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Work Package 6 | Deliverable 1

D6.1 The impact of Inquiry Based Science Education on second level students

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A. Background to this report

This report is a deliverable of Work Package 6 (WP6) of the European FP7-funded project "European Science and Technology in Action: Building Links with Industry, Schools and Home" (ESTABLISH; 244749, 2010-2013). This additional deliverable presents a summary of the impact of ESTABLISH's Inquiry Based Science Education on second level students' learning and their attitudes towards science and technology. Further details about the development of the evaluation tools and analysis of impact on student learning are described in the Milestone reports MS21 & MS 22**.**

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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

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1. Introduction

This work package focuses on collecting and assessing feedback from teachers and students so as to assess the impact of ESTABLISH's promotion and facilitation of inquiry based science education (IBSE) on students' attitude to science and students' learning skills.

Particularly, the tasks of this work package were to:

- **Task 1:** Collect evidence to assess the development of students' analytical skills and learning processes.
- **Task 2**: Assess the impact on intrinsic motivation for learning science, taking into account various pre-conditions, e.g. gender, cultural differences.
- **Task 3:** Assess the impact on student's (both boys and girls) appreciation of the importance of science and technology in society.
- **Task 4:** Assess the impact on student's inclination towards taking up careers in science and technology.

So as to determine the impact of the project as per these tasks, both qualitative and quantitative research methods were used. Due to international character of the project, where many countries speaking different languages were involved, quantitative research methods were preferred.

To develop instruments to determine the impact of the tasks mentioned above the relevant literature was surveyed and instruments developed were examined.. Based on the literature, questionnaires were created which reflected the special features of the project and the procedures undertaken within Tasks 1 - 4.

2. Instruments for assessing the impact on students

2.1 Development of the instruments

Generally, scientific inquiry can be divided into two groups (Champagne, Kouba, Hurley, 2000): scientific inquiry, practiced by natural scientists and also science-related inquiry, practiced by science literate adults and students. The purpose in carrying out scientific inquiry by the first group is to understand the natural world, whilst the purpose of the second group is prevalently to obtain scientific information necessary to make reasoned decisions.

It is obvious that the purpose in the educational field relates to the second group and assessment concerns the way of working. Nevertheless, such science related inquiry usually has several phases (Champagne, Kouba, Hurley, 2000): a precursor phase, planning, implementation and closure or extension. This is in agreement with the definition stated by Linn, Davis and Bell (2004) that: "Inquiry is the intentional process of diagnosing problems, critiquing experiments….planning investigations, researching conjectures, searching for

information, constructing models, debating with peers and forming coherent argument." For example, an important part of the first phase is the formulating of an appropriate question which will guide the investigation. This includes formulating a rationale for the question, communication the question and rationale with peers, responding reasonably to criticism by peers and so on.

Assessment on inquiry-based learning can be undertaken during or after each phase. And both partners enrolled in education process (teacher & students) can participate in such assessment. As the inquiry process usually takes much time and is not just planned for 45 minutes, this needs to be taken into account when creating assessment strategies. A typical assessment process is complex and includes both daily and weekly/long term assessment. The daily assessment strategy, for example, can include (Champagne, Kouba, Hurley, 2000): questions posed to students during lessons, cursory reviews of student work, and short-term observations of student performance. Long term assessment, for example, can include: giving short quizzes, reviewing student work, or undertaking long term observation of student performance.

In agreement with the indicators above, evidence collecting about the impact of the ESTABLISH project on students can be designed with emphasis on the students' outcomes, rather than on the teaching and learning process. However, it is necessary to discuss and choose areas of particular interest of the impact when planning assessment. As generally, assessment reflects the set objectives of interest, the goals which influence both the affective and cognitive part of students' development are discussed. The ESTABLISH project is operating in line with educational goals of EU, where there is strong interest for engagement of young people in the science fields (EC, 2004). With this in mind, the ESTABLISH project sets out to collect evidence about the impact of the project on students in the following areas:

- students' motivation to understand science and the world around us;
- students' appreciation of the importance of science and technology for society, and
- students' motivation to take-up careers in the science and technology field.

These aspects concern students' attitudes towards science. In addition, finding out about the impact of the project on students' cognitive skills can be focused on several aspects (Learning how to learn, 2006):

- knowledge about the natural world,
- logical reasoning about evidence,
- conceptual evolution,
- participation in scientific practices and
- observing, questioning and experimenting.

The two latter aspects are best determined via the observation of classroom processes.

In developing the instruments, findings from instruments described in the literature are divided into several components according to their main focus. The findings are divided into:

i. students' analytical skills and learning processes;
ii. students'their intrinsic motivation;
iii. students' appreciation of science and technology and taking up career in science and technology

i. Students' analytical skills and learning processes

This tool is intended to focus on how students, or generally people, learn what strategies they use, etc. Such questions are at the forefront of pedagogical practices, namely learning processes, or cognitive psychology.

Learning process can be classified into several groups called ***learning styles***. Learning styles are "characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Keefe, 1979).

A list of the tools examined is provided below:

1. Experiential Learning Theory, Kolb's learning styles
Mainemelis C., Boyatzis R. E., and Kolb D. A.: *Learning styles and adaptive flexibility - Testing experiential learning theory*, in Management Learning, Vol. 33 (1), pgs. 5-33, 2002.

Instrument: *The Learning Skills Profile (LSP)*

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2. Triarchic theory of intelligence
Sternberg R. J. *Beyond IQ: A Triarchic Theory of Intelligence.* Cambridge: Cambridge University Press. 1985

Instrument: *Sternberg Triarchic Abilities Test*

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3. Felder-Silverman Learning Style Model

R. M. Felder and L. K. Silverman: *Learning and Teaching Styles in Engineering Education*, Engr. Education, 78(7), pgs. 674-681, 1988.

Instrument: *The Index of Learning Styles (ILS)*

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4. Mayers-Briggs Typology

Although this typology assesses personality types, it can be use also for assessing learning styles. For more, see (Lawrence, 1993 and Pittenger 1993).

5. The Maryland Physics Expectations survey

E. F. Redish, R. N. Steinberg,J. M. Saul: *Student Expectations in Introductory Physics*. Am. J. Phys. 66, 212-224, 1998.

Instrument: *The Maryland Physics Expectation (MPEX) survey*

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6. Views About Science Survey

I. Halloun: *Student Views about Science: A Comparative Survey*. Lebanese University, Beirut, Lebanon, 2001.

Instrument: *Views About Science Survey VASS* – version P204

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7. Epistemological beliefs assessment for physical science

EBAPS is a forced-choice instrument designed to probe students' ***epistemologies***, their views about the nature of knowledge and learning in the physical sciences.

Instrument is available on-line at:

http://www2.physics.umd.edu/~elby/EBAPS/EBAPS_items.htm

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8. Formal reasoning

A. E. Lawson: *The development and validation of a classroom test of formal reasoning,* in Journal of Research in Science Teaching Vol. 15 (1), pgs. 11-24, 1978.

ii. Intrinsic motivation

1. Self-determination theory

Deci, E. L., & Ryan, R. M. (1985). ***Intrinsic motivation and self-determination in human behavior***. New York: Plenum.

Ryan, R. M., & Deci, E. L. (2000). *Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being.* American Psychologist, 55, 68-78.

Instrument: Intrinsic Motivation Inventory

iii. Appreciation of science and technology and taking up career in science and technology

This issue has been studied by two international projects targeted to students at the lower secondary school level (age 13 and 15): the SAS project, followed subsequently by the ROSE project, in which students participated from both developed and developing countries.

1. The SAS project: Science And Scientists
Instrument: *The SAS questionnaire*

Available on-line at [http://folk.uio.no/sveinsj/SAStest.htm].

