBSE materials

The provision of teacher education in IBSE is central to 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[1] and MS16[2]. 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[3]). 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[4]), 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 in IBSE** and require information on how they can incorporate aspects into their teaching practice;
- Teachers who are **aware of and have varied experience in 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 in IBSE, and a section which focused on presenting teaching and learning materials **(IBSE Units)** on particular scientific topics, appropriate for those with some experience in IBSE.

As in-service teachers tend to be those who have greater experience in IBSE, this section of the e-platform will be addressed in this report (D4.4[5]), with the section appropriate for those with little or no experience in

[1] MS11: Agreed criteria for in-service science teacher education
[2] MS16: Agreed criteria for pre-service science teacher education
[3] D4.2: Interim web-based materials of teacher education
[4] MS2: Selection of suitable e-platform for the project
[5] D4.4: Web-based materials for in-service teacher education

IBSE addressed in the parallel report (D5.4[6]). It is noted though, that both sections of the e-platform will be made freely available for all teachers without distinction.

3. Developing web-based IBSE materials

The provision of teacher education in IBSE is the core objective of the ESTABLISH project. As referred to within the interim report (D4.2[3]), 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).

Table 1 List of ESTABLISH Teacher Education Elements

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

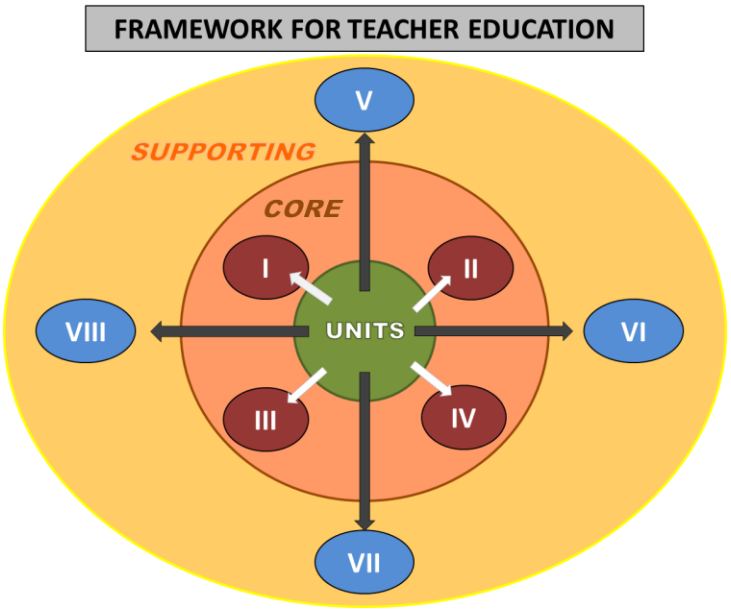

Figure 1. Framework for ESTABLISH Teacher Education

[6] D5.4: Web-based materials for pre-service teacher education

Central to the programme elements, as shown in Figure 1, are the ESTABLISH Teaching and Learning units. These 18 substantial IBSE teaching and learning units (listed in Table 2) encompass an extensive range of science activities that have been shown to be suitable for use in inquiry based teaching and learning across the participating 11 beneficiary countries. These activities are available for reference in Appendix 1. While the details of these units are available elsewhere[7] it is worth noting that each unit has undergone an extensive piloting, trialling and implementation phase to ensure that the content presented is not only theoretically educational but also practical and fit for purpose.

Table 2 List of ESTABLISH Units and lead authors

	Topic	Area	Authoring Beneficiary (Lead Contact)
1	Sound	Physics	CMA (Ewa Kedzierska)
2	Disability	Biology	MaH (Margareta Ekborg)
3	Exploring Holes	Chemistry	DCU (Odilla Finlayson)
4	Designing a low energy home	Physics	UNIPA (Rosa Maria Sperandeo)
5	Chitosan – Fatmagnet?	Chemistry	IPN (Wolfgang Gräber)
6	Direct current electricity	Physics	UPJS (Zuzana Jeskova)
7	Cosmetics	Chemistry	UTARTU (Miia Rannikmäe)
8	Blood donation	Biology	CUNI (Katarína Kimáková)
9	Photochemistry	Chemistry	JU (Paweł Bernard)
10	Renewable energy	Integrated Sciences[8]	MLU (Stephan Domschke)
11	Chemical Care	Chemistry	IPN (Ilka Parchmann)
12	Light	Physics	DCU (Eilish McLoughlin)
13	Photosynthesis	Chemistry	UTARTU (Miia Rannikmäe)
14	Polymers around us	Chemistry	CUNI (Hana Ctrnactova)
15	Forensic science	Integrated Sciences[8]	CMA (Ton Ellermeijer)
16	Medical imaging	Integrated Sciences[8]	CMA (Ewa Kedzierska)
17	Eco-Biology	Biology	UCY/FU (Constantinos Phanis)
18	Water in the Life of man	Biology	CUNI (Vera Cizkova)