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2. The ROSE project: The Relevance of Science Education
Instrument: *ROSE questionnaire*

Online available as appendix within the report [http://roseproject.no./key-documents/key-docs/ad0404-sowing-rose.pdf]

2.2 Instruments on assessment used in projects about IBSE

1. The Constructivist Learning Environment Survey
Taylor P. C., Fraser B. J., White L. R. (1994): *CLES: An instrument for monitoring the development of constructivist learning environments.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans. On-line available at http://surveylearning.moodle.com/cles/papers/CLES_AERA94_Award.htm

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2. A questionnaire from the Pollen project
The Pollen project focused on promoting science teaching, based on the inquiry approach at primary school level. An evaluation process involved children's and teachers' attitudes towards science.

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3. Learning How to Learn
Black, P., Swann, J., Wiliam D. (2006): School pupils' beliefs about learning. Research Papers in Education, 21(2) 151-170

2.3 The ESTABLISH project instruments

For the ESTABLISH project, a new instrument was created meeting the needs associated with the identified tasks in WP6. The instrument as a whole is new, but parts have been adopted from the instruments indicated above.

Rationale for choosing particular instruments

From the wide range of instruments on **assessing learning processes, skills**, etc., instruments focused particularly on science learning were considered.i.e MPEX, VASS and EBAPS. These instruments were developed in order to find out students' views about the nature of knowledge and learning in physics.

For the ESTABLISH project, the EBAPS questionnaire is considered to fit best, because:

1) items involved in EBAPS are formulated as a story related to student's real life, a suitable way for testing students in the age cohort within ESTABLISH;

2) EBAPS is not focused on course-specific expectations.

This instrument altogether contains 30 items in 5 subscales. In order to focus the testing on the specific objectives in task 6.3, only three dimensions are included, namely:

Structure of scientific knowledge,

Nature of knowing and learning and

Evolving knowledge.

In addition, because the EBAPS tool is aimed at high-school or college students, several items, seen as possibly causing difficulty with lower secondary schools, are omitted. The remaining items are divided into three parts; the first part containing items with 5-point Likert scale from 'Disagree' to 'Agree'; the last two parts containing multiple choice items.

The learning process instrument is adopted from CLES. This part is focused mainly on engaging students in reflective negotiations with each other - an important quality in a constructivist approach so as to be seen as part of IBSE assessment.

For determining students' **intrinsic motivation,** the stated IMI questionnaire was used, consisting of several different subscales. For ESTABLISH, the subscales ***Interest/enjoyment***, ***Value/usefulness*** and ***Perceived choice*** **were seen as the** most relevant, although **the latter subscale was not included in the tool used with younger students. The questionnaire contained 17 or 25 statements,** each with a 5-point Likert scale from 'True' to 'Not true'.

For collecting evidence of the impact on **students' attitudes to science** and **taking up a career in science,** parts F and G of ROSE questionnaire were used. Each part contains 16 statements, based on a 4-point Likert scale from 'Disagree' to 'Agree'. Part F focused on students' perception of their science classes, their self-confidence in their own abilities, their choice related to taking up a career in science and technology. Part G probed different

aspects indicating how students perceived the role and the function of science and technology in society.

The selected instruments, or part instruments, in the original graphic form, are presented in the Appendix I.

Description of the designed tools

In order to collect this evidence two types of questionnaires were generated. The first type of the questionnaires was aimed at getting fast feedback, an immediate reaction following exposure (through teaching in the classroom) to each learning unit.

The second type of the questionnaire was aimed at collecting the of impact after several learning units have been used.

Each questionnaire was made available in two versions; one version for lower secondary (about 12 to 15 years old, ISCED 2), and in one for upper secondary schools (about 16 to 18 years old, ISCED 3).

Two lessons were used for the testing: 1 lesson for the pre-test and the same for the post-test.

Tool	Version	Purpose
1	A	Fast feedback for use with upper secondary school students (16-18 years)
1	B	Fast feedback for use with lower secondary school students (12-15 years)
2	A	Longer-term feedback for use with upper secondary school students
2	B	Longer-term feedback for use with lower secondary school students

Tool 1, version A (1A) – (for Task 2 assessement)

This instrument focused on collecting and assessing feedback immediately after a learning unit. It is determined to be for ”older pupils”, at the age of about 16 – 18 years (upper secondary schools). It consisted of two parts (25 and 6 items respectively) and focused on the intrinsic motivation (Task 2) and on communication within learning units (Task 1 - learning processes). For this questionnaire, three dimensions of IMI - Intrinsic Motivation Inventory based on self-determination theory and one part of the CLES - Constructivist Learning Environment Survey were adapted for use.

Tool 1, version B (1B) – (for Task 2 assessement)

This simplified version of tool 1A was intended for use with ”younger pupils“, at the age of about 12 – 15 years (lower secondary schools). It also consisted of two parts (17 and 6 items

respectively) concerning learning activities (a part of the IMI questionnaire) and communication (a part of the CLES questionnaire) undertaken during the learning unit. The more complicated items (included in 1A) were omitted for the 1B version.

Tool 2, version A (2A) – (for Task 1, 3 and 4 assessement)

This tool was intended for use as a pre- and post-test, before and after a series of several (min. three) learning units. It meant that pre-test was administered before the first learning unit and the post-test, after the last learning unit (min. three). In cases were students did not participate in a minimum of three learning units, they did not participate in the post-test. The instrument was administered to ”older pupils“, at the age of about 16 – 18 years (upper secondary schools). It was divided into five parts, focusing on students´ opinions about science classes (a part of the ROSE questionnaire); learning and understanding science; solution of several situations related to how science and scientists work; students´ beliefs about the nature of science (parts of the EBAPS questionnaire), and about science and technology (an additional part of the ROSE questionnaire).

Tool 2, version B (2B) – (for Task 1, 3 and 4 assessement)

This simplified version of the tool 1A was administered to „younger pupils“, at the age of about 12 – 15 years (lower secondary schools). Again the tool was intended to be used as a pre- and post-test, before and after a series of several (min. three) learning units and again meant that this test was administered before the first learning unit and then after the last one (min. three). In cases where students did not particate in a minimum of three learning units, this test was not administered to them. The tool was divided into three parts focusing on pupils´ opinions about science classes (a part of the ROSE questionnaire); pupils´ beliefs about the nature of science (a part of the EBAPS questionnaire), and about science and technology (a further part of the ROSE questionnaire).

The design of the instruments is presented in Appendix I. The instruments were designed to provide assessment as outlined by the tasks 1-4.

3. Pilot study

3.1 Introduction

The item analysis and interpretation of a pilot study were inspired by TIMSS 1999 Technical Report (2000) [1], where several diagnistic statistics were computed. These statistics were carefully checked for any evidence of unusual item behavior. If an item had an untypical property, this was futher examined; sometimes it was suggested there was a translation or printing problem. Any item that was discovered to have a flaw in a particular type of the questionnaires (in a particular country), special attention was paid to similar cases in other types of the questionnaires and their translations.

This item analysis and interpretation consisted of the following parts:

- student sample
- time needed to complete the questionnaire
- omitted items
- consistency of results
- survey of problems and their solutions
- conclusion
- literature review

The basic statistics for the item analysis were calculated using MS Excel and Statistica.

3.2 Sample

The sample of the participants **included in the pilot study** is shown in Table 1.

Table 1. Sample of participants

Country	**Czech Republic**	**Italy**	**Poland**	**Slovakia**	***Total***
Type of questionnaire	No. students	No. students	No. students	No. students	*No. students*
1 A	136	54	15		*205*
1 B		64	31		*95*
2 A	22	54	13	199	*288*
2 B		64	57		*121*
Total	*158*	*236*	*116*	*199*	

3.3 Time needed to complete the questionnaire

Based on feedback obtained, the estimated time to complete the questionnaires did not exceed:

- 15 minutes for 1A
- 10 minutes for 1B
- 35 minutes for 2A
- 25 minutes for 2B

3.4 Omitted items

In general, the percentage of students who omitted any one item was less than 5% (per country or questionnairetype).

However, there are several exceptions:

Questionnaire 1A

In the Polish version, the percentage of omitted items was almost 7 %; however, this came from only 1 student (of total 15).

In the Italian version, the percentage of omitted items was 9% covering tasks 19, 21, 22, 23, and 25 (part 1). As the more frequently omitted items were at the end of the questionnaire, the students may have had low motivation to complete the questionnaire.

Questionnaire 1B

In the Polish version, the percentage of the omitted items was 6% in task 14 (part 1); however, it was only related to 2 students (from a total of 31).

In the Italian version, the percentage of the omitted items was almost 16%. The systematically omitted items might be connected to low motivation of students.

Questionnaire 2A

In the Italian version, the percentage of the omitted items was 7% (in part 5). The systematically omitted items might be connected to low motivation of students.

In the Polish version, the percentage of some omitted items was almost 8%; however, it was by 1 student (from a total of 13).

In the Slovak version, the percentage of the omitted items was almost 9% for task 9 (part 1), and about 12% for task 4 (part 4).

Questionnaire 2B

In the Italian version, the percentage of the omitted items was almost 8% for task 12 (part 1), and for task 1 (part 2). For tasks 8 – 12 (part 3), there was 25% omissions. The students might have low motivation to complete this final part of the questionnaire.

3.5 Consistency of results

To determine the consistency of results, Pearson correlation coefficients were computed (available in Statistica). For this purpose, the data from the Czech Republic (1A, N = 136) was used, because this sample was the largest. In the case of the Italian and Polish 1A questionnaires, there was a huge amount of missing data, or the data was of poor quality.

Table 2. Subscale Interest / Enjoyment (Czech Republic, 1 A, N = 136)

	Item 3	Item 5	Item 7	Item 11	Item 12 R	Item 15	Item 17
Item 3							
Item 5	0,725						
Item 7	0,760	0,747					
Item 11	0,741	0,679	0,714				
Item 12 R	**-0,610**	**-0,575**	**-0,670**	**-0,640**			
Item 15	0,681	0,626	0,678	0,722	**-0,494**		
Item 17	0,620	0,628	0,707	0,645	**-0,598**	0,635	
Item 23	0,709	0,728	0,814	0,731	**-0,662**	0,692	0,684

Table 3. Subscale *Perceived Choice* (Czech Republic, 1A, N = 136)

	Item 2	Item 8 R	Item 9	Item 14	Item 18 R	Item 20 R	Item 22
Item 2							
Item 8 R	**-0,322**						
Item 9	0,458	**-0,329**					
Item 14	**-0,452**	0,639	**-0,397**				
Item 18 R	**-0,376**	0,483	**-0,318**	0,649			
Item 20 R	**-0,472**	0,615	**-0,433**	0,707	0,695		
Item 22	0,429	**-0,363**	0,286	**-0,443**	**-0,403**	**-0,408**	
Item 24 R	**-0,473**	0,392	**-0,484**	0,489	0,414	0,511	**-0,286**

Table 4. Subscale *Value / Usefulness* (Czech Republic, 1A, N = 136)

	Item 1	Item 4	Item 6	Item 10	Item 13	Item 16	Item 19	Item 21
Item 1								
Item 4	0,449							
Item 6	0,421	0,553						
Item 10	0,364	0,445	0,407					
Item 13	0,358	0,654	0,363	0,342				
Item 16	0,348	0,492	0,478	0,385	0,479			
Item 19	0,528	0,531	0,584	0,466	0,535	0,661		
Item 21	0,406	0,652	0,642	0,355	0,657	0,570	0,608	
Item 25	0,346	0,652	0,592	0,402	0,414	0,771	0,714	0,556

According to Table 3, the values for item 14 was reversed. In fact, item 14 was used in reverse (there was a typing error in the instruction for administration).

Based on the findings (Table 2, 3, and 4), we can conclude that participants´ answers (questionnaire results) were consistent (not responded mechanically).

3.6 Survey of problems and their solutions

Translation problems

As translation was an issue, the suggested solution was to pay extra special attention in translating into national languages. With this, the number of omitted items was expected to decrease. Attention was also required in reviewing existing translations.

Printing and technical problems

Clarity of the printing and presentation was an issue. The suggested solution was to pay special attention to printing the paper questionnaires. For example:

It is appropriate to mark part 5 (in 2B) as part 3.

Unify values ”99”, ”88”, ”0”, and ”0!”

It is appropriate to unify values ”99”, ”88”, ”0”, and ”0!” for the meaning of „omitted“.

State the participant´s birth date

The code identifying the participant´s birth date would enable the pairing of statistical tests (to determine added value of undertaking IBSE).

Add the field H to the code - a six-digit number composed of the date of the student´s birth (day, month, and year - without "19" or "20"). This could serve for identifying the student in the "pre-test" and "post-test".

Example – the field H for a student who was born on the 3rd August 1997:

H					
0	3	0	8	9	7

3.7 Conclusion

The main changes proposed for the improvement of the questionnaire survey, as mentioned above, were - review of translation, attention to printing, unifying values with the same meaning, and adding the participant´s birth date to the code in the header of the questionnaire. Also suggested was to add that it is necessary to increase motivation of students (and teachers as well) to complete the questionnaires.

4. Results

The data was processed at the following levels:

- tool 1 and tool 2
- upper (A) and lower (B) secondary school students
- separately for each country

In this section, results are presented according to the questionnaire type (1A, 1B, 2A, 2B) and country.

4.1 Sample

Questionnaires 1 (A and B) was addressed to more than 3100 students aged in range 11 to 18. Questionnaire A for upper secondary schools was answered by 2502 students from Slovakia, Poland, Italy and Czech Republic. In the sample, there were almost 60 % of girls there. Questionnaire B for lower secondary schools was answered by 646 students from Slovakia, Poland, Italy, Czech and Germany (48 % of girls).

Almost 900 students participated in pre- and post- testing, i.e. Questionnaire 2 (A and B) was addressed to them. They were aged in range 11 to 18.

Firstly, we present results concern Task 2 – students' interest and motivation. These are included in subchapters 5.1 and 5.2.

4.2 Upper secondary schools – 1A

Summary

Table 5. Summary of results – upper secondary school students (more detailed below)

Country	*Dimension*	*Interest/Enjoyment*	*Perceived choice*	*Value/Usefulness*
Czech Republic	*Score*	57 %	42 %	51 %
	General evaluation	average	negative	average/slightly negative
	Gender difference	girls > boys	no	no
Italy	*Score*	76 %	69 %	71 %
	General evaluation	positive	slightly positive	positive
	Gender difference	no	no	no
Poland	*Score*	69 %	67 %	64 %
	General evaluation	slightly positive	slightly positive	average/slightly negative
	Gender difference	no	boys > girls	boys > girls
Slovakia	*Score*	69 %	60 %	69 %
	General evaluation	slightly positive	average	positive
	Gender difference	girls > boys	girls > boys	girls > boys

Table 6. Consistency of results – dimension Interest/Enjoyment (see 4.5)