While the face-to-face Teacher Education Programmes serve a very necessary function of the project, to introduce teachers to IBSE and increase their use of IBSE in the classroom, they are inherently limited in the impact they will have in each country regarding the number of teachers that have participated and the finite duration of the project. It is acknowledged that science teachers have varying degrees of prior experiences of IBSE as well as different expectations of the scientific topics covered during the Teacher Education Programmes. Thus, it is highlighted that participating teachers (at in-service or pre-service) will require additional support and IBSE resources to extend their use of IBSE as their teaching methodology. For this reason ESTABLISH agreed to make the piloted, culturally adapted teaching and learning units available as **web-based units** on the Moodle e-platform, so as to extend the use and dissemination of IBSE across Europe.

[7] D3.1, D3.2, D3.3: Piloted culturally adapted IBSE Units Part I, II, III
[8] Integrated Sciences = Physics, Chemistry & Biology

Presenting the web-based IBSE units

The main objective of these web-based materials is to provide a self-instructive online resource that teachers can access at their own convenience, with the web-based teacher education programme providing a structure for individual teachers to self-direct their own professional development. The collection of IBSE Units provides detailed exemplary materials and suggested learning paths for teaching specific science topics. To assist with the navigation of the web-based IBSE materials the following template for the presentation of each unit was agreed and adopted[9]:

The collection of IBSE Units provides detailed exemplary materials and suggested learning paths for

Template for e-platform content for UNITS

Unit Heading

- **Introduction** - *this presents an overview description of the unit and possibly sub-units*

Sub-unit Sections

- **Background** - *purpose and scope of the sub-unit*
- **Details of expected audience** – *student level, discipline & expected number of class periods*
- **Teacher Information** – *IBSE Character; Science Content; Pedagogical Content knowledge; Industrial Content Knowledge; Learning Paths; Assessment*
- **Learning Activities** –*details of activities*
- **Classroom Materials** – *worksheets and computer files if required*

The selection of content for the web-based units has been conducted as a cumulative and collaborative effort of the project. Building on previous discussions about the teaching and learning units and drawing on their experiences of holding workshops with teachers (pre-service and in-service), the activities available within the units (D3.1[10], D3.2[11], D3.3[12] and presented in Appendix 1) were adapted and enriched with ICT to enhance their suitability.

Thus, each web-based IBSE unit follows a simple template so as to present exemplar workshop activities, as suggested by partners, based on evidence of their implementation, in a simple sequence so that the user can explore a greater number of scientific topics and gain a deeper appreciation and understanding of how to implement IBSE into their teaching.

[9] D1.1: Agreed framework for IBSE teaching and learning units
[10] D3.1: Piloted, culturally adapted, teaching and learning units – Part 1
[11] D3.2: Piloted, culturally adapted, teaching and learning units – Part 2
[12] D3.3: Piloted, culturally adapted, teaching and learning units – Part 3

4. Accessing ESTABLISH Teacher Education resources

The web-based IBSE 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 from 1st November 2013.

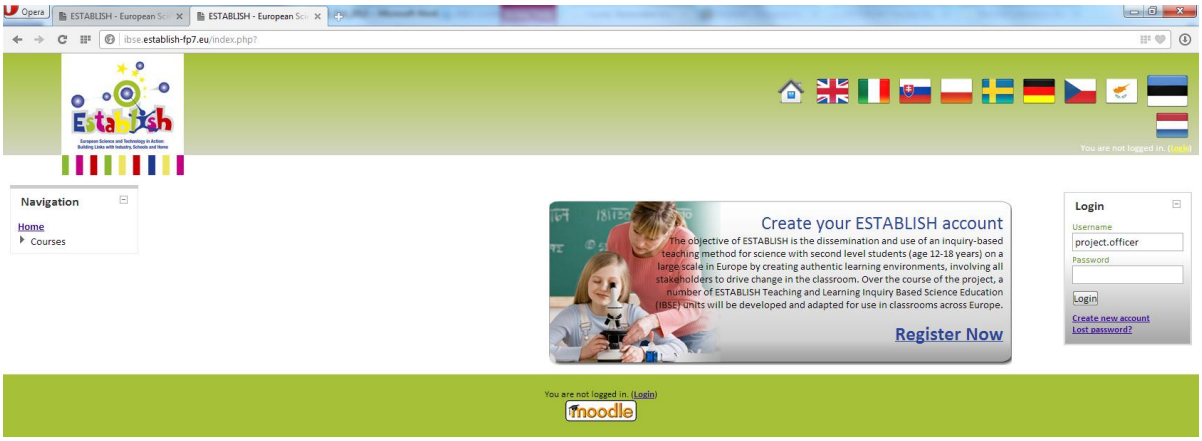

Figure 2 Screenshot of ESTABLISH e-platform

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

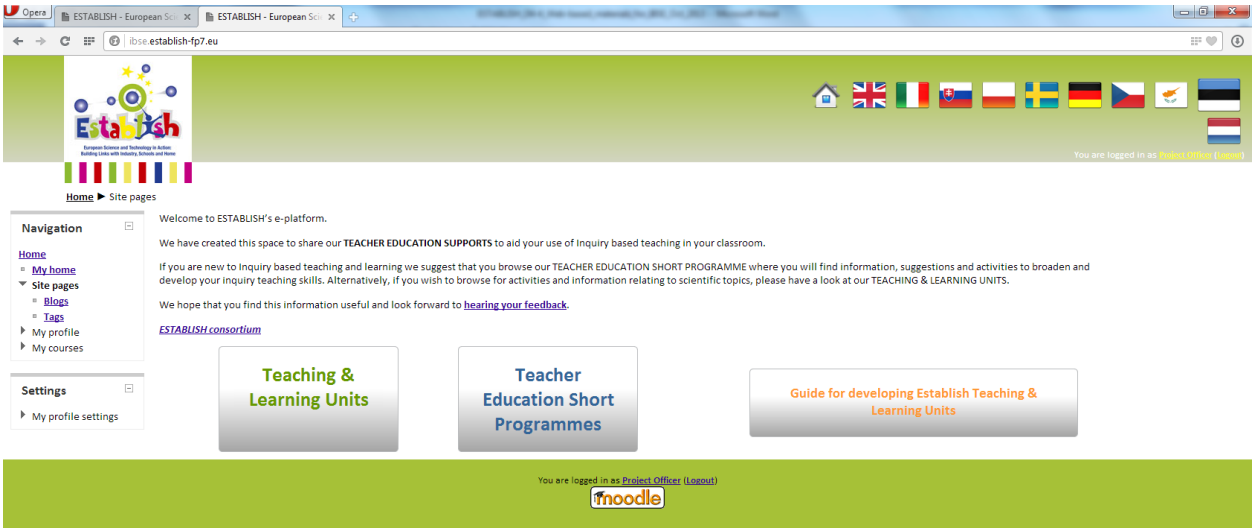

Figure 3 Screenshot of ESTABLISH e-platform landing page

By clicking on the TEACHING & LEARNING UNITS, the user is introduced to the units and invited to explore each of 18 developed and adapted units, listed in Table 2, which are grouped in terms of scientific discipline, Figure 4.

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. This multi-lingual content is available by clicking on the appropriate flag icon.

The resulting product, thus, presents a variety of web-based IBSE materials and activities, inspired by the face-to-face workshops implemented by the ESTABLISH consortium, as a self-instructive online resource that users (namely teachers) can access at their own convenience to support them in incorporating IBSE into their teaching practices.

The ESTABLISH consortium members continue to support and inspire the further development of IBSE activities and units and facilitate the sharing and dissemination of these materials.