Variable	Correlations (Date summary_1A) Marked correlations are significant at p < ,05000 N=2252 (Casewise deletion of missing data) Part1_3	Part1_5	Part1_7	Part1_11	Part1_12R	Part1_15	Part1_17	Part1_23
Part1_3	1,00000	0,69316	0,69176	0,72245	-0,46225	0,65601	0,68338	0,64456
Part1_5	0,69316	1,00000	0,78533	0,75286	-0,51184	0,67760	0,70830	0,74579
Part1_7	0,69176	0,78533	1,00000	0,78086	-0,51930	0,70995	0,74242	0,72674
Part1_11	0,72245	0,75286	0,78086	1,00000	-0,55859	0,73114	0,75969	0,72765
Part1_12R	-0,46225	-0,51184	-0,51930	-0,55859	1,00000	-0,51789	-0,50350	-0,47540
Part1_15	0,65601	0,67760	0,70995	0,73114	-0,51789	1,00000	0,76864	0,70908
Part1_17	0,68338	0,70830	0,74242	0,75969	-0,50350	0,76864	1,00000	0,74712
Part1_23	0,64456	0,74579	0,72674	0,72765	-0,47540	0,70908	0,74712	1,00000

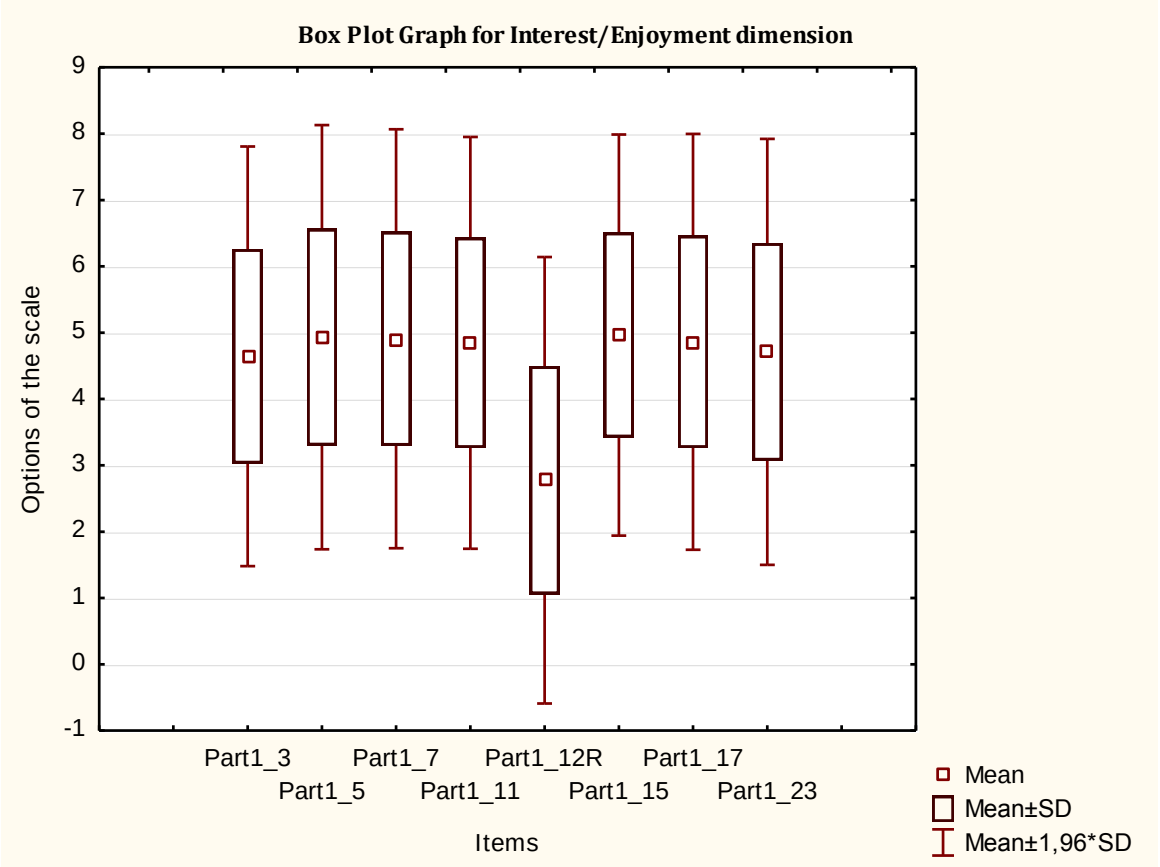

Figure 1. Box plot graph for Interest/Enjoyment dimension (mean = 4). Students assess the items positive (nearly 5 on the scale) whereas the only reverse expressed item (no. 12) negative (approx. 3 on the scale).

Table 7. Consistency of results – dimension Perceived Choice

Variable	Correlations (Date summary_1A) Marked correlations are significant at p < ,05000 N=2346 (Casewise deletion of missing data) Part1_2	Part1_8R	Part1_9	Part1_14R	Part1_18R	Part1_20R	Part1_22	Part1_24R
Part1_2	1,00000	-0,43823	0,50695	-0,36241	-0,23611	-0,37113	0,52712	-0,23450
Part1_8R	-0,43823	1,00000	-0,34559	0,62677	0,46492	0,55131	-0,36278	0,45408
Part1_9	0,50695	-0,34559	1,00000	-0,36695	-0,24593	-0,39320	0,50053	-0,22287
Part1_14R	-0,36241	0,62677	-0,36695	1,00000	0,52122	0,61419	-0,34386	0,53076
Part1_18R	-0,23611	0,46492	-0,24593	0,52122	1,00000	0,58813	-0,26223	0,41659
Part1_20R	-0,37113	0,55131	-0,39320	0,61419	0,58813	1,00000	-0,34798	0,52878
Part1_22	0,52712	-0,36278	0,50053	-0,34386	-0,26223	-0,34798	1,00000	-0,20520
Part1_24R	-0,23450	0,45408	-0,22287	0,53076	0,41659	0,52878	-0,20520	1,00000