Appendix 1 – List of Units Activities

No.	Unit	Subunit (if applicable)	Activity #	Activity Title
1	Sound	Exploring sound	1.1	Introduction to sound
1	Sound	Exploring sound	1.2	How sounds are made?
1	Sound	Exploring sound	1.3	Make sound visible
1	Sound	Exploring sound	1.4	Analysis of voice sounds
1	Sound	Exploring sound	1.5	How sound travels?
1	Sound	Exploring sound	1.6	How fast sound travel?
1	Sound	Exploring sound	1.7	Hearing sound
1	Sound	Exploring sound	1.8	How loud is too loud?
1	Sound	Exploring sound	1.9	What have you learned about sound
1	Sound	String instruments and wind instruments	2.1	Resonance
1	Sound	String instruments and wind instruments	2.2	Fundamental frequency, double bass
1	Sound	String instruments and wind instruments	2.3	Fundamental frequency, guitar
1	Sound	String instruments and wind instruments	2.4	Melde's experiment
1	Sound	String instruments and wind instruments	2.5	Harmonics of the guitar
1	Sound	String instruments and wind instruments	2.6	Standing waves in air; air column
1	Sound	String instruments and wind instruments	2.7	Standing waves in air; soprano saxophone
1	Sound	String instruments and wind instruments	2.8	Timbre
1	Sound	String instruments and wind instruments	2.9	Beats
1	Sound	String instruments and wind instruments	2.11	Tuning the guitar
1	Sound	Human speech	3.1	Sound graphs
1	Sound	Human speech	3.2	Model of human speech production
1	Sound	Human speech	3.3	Sound signal analysis
1	Sound	Human speech	3.4	Human speech analysis
1	Sound	Human speech	3.5	Human speech synthesis
2	Disability	Disability	1	Discussion about body fixation, disabilities and handicaps
2	Disability	Disability	2	Disability aids
2	Disability	Disability	3	Study visit to disability aid centre
2	Disability	Disability	4	Technical aids
2	Disability	Disability	5	How do muscles work?
2	Disability	Disability	6	The strength and function of muscles
2	Disability	Disability	7	Receptors, nerves and nerve impulses
2	Disability	Disability	8	Why do we breathe?
2	Disability	Disability	9	How is the pulse and respiratory rate affected by different activities?
2	Disability	Disability	10	Fitness training
2	Disability	Disability	11	Can you cope with a wheelchair at your school?
2	Disability	Disability	12	What does the future hold for the development of disability aids?
3	Exploring Holes	Visible holes	1.1	Making sieves
3	Exploring Holes	Visible holes	1.2	Observation and explanation of filters
3	Exploring Holes	Visible holes	1.3	Use of filters in industry

3	Exploring Holes	Visible holes	1.4	Separation challenge
3	Exploring Holes	Visible holes	1.5	Assessment activity
3	Exploring Holes	Visible holes	1.6	Transfer: Air filters
3	Exploring Holes	Invisible holes	2.1	Membranes with invisible holes
3	Exploring Holes	Invisible holes	2.2	Set of activities on diffusion, particles and holes
3	Exploring Holes	Invisible holes	2.3	Transfer and Extension/Assessment: Dialysis
3	Exploring Holes	Invisible holes	2.4	What is the best wrapping material?
3	Exploring Holes	Invisible holes	2.5	Extra Activities
3	Exploring Holes	Interesting holes	3.1	Investigating the development of particular polymer products
3	Exploring Holes	Interesting holes	3.2	Investigations of properties and factors affecting SAP
3	Exploring Holes	Interesting holes	3.3	Properties and applications of cyclodextrines
3	Exploring Holes	Interesting holes	3.4	Extra Activities
4	Designing a Low Energy Home (DLEH)	Testing a house model	1.1	How to maintain warm your house model
4	Designing a Low Energy Home (DLEH)	Testing a house model	1.2	How is the temperature distributed inside your house model ?
4	Designing a Low Energy Home (DLEH)	Testing a house model	1.3	What is the effect of sunlight on the temperature inside your house model?
4	Designing a Low Energy Home (DLEH)	Conduction	2.1	Observing ice melting in plates of different materials
4	Designing a Low Energy Home (DLEH)	Conduction	2.2	Measuring insulation properties of different materials
4	Designing a Low Energy Home (DLEH)	Convection	3.1	Observing convection currents
4	Designing a Low Energy Home (DLEH)	Convection	3.2	Experimenting different kinds of convection
4	Designing a Low Energy Home (DLEH)	Thermal Radiation	4.1	Build and use home-made radiometers
4	Designing a Low Energy Home (DLEH)	Thermal Radiation	4.2	Illuminating objects of different colours.
4	Designing a Low Energy Home (DLEH)	Thermal Radiation	4.3	Radiation from hot and cool bodies
4	Designing a Low Energy Home (DLEH)	Thermal Radiation	4.4	An open Inquiry about Infrared thermography
4	Designing a Low Energy Home (DLEH)	Thermal Radiation	4.5	Analysis of the cooling processes of an hot body in different conditions. Cooling in air and in a vacuum environment.
5	Chitosan	Chitosan	1	Chitin from Crab Shells
5	Chitosan	Chitosan	2	Chitosan from Chitin
5	Chitosan	Chitosan	3	Solubility of Chitosan
5	Chitosan	Chitosan	4	Chitosan binding Fat
5	Chitosan	Chitosan	5	Preparation of Chitosan Films
5	Chitosan	Chitosan	6	Clarification of Fruit Juices
6	DC Electricity	Electric current, battery and bulb	1.1	How torch works
6	DC Electricity	Electric current, battery and bulb	1.2	Construct a simple electric device
6	DC Electricity	What material conducts electric current?	2.1	What material conducts electric current?
6	DC Electricity	How is it connected inside the black box?	3.1	How is it connected inside the black box?
6	DC Electricity	Measuring current and voltage	4.1	Measuring current and voltage