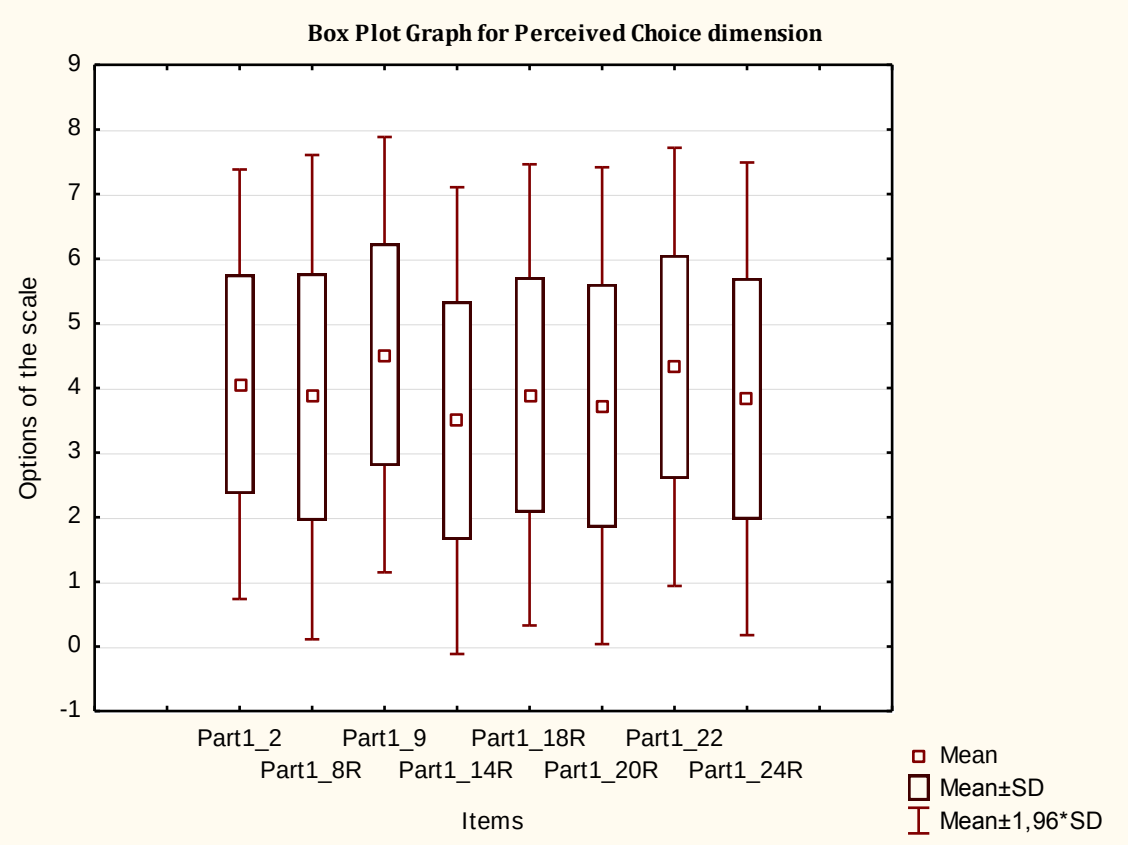

Figure 2. Box plot graph for Perceived choice dimension (mean = 4). Students assess the direct items (no. 2, 9, 22) slightly positive (more than 4 on the scale) whereas the reversely expressed items (no. 8, 14, 18, 20, 24) slightly negative (approx. less than 4 on the scale).

Table 8. Consistency of results – dimension Value/Usefulness

	Correlations (Date summary_1A) Marked correlations are significant at p < ,05000 N=2296 (Casewise deletion of missing data)								
Variable	Part1_1	Part1_4	Part1_6	Part1_10	Part1_13	Part1_16	Part1_19	Part1_21	Part1_25
Part1_1	1,00000	0,52855	0,61932	0,60816	0,47358	0,60263	0,61619	0,42380	0,58787
Part1_4	0,52855	1,00000	0,61369	0,55834	0,61516	0,56352	0,56173	0,55233	0,56381
Part1_6	0,61932	0,61369	1,00000	0,67906	0,56402	0,62161	0,67287	0,54515	0,60657
Part1_10	0,60816	0,55834	0,67906	1,00000	0,53193	0,66663	0,67455	0,49697	0,64939
Part1_13	0,47358	0,61516	0,56402	0,53193	1,00000	0,54993	0,56833	0,66886	0,54926
Part1_16	0,60263	0,56352	0,62161	0,66663	0,54993	1,00000	0,67170	0,50953	0,76217
Part1_19	0,61619	0,56173	0,67287	0,67455	0,56833	0,67170	1,00000	0,59357	0,69004
Part1_21	0,42380	0,55233	0,54515	0,49697	0,66886	0,50953	0,59357	1,00000	0,56508
Part1_25	0,58787	0,56381	0,60657	0,64939	0,54926	0,76217	0,69004	0,56508	1,00000

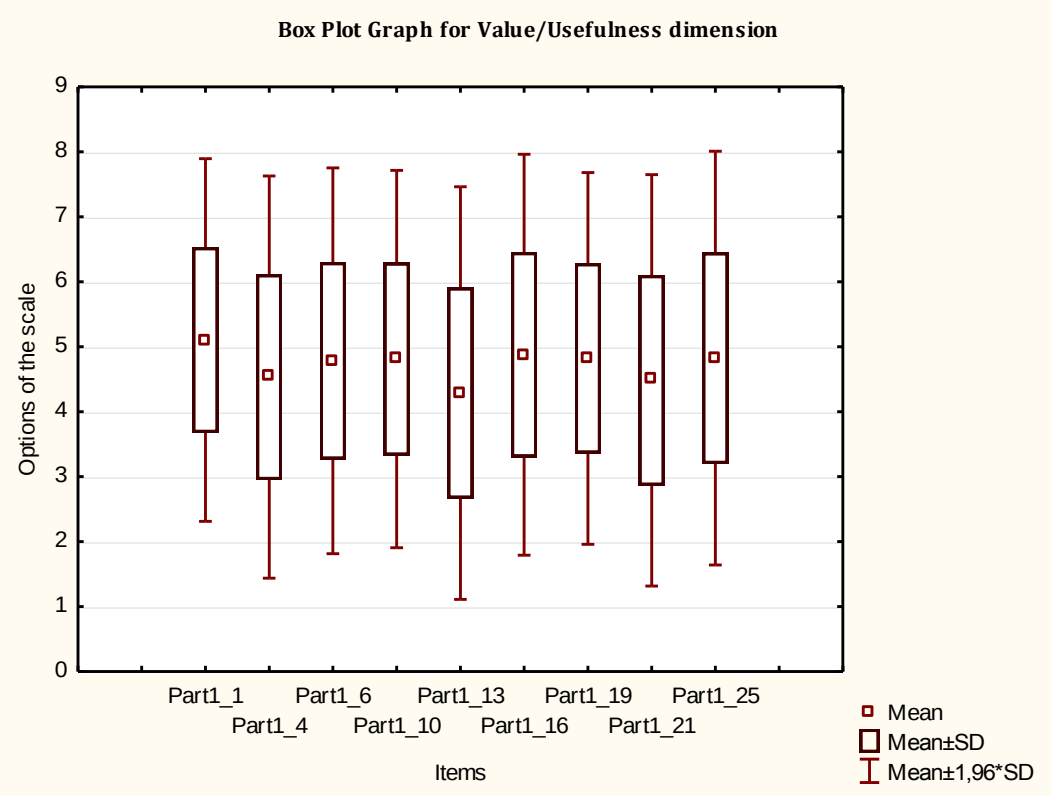

Figure 3. Box plot graph for Value/Usefulness dimension (mean = 4). Students assess the items positive (mostly between 4 and 5 on the scale).

Czech Republic (approx. 130 students, aged 15 to 18)

Dimension Interest/Enjoyment - score 57 %.

The general evaluation is **average** (approx. 3,5 to 4,2 on 7point scale for direct items). **Girls are more positive** than **boys** (statistically significant), assess learning units as more interesting.

Dimension Perceived Choice – score 42 %.

The general evaluation is **negative** (approx. 2,4 to 3,1 on 7point scale for direct items). There is **no** statistically significant **difference between gender**.

Dimension Value/Usefulness – score 51 %.

The general evaluation is **average or slightly negative** (mostly between 3,5 and 4,1 on 7-point scale). There is **no** statistically significant **difference between gender**.

The above mentioned assessment is consistent in the case of the subscale Interest/Enjoyment (quite high correlation coefficient). The assessment is lesser consistent for the subscale Perceived Choice (7 of 28 correlation coefficients are not significant) and for the subscale Value/Usefulness (5 of 36 correlation coefficients are not significant).

The communication is assessed mostly as **average** (approx. 3 on 5-point scale) and **positive** in case of items *I got the chance to talk to other students* (4 on 5point scale). There is very similar evaluation provided by girls and boys (no statistically difference).

Italy (approx. 180 students, aged mostly 17 and 18)

Dimension Interest/Enjoyment – score 76 %.

The general evaluation is **positive** (approx. 5 to 6 on 7point scale for direct items). There is **no** statistically significant **difference between gender**, both assess learning units as interesting.

Dimension Perceived Choice – score 69 %.

The general evaluation is **slightly positive** (between 4 and 5 on 7point scale for direct items). There is **no** statistically significant **difference between gender**, both assess learning units as providing choice about doing activities.

Dimension Value/Usefulness – score 71 %.

The general evaluation is **positive** (approx. from 4,1 to 5,6 on 7point scale). There is **no** statistically significant **difference between gender**, both assess learning units as useful.

The above mentioned assessment is quite consistent (quite high correlation coefficient). There are a few exceptions – 1 in the subscale Interest/Enjoyment and 8 in the subscale Perceived Choice.

The communication is assessed mostly as **positive** (approx. 4 on 5point scale). There is very similar evaluation provided by girls and boys.

Poland (approx. 520 students, aged mostly 17 and 18)

Dimension Interest/Enjoyment –score 69 %.

The general evaluation is **slightly positive** (5 on a 7-point scale for direct items). There is **no** statistically significant **difference between gender**, both assess learning units as interesting.

Dimension Perceived Choice –score 67 %.

The general evaluation is **slightly positive** (approx. 5 on 7point scale for direct items). **Boys are more positive** than **girls** (statistically significant), assess learning units as providing greater choice about doing activities.

Dimension Value/Usefulness – score 64 %.

The general evaluation is **average** or **slightly positive** (approx. 4 to 5 on 7point scale). **Boys are more positive** than **girls** (statistically significant), assess learning units as more useful.

The above mentioned assessment is consistent (quite high correlation coefficient), with an exception of the subscale Perceived Choice (5 of 28 correlation coefficients are not significantly different from zero).

The communication is assessed as **positive** (approx. 3,4 to 4,3 on a 5-point scale). There is very similar evaluation provided by girls and boys with one exception: **Boys are more positive** in the item ***Other students asked me to explain my ideas***.

Slovakia (approx. 1600 students, aged mostly 15 to 18)

Dimension Interest/Enjoyment –score 69 %.

The general evaluation is **slightly positive** (5 on a 7-point scale for direct items, see Fig. 1). **Girls are more positive** than **boys** (statistically significant), assess learning units as more interesting.

Dimension Perceived Choice – score 60 %.

The general evaluation is **average** (4 on a 7-point scale for direct items). **Girls are more positive** than **boys** (statistically significant), assess learning units as providing greater choice about doing activities.

Dimension Value/Usefulness – score 69 %.

The general evaluation is **positive** (5 on a 7-point scale). **Girls are more positive** than **boys** (statistically significant), assess learning units as more useful.

The above mentioned assessment is consistent (quite high correlation coefficient).

The communication is assessed mostly as **average** (3 on a 5-point scale) and **positive** in case of items *I got the chance to talk to other students* and *I talked with other students about how to solve problems* (4 on a 5-point scale). There is very similar evaluation provided by girls and boys with one exception: **Girls are more positive** in the item ***I asked other students to explain their ideas***.

4.3 Lower secondary schools – 1B

Summary

Table 9. Summary of results – lower secondary school students (more detailed below)

Country	*Dimension*	*Interest/Enjoyment*	*Value/Usefulness*
Czech Republic	*Score*	36 %	33 %
	General evaluation	negative	negative
	Gender difference	---	---
Germany	*Score*	63 %	42 %
	General evaluation	average/slightly positive	average
	Gender difference	---	---
Italy	*Score*	74 %	73 %
	General evaluation	slightly positive	positive
	Gender difference	girls > boys	girls > boys
Poland	*Score*	83 %	78 %
	General evaluation	very positive	positive
	Gender difference	no	no
Slovakia	*Score*	79 %	76 %
	General evaluation	positive	positive
	Gender difference	no	girls > boys

Table 10. Consistency of results – dimension Interest/Enjoyment (see 4.5)

Variable	Correlations (Date summary_1B) Marked correlations are significant at p < ,05000 N=582 (Casewise deletion of missing data)							
	Part1_2	Part1_4	Part1_6	Part1_8	Part1_9R	Part1_11	Part1_13	Part1_16
Part1_2	1,00000	0,67665	0,49322	0,63615	0,16335	0,54167	0,65485	0,33548
Part1_4	0,67665	1,00000	0,62582	0,62627	0,04779	0,55682	0,68984	0,47996
Part1_6	0,49322	0,62582	1,00000	0,52818	-0,14263	0,62159	0,58616	0,53061
Part1_8	0,63615	0,62627	0,52818	1,00000	0,02125	0,58654	0,70790	0,44880
Part1_9R	0,16335	0,04779	-0,14263	0,02125	1,00000	-0,17197	0,03507	-0,40259
Part1_11	0,54167	0,55682	0,62159	0,58654	-0,17197	1,00000	0,66815	0,50269
Part1_13	0,65485	0,68984	0,58616	0,70790	0,03507	0,66815	1,00000	0,50292
Part1_16	0,33548	0,47996	0,53061	0,44880	-0,40259	0,50269	0,50292	1,00000

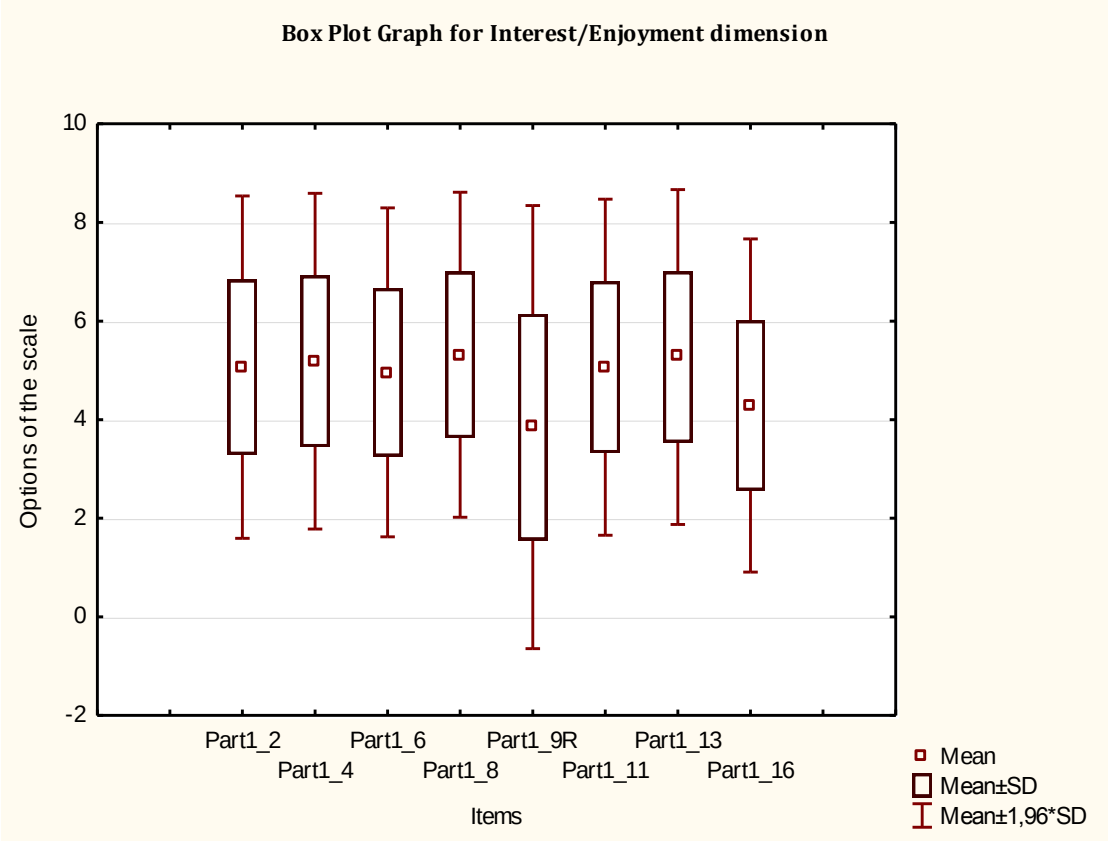

Figure 4. Box plot graph for Interest/Enjoyment dimension (mean = 4). Students assess the items positive (approx. 5 on the scale) whereas the only reverse expressed item (no. 9) slightly negative (3,85 on the scale).