6	DC Electricity	Electric element in a dc circuit	5.1	Resistor
6	DC Electricity	Electric element in a dc circuit	5.2	Bulb
6	DC Electricity	Electric element in a dc circuit	5.3	Other elements in a dc circuit (diode)
6	DC Electricity	Electric element in a dc circuit	5.4	What element is hidden in the black box?
6	DC Electricity	Resistance and temperature (build your own thermometer)	6.1	Metal conductor
6	DC Electricity	Resistance and temperature (build your own thermometer)	6.2	Thermistor
6	DC Electricity	Model of electric conductivity (why is it more or less resistive)	7.1	Model of electric conductivity (why is it more or less resistive)
6	DC Electricity	Does human body obey Ohm's Law?	8.1	Does human body obey Ohm's Law?
6	DC Electricity	Intriguing behaviour of bulbs	9.1	Two identical bulbs in series
6	DC Electricity	Intriguing behaviour of bulbs	9.2	Two different bulbs in series
6	DC Electricity	Intriguing behaviour of bulbs	9.3	Switch on the circuit
6	DC Electricity	Intriguing behaviour of bulbs	9.4	Two identically labelled bulbs
6	DC Electricity	Build your own battery	10.1	Coins in solution
6	DC Electricity	Build your own battery	10.2	Fruit cell
6	DC Electricity	Build your own battery	10.3	Lead storage battery
6	DC Electricity	Battery and its basic parameters	11.1	Terminal voltage
6	DC Electricity	Battery and its basic parameters	11.2	Power transfer to the load
6	DC Electricity	Battery and its basic parameters	11.3	Power transfer efficiency
6	DC Electricity	Battery and its basic parameters	11.4	Build up a model of battery behaviour
6	DC Electricity	Batteries in series and in parallel	12.1	Batteries in series and in parallel
6	DC Electricity	How electric eel kills its prey	13.1	How electric eel kills its prey
6	DC Electricity	How much energy is stored in a battery?	14.1	How much energy is stored in a battery?
6	DC Electricity	Batteries and their reasonable use	15.1	Batteries and their reasonable use
6	DC Electricity	Other alternative electrical sources	16.1	Fuel cell
6	DC Electricity	Other alternative electrical sources	16.2	Photovoltaic cell
7	Cosmetics	Cosmetics	1	Capturing students' interest
7	Cosmetics	Cosmetics	2	Exploring the science behind cosmetic creams
7	Cosmetics	Cosmetics	3	Exploring the ingredients of and their role in cosmetic creams
7	Cosmetics	Cosmetics	4	Analysis of the cosmetic cream
7	Cosmetics	Cosmetics	5	Preparations for making an emulsion cream
7	Cosmetics	Cosmetics	6	Experiment: making the product