Table 11. Consistency of results – dimension Value/Usefulness

Variable	Correlations (Date summary_1B) Marked correlations are significant at p < ,05000 N=582 (Casewise deletion of missing data)								
	Part1_1	Part1_3	Part1_5	Part1_7	Part1_10	Part1_12	Part1_14	Part1_15	Part1_17
Part1_1	1,00000	0,61341	0,23593	0,63392	0,56891	0,55629	0,48802	0,48018	0,46721
Part1_3	0,61341	1,00000	0,05571	0,61080	0,69316	0,57483	0,35049	0,49122	0,39298
Part1_5	0,23593	0,05571	1,00000	0,10956	-0,06093	0,13201	0,55578	0,49556	0,52096
Part1_7	0,63392	0,61080	0,10956	1,00000	0,60784	0,59809	0,45563	0,45431	0,43820
Part1_10	0,56891	0,69316	-0,06093	0,60784	1,00000	0,55021	0,36792	0,43584	0,32859
Part1_12	0,55629	0,57483	0,13201	0,59809	0,55021	1,00000	0,46573	0,42940	0,51550
Part1_14	0,48802	0,35049	0,55578	0,45563	0,36792	0,46573	1,00000	0,59583	0,59666
Part1_15	0,48018	0,49122	0,49556	0,45431	0,43584	0,42940	0,59583	1,00000	0,62412
Part1_17	0,46721	0,39298	0,52096	0,43820	0,32859	0,51550	0,59666	0,62412	1,00000

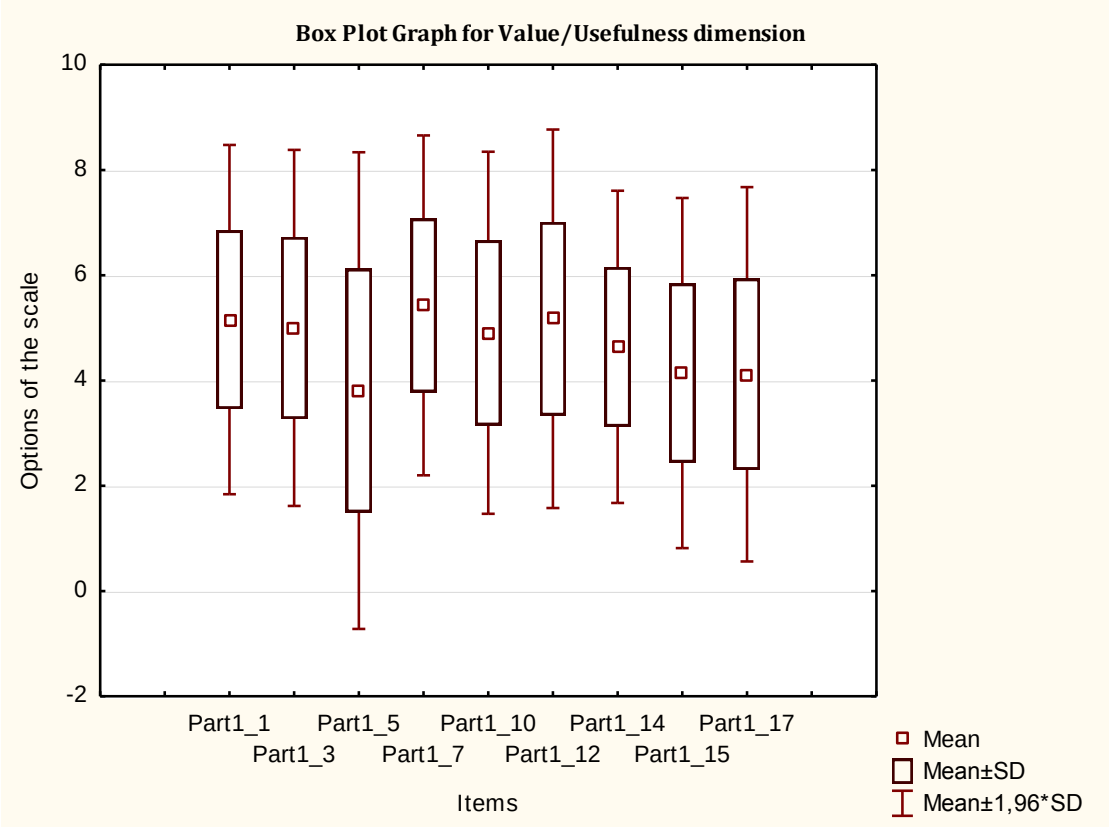

Figure 5. Box plot graph for Value/Usefulness dimension (mean = 4). Students assess the items positive (mostly between 4 and 5,5 on the scale).

Czech Republic (39 students, aged mostly 14 and 15)

Dimension Interest/Enjoyment – score 36 %.

The general evaluation is **negative** (approx. 2 on a 7-point scale for direct items).

Dimension Value/Usefulness – score 33 %.

The general evaluation is **negative** (between 2 and 3 on a 7-point scale).

The communication is assessed mostly **under average** (between 2 and 3 on a 5-point scale) and **positive** in case of the item *I got the chance to talk to other students* (approx. 4 on verya 5-point scale).

Germany (19 students, aged mostly 16)

Dimension Interest/Enjoyment –score 63 %.

The general evaluation is **average** or **slightly positive** (approx. between 4 and 5 on a 7-point scale for direct items).

Dimension Value/Usefulness –score 42 %.

The general evaluation is **average** (between 2 and 4 on a 7-point scale).

The communication is assessed **very positive** in case of the item *I got the chance to talk to other students* (approx. 5 on a 5-point scale), as **average** or **slightly under average** in case of the other items.

Italy (approx. 330 students, aged mostly 11 to 18)

Dimension Interest/Enjoyment –score 74 %.

The general evaluation is **slightly positive** (approx. 5 on a 7-point scale for direct items). **Girls are more positive** than **boys** (statistically significant), assess learning units as more interesting….

Dimension Value/Usefulness –score 73 %.

The general evaluation is **positive** (between 5 and 6 on a 7-point scale). **Girls are more positive** than **boys** (statistically significant), assess learning units as more useful.

The above mentioned assessment is consistent (quite high correlation coefficient).

The communication is assessed mostly as **average** (3 on a 5-point scale) and **positive** in case of the items *I got the chance to talk to other students* and *I talked with other students about how to solve problems* (4 on a 5-point scale). **Girls are more positive** than **boys** (statistically

significant) in the items: *I talked with other students about how to solve problems*, *I explained my ideas to other students, I asked other students to explain their ideas.*

Poland (approx. 110 students, aged mostly 12, 13 and 15)

Dimension Interest/Enjoyment –score 83 % (more than for upper secondary).

The general evaluation is **very positive** (between approx. 5,4 and 6,3 on a 7-point scale for direct items). There is **no** statistically significant **difference between gender** (Table 7), both assess learning units as interesting.…

Dimension Value/Usefulness –score 78 % (more than for upper secondary).

The general evaluation is **positive** (between 5 and 6 on a 7-point scale). There is **no** statistically significant **difference between gender**, both assess learning units as useful.

The above mentioned assessment is consistent (quite high correlation coefficient) – there is the only two exceptions.

The communication is assessed as **positive** (approx. 4 on a 5-point scale). There is very similar evaluation provided by **girls and boys with no statistically significant difference**.

Slovakia (approx. 130 students, aged mostly 12 to 14).

Dimension Interest/Enjoyment –score 79 % (more than for upper secondary).

The general evaluation is **positive** (between 5 and 6 on a 7-point scale for direct items), in comparison of upper secondary more positive. There is **no** statistically significant **difference between gender**, both assess learning units as interesting.