7	Cosmetics	Cosmetics	7	Testing the product
7	Cosmetics	Cosmetics	8	Presenting the product
7	Cosmetics	Cosmetics	9	Making the decision
7	Cosmetics	Cosmetics	10	Exploring careers related to the cosmetics industry
8	Blood Donation	Blood Donation	1	Appeal for donating blood
8	Blood Donation	Blood Donation	2	Looking up information
8	Blood Donation	Blood Donation	3	Study visit at a transfusion center
8	Blood Donation	Blood Donation	4	Separation of blood constituents
8	Blood Donation	Blood Donation	5	Scientific conference
8	Blood Donation	Blood Donation	6	Interview
8	Blood Donation	Blood Donation	7	Determining blood types
8	Blood Donation	Blood Donation	8	Is Pavol the father?
8	Blood Donation	Blood Donation	9	Blood as a transporter
8	Blood Donation	Blood Donation	10	Blood as a guard
8	Blood Donation	Blood Donation	11	Blood preservation
8	Blood Donation	Blood Donation	12	Is it possible to produce artificial blood?
9	Photochemistry	The magic of colours	1.1	Where does colour of an object come from?
9	Photochemistry	The magic of colours	1.2	Mixing colours
9	Photochemistry	In the rainbow-hued land	2.1	Are the rainbow colours always the same?
9	Photochemistry	In the rainbow-hued land	2.2	What is the spectrum of white light after passing through the coloured objects?
9	Photochemistry	In the rainbow-hued land	2.3	The visible light and what's next?
9	Photochemistry	In the rainbow-hued land	2.4	What is the difference between the light from the fluorescent lamp and the light of bulb?
9	Photochemistry	How to measure the colour?	3.1	Construction of a colorimeter
9	Photochemistry	How to measure the colour?	3.2	Determination of the Lambert Beer's law
9	Photochemistry	How to measure the colour?	3.3	Determination of CuSO4 concentration in unknown samples.
9	Photochemistry	How to measure the colour?	3.4	Estimation of the iron(III) ions amount in water.
9	Photochemistry	How to measure the colour?	3.5	The equilibrium between cobalt complexes
9	Photochemistry	How to measure the colour?	3.6	Cyanotype.
9	Photochemistry	In the world of energy	4.1	Photos from the starch. How do plants get their energy?
9	Photochemistry	In the world of energy	4.2	The photosynthesis performance
9	Photochemistry	In the world of energy	4.3	How can we use the solar energy?
10	Renewable Energy	Renewable Energy	1	Designing a wind turbine
10	Renewable Energy	Renewable Energy	2	The power of a wind turbine
10	Renewable Energy	Renewable Energy	3	Designing a hydroelectric power plant
10	Renewable Energy	Renewable Energy	4	Cooking with the heat of the sun
10	Renewable Energy	Renewable Energy	5	Designing a solar collector
10	Renewable Energy	Renewable Energy	6	Building a dye-sensitized solar cell
10	Renewable Energy	Renewable Energy	7	Measuring the power of a photovoltaic module
10	Renewable Energy	Renewable Energy	8	The power of a solar powered garden pump
10	Renewable Energy	Renewable Energy	9	My ipod runs on effluent energy
10	Renewable Energy	Renewable Energy	10	The efficiency of a hybrid hydrogen power plant
10	Renewable Energy	Renewable Energy	11	Designing a hydrogen vehicle
10	Renewable Energy	Renewable Energy	12	Design an island system!
10	Renewable Energy	Renewable Energy	1	
11	Chemical Care	Become a Household Detective!	1.1	Formulating questions
11	Chemical Care	Become a Household Detective!	1.2	Formulating hypotheses

11	Chemical Care	Become a Household Detective!	1.3	Planning an investigation
11	Chemical Care	Become a Household Detective!	1.4	Carrying out experiments
11	Chemical Care	Become a Household Detective!	1.5	Transfer of knowledge
11	Chemical Care	Become a Household Detective!	1.6	Further applications I
11	Chemical Care	Become a Household Detective!	1.7	Further applications II
11	Chemical Care	Become a Household Detective!	1.8	Further applications II
11	Chemical Care	Become a Household Detective!	1.9	Further applications III
11	Chemical Care	Chemical Care at Home	2.1	Which household products contain acids?
11	Chemical Care	Chemical Care at Home	2.2	How much acid do we find in a household product?
11	Chemical Care	Chemical Care at Home	2.3	Why do companies include acids into cleaning products? – Intended effects
11	Chemical Care	Chemical Care at Home	2.4	Which effects can acids have on different materials and on our health? – Not intended effects
11	Chemical Care	Chemical Care at Home	2.5	Comparison of the effectiveness of different household detergents
11	Chemical Care	Chemical Care for functional products	3.1	Analysing fibres
11	Chemical Care	Chemical Care for functional products	3.2	The history of fibres
11	Chemical Care	Chemical Care for functional products	3.3	Production processes of textile fibres
11	Chemical Care	Chemical Care for functional products	3.4	Characteristics/Properties of fibres
11	Chemical Care	Chemical Care for functional products	3.5	Membranes – Multifunctional fabrics
11	Chemical Care	Chemical Care for functional products	3.6	Keeping textiles clean
11	Chemical Care	Chemical Care for functional products	3.7	Economic view on textiles
11	Chemical Care	Chemical Care for functional products	3.8	Ecological view on textile care
11	Chemical Care	Chemical Care for functional products	3.9	Synthesis of bio-fibres
11	Chemical Care	Chemical Care for functional products	3.10	The dream fibre/plant
12	Light	Introducing Light	1.1	Sources of light
12	Light	Introducing Light	1.2	How does light travel?
12	Light	Introducing Light	1.3	Understanding shadows
12	Light	Introducing Light	1.4	Exploring white light and filters
12	Light	Introducing Light	1.5	Exploring primary colours
12	Light	Introducing Light	1.6	Exploring mirrors
12	Light	Introducing Light	1.7	Exploring refraction
12	Light	Introducing Light	1.8	Exploring lenses
12	Light	Exploring Light	2.1	Investigating mirror images
12	Light	Exploring Light	2.2	Investigating Snell's law
12	Light	Exploring Light	2.3	Studying real and apparent depths
12	Light	Exploring Light	2.4	Investigating lenses

12	Light	Exploring Light	2.5	Optical Storage
12	Light	Exploring Light	2.6	How do sunglasses work?
12	Light	Exploring Light	2.7	Why are sunsets red?
13	Photosynthesis	Photosynthesis	1	Capturing students' interest
13	Photosynthesis	Photosynthesis	2	Exploring history of the development of photosynthesis knowledge
13	Photosynthesis	Photosynthesis	3	Exploring plant pigment
13	Photosynthesis	Photosynthesis	4	The processes of light-dependent and light-independent reactions
13	Photosynthesis	Photosynthesis	5	Inquiry on „What factors influence the intensity of photosynthesis?"
13	Photosynthesis	Photosynthesis	6	Designing the model of a space station
14	Plastics and Plastic Waste	Properties of plastic materials	0.1	Kinds of packaging plastic materials and their labelling
14	Plastics and Plastic Waste	Properties of plastic materials	1.1	Weight of plastic materials
14	Plastics and Plastic Waste	Properties of plastic materials	1.2	Determining density of plastic materials polyethylene (PE), polypropylene (PP), polystyrene(PS), polyvinyl chloride (PVC) by comparing with water density.
14	Plastics and Plastic Waste	Properties of plastic materials	1.3	Combustion of plastic materials
14	Plastics and Plastic Waste	Properties of plastic materials	1.4	Thermal stability of plastic materials
14	Plastics and Plastic Waste	Properties of plastic materials	1.5	Verifying thermal conductivity of plastic materials
14	Plastics and Plastic Waste	Properties of plastic materials	1.6	Electrical conductivity of plastic materials
14	Plastics and Plastic Waste	Properties of plastic materials	1.7	Solubility of plastic materials
14	Plastics and Plastic Waste	Properties of plastic materials	1.8	Reacting with acids, alkalis and solutions of salts
14	Plastics and Plastic Waste	Properties of plastic materials	1.9	Tensile strength of plastic
14	Plastics and Plastic Waste	Plastic waste	0.2	Resolubility of waste in the environment
14	Plastics and Plastic Waste	Plastic waste	2.1.1	Tracing waste
14	Plastics and Plastic Waste	Plastic waste	2.1.2	Resolubility of plastics and different materials in the soil
14	Plastics and Plastic Waste	Plastic waste	2.2	Separation of waste
14	Plastics and Plastic Waste	Plastic waste	2.3	Influence of acid rains on plastic products
14	Plastics and Plastic Waste	Plastic waste	2.4	Recycling plastics – using project-based method
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.1	Materials around us and what plastics and polymers are
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.2	Polymerization – polycondensation
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.3	Cross-linking of polymers
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.4	Preparation of polymers, influencing their properties
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.5	Properties of polymers
14	Plastics and Plastic	Plastics and Plastic Waste	3.6	Properties of polymers – elasticity and cross-

	Waste			linking
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.7	Properties of polymers – dissolution of polymers
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.8	Identification of polymers
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.9	Application of polymers
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.10	PAIRS
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.11	Where can I find the polymer?
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.12	Estimate and discuss some information regarding polymers
14	Plastics and Plastic Waste	Plastics and Plastic Waste	3.13	Pointing out the importance of polymers in everyday life
15	Forensic Science	Subunit 1	1.1	How can fingerprints be categorized?
15	Forensic Science	Subunit 1	1.2	Fingerprints as a way to identify persons.
15	Forensic Science	Subunit 1	1.3	Take your own fingerprint.
15	Forensic Science	Subunit 1	1.4	Take fingerprints from an object
15	Forensic Science	Subunit 1	1.5	Identify the criminal
15	Forensic Science	Subunit 1	2.1	Solve another crime.
15	Forensic Science	Subunit 1	2.2	Crime solving game.
15	Forensic Science	Subunit 1	3.1	Properties of human beings
15	Forensic Science	Subunit 1	3.2	Whodunit
15	Forensic Science	Subunit 1	3.3	Traces in the snow
15	Forensic Science	Subunit 1	3.4	Can you use footprints to determine if a person was running or walking?
15	Forensic Science	Subunit 1	3.5	Other indirect clues
15	Forensic Science	Subunit 2	1.1	Introduction movie
15	Forensic Science	Subunit 2	1.2	Historical Trials
15	Forensic Science	Subunit 2	1.3	Modelling the ballpoint case
15	Forensic Science	Subunit 2	1.4	Calculations on the ballpoint case
15	Forensic Science	Subunit 2	1.5	Other effects of collisions
15	Forensic Science	Subunit 2	1.6	Telescoping effect
15	Forensic Science	Subunit 2	1.7	The trial
15	Forensic Science	Subunit 2	2.1	Face recognition
15	Forensic Science	Subunit 2	2.2	Ballpoint theft, cloths and glasses
15	Forensic Science	Subunit 2	2.3	Awareness test and change blindness.
15	Forensic Science	Subunit 2	3.1	What is DNA?
15	Forensic Science	Subunit 2	3.2	PCR technique
15	Forensic Science	Subunit 2	3.3	Analysing the DNA
15	Forensic Science	Subunit 2	3.4	Identifying with the use of DNA
15	Forensic Science	Subunit 2	4.1	Measuring on crime-scene pictures
16	Medical Imaging	Subunit 1	1.1	Can we use sound to "see"?
16	Medical Imaging	Subunit 1	1.2	1.2. Do muscle, fat and bone sound the same?
16	Medical Imaging	Subunit 1	1.3	Make an A-scan
16	Medical Imaging	Subunit 1	1.4	Make a B-scan. Guided inquiry 4.1. Engagement/Exploration
16	Medical Imaging	Subunit 1	1.5	Ultrasound imaging
16	Medical Imaging	Subunit 2	2.1	X the unknown Guided discovery
16	Medical Imaging	Subunit 2	2.2	Interaction with matter
16	Medical Imaging	Subunit 2	2.3	X-ray medical machine Guided discovery 1. Engagement/Exploration
16	Medical Imaging	Subunit 2	2.4	CT scans
16	Medical Imaging	Subunit 2	2.5	Are X-rays bad for you?

16	Medical Imaging	Subunit 3	3.1	α, β, and γ
16	Medical Imaging	Subunit 3	3.2	Radioactive decay Guided inquiry
16	Medical Imaging	Subunit 3	3.3	Tracing substances in the human body
16	Medical Imaging	Subunit 3	3.4	Radiation exposure
16	Medical Imaging	Subunit 3	3.5	Radiation protection
17	Eco Biology	Eco Biology	1	Estimating the density of an endangered plant species in a named ecosystem
17	Eco Biology	Eco Biology	2	Plant adaptations and effects of global warming on endangered and/or farmed plant species
17	Eco Biology	Eco Biology	3	The science of taxonomy
17	Eco Biology	Eco Biology	4	Flowering plant reproduction
17	Eco Biology	Eco Biology	5	Plant extracts and antibiotics
18	Water in the life of man	Water in the life of man	1	Discussion over the importance of water
18	Water in the life of man	Water in the life of man	2	My water intake
18	Water in the life of man	Water in the life of man	3	Which water tastes better, bottled or tap water?
18	Water in the life of man	Water in the life of man	4	Waterworks or production of drinking water
18	Water in the life of man	Water in the life of man	5	Can we get drinking water?
18	Water in the life of man	Water in the life of man	6	Analysis of beverages
18	Water in the life of man	Water in the life of man	7	How does the water travel through our body after drinking?
18	Water in the life of man	Water in the life of man	8	How is finite urine formed?
18	Water in the life of man	Water in the life of man	9	Importance of kidneys for life
18	Water in the life of man	Water in the life of man	10	Is it possible to develop an artificial kidney?
18	Water in the life of man	Water in the life of man	11	A visit to a dialysis centre
18	Water in the life of man	Water in the life of man	12	World Kidney Day