Dimension Value/Usefulness –score 76 % (more than for upper secondary).

The general evaluation is **positive** (between 5 and 6 on a 7-point scale). **Girls are more positive** than **boys** (statistically significant), assess learning units as more useful.

The above mentioned assessment is consistent (quite high correlation coefficient) – there is the only one exception (items 1 vs. 15).

The communication is assessed mostly as **average** (3 on a 5-point scale) and **positive** in case of the item *I got the chance to talk to other students* (4 on a 5-point scale). There is very similar evaluation provided by **girls and boys with no statistically significant difference**.

Secondly, we present results concern Task 1, 3 and 4 – students' cognitive skills and their attitudes toward science. These results are included in subchapters 5.3 and 5.4.

4.4 Upper secondary schools – 2A

Czech Republic (19 students, aged mostly 16)

Students' attitudes towards science in school - My science classes

As **positive** (agreement) evaluated: ***School science is interesting*** (3,47, item 2) and ***School science has shown me the importace of science for our way of living*** (3,32, item 12). The other statements evaluated average (between 3 and 2), the **worst** (disagreement)**:** ***School science has made me more critical and sceptical*** (item 9), ***I would like to become a scientist*** (item 14) and ***I would like to get job in technology*** (item 16).

Students' attitudes towards science - About science and technology

Students **agree mainly** with: ***Science and technology are important for society*** (item 1) and ***Thanks to science and technology, there will be greater opportunities for future generations*** (3).

Students **disagree mainly** with:

Science and technology will help to eradicate poverty and famine in the world (item 7), ***science and technology can solve nearly all problems*** (item 8), ***science and technology are helping the poor*** (item 9) and ***we should always trust what scientists have to say*** (item 14).

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score 54 %

Dimension **Nature of knowing and learning** – score 58 %

Dimension **Evolving knowledge** – score 49 %

Italy (approx. 100 students, aged mostly 17 and 18)

Students' attitudes towards science in school - My science classes

In the **pre-test**, there is one **statistically significant difference** between **girls and boys** (Table 4): **Girls agree more** than boys with ***School science is interesting*** (item 2).

There are **no statistically significant differences** between girls / boys or pre- / post-test.

Students' attitudes towards science - About science and technology

Students **agree** mainly with the item 1 ***Science and technology are important for society, science and technology will find ceres to diseases such as HIV/AIDS, cancor, etc.*** (item 2) and ***Thanks to science and technology, there will be greater opportunities for future generation*** (item 3).

Students **disagree** with ***Science and technology are helping the poor*** (items 7).

There are **no statistically significant differences** between girls / boys or pre- / post-test.

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score in the pre-test 63 % and 62 % in the post-test.

Dimension **Nature of knowing and learning** – score in the pre-test 58 % and 56 % in the post-test.

Dimension **Evolving knowledge** – score in the pre-test 47 % and 51 % in the post-test.

There are **no statistically significant differences** between girls / boys or pre- / post-test.

Poland (approx. 260 students, aged mostly 17 and 18)

Students' attitudes towards science in school - My science classes

In the **pre-test**, there are **statistically significant differences** between **girls and boys**: **Boys agree more** than girls with ***I would like to get a job in technology*** (item 16, similar to Slovakia, 2A).

There are **no statistically significant differences** between the pre- and post-test.

Girls **agree more in the post-test** (than in the pre-test) with the item 16 ***I would like to get job in technology.***

There are **no statistically significant differences** between the pre- and post-test **boys**.

Students' attitudes towards science - About science and technology

There are **no statistically significant differences** between the pre- and post-test (Tables 8A to 12B).

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score in the pre-test 49 % and 52 % in the post-test.

Dimension **Nature of knowing and learning** – score in the pre-test 54 % and 53 % in the post-test.

Dimension **Evolving knowledge** – score in the pre-test 52 % and 50 % in the post-test.

There are **no statistically significant differences** between the pre- and post-test.

Slovakia (approx. 290 students, aged mostly 16 to 18)

(*****significant also by **girls, ****significant also by **boys**)

Students' attitudes towards science in school - My science classes

In the **pre-test**, there are **statistically significant differences** between **girls and boys**: **Girls agree more** than boys with ***School science is a difficult subject*** (item 1) and ***The things that I learn in science at school will be helpful in my everyday life*** (item 7).

Boys agree more than girls with ***I would like to get a job in technology*** (item 16).

Students **agree more in the post-test** (than in the pre-test) with the item 1 ***School science is a difficult subject* **; School science has made me more critical and sceptical* **** (item 9)***; School science has increased my curiosity about things we cannot yet explain**** (item 10)***; School science has increased my appreciation of nature***** (item 11)***; I would like to have as much science as posible at school**** (item 15) and ***I would like to get job in technology***** (item 16).

However, students **agree less in the post-test** (than in the pre-test) with the item 3 ***School science is rather easy for me to learn***.

Students' attitudes towards science - About science and technology

In the **pre-test**, **boys agree more** with ***The benefits of science are greater than the harmful effects it could have*** (item 6).

Students **agree less in the post-test** (than in the pre-test) with the item 1 ***Science and technology are important for society**;*** item 3 ***Thanks to science and technology, there will be greater opportunities for future generation* **;*** item 11 ***A country needs science and technology to become developed* **;*** item 16 ***Scientific theories develop and change all the time*.***

However, students **agree more in the post-test** (than in the pre-test) with the item 9 ***Science and technology are helping the poor**;*** item 14 ***We should always trust what scientists have to say*****.

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score in the pre-test 55 % and 56 % in the post-test.

Dimension **Nature of knowing and learning** – score in the pre-test 56 % and 52 % in the post-test.

Dimension **Evolving knowledge** – score in the pre-test 50 % and 53 % in the post-test.

In the **pre-test, girls** obtained **statistically significant more** points in ***Evolving knowledge*** than boys.

In the **post-test,** the evaluation is **statistically significant worse** than in the pre test in ***Nature of knowing* ****, however **better** in ***Evolving knowledge***.

4.5 Lower secondary schools – 2B

Czech Republic (19 students, aged mostly 14)

Students' attitudes towards science in school - My science classes

As **negative** (disagreement) evaluated: ***School science is a difficult subject*** (1,58, item 1) and item 13 ***I would like to get job in technology.*** The other statements evaluated average (between 3 and 2).

Students' attitudes towards science - About science and technology

Students **disagree** with ***Science and technology are helping the poor*** (items 7). The other statements evaluated average (between 3 and 2).

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score 53 %

Dimension **Nature of knowing and learning** – score in the pre-test 51 %

Dimension **Evolving knowledge** – score in the pre-test 41 %

Germany (21 students, aged mostly 16)

Students' attitudes towards science in school - My science classes

As **positive** (agreement) evaluated: ***School science is interesting*** (3,24, item 2) and ***School science is rather easy for me to learn*** (3,05, item 3). The other statements evaluated average (between 3 and 2), the **worst** (disagreement)**:** ***I think everybody should learn science at school*** and ***I would like to get job in technology.***

Students' attitudes towards science - About science and technology

Students **agree mainly** with: ***Science and technology are important for society*** (items 1, 2, 3, 9).

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score 76 %

Dimension **Nature of knowing and learning** – score in the pre-test 71 %

Dimension **Evolving knowledge** – score in the pre-test 69 %

Italy (approx. 180 students, aged mostly 11 to 17)

Students' attitudes towards science in school - My science classes

In the **pre-test**, **girls** are **more positive** than boys:

Item 2 – School science is interesting

Item 3 – School science is rather easy for me to learn

Item 5 – I think everybody should learn science at school

Item 6 – The things that I learn in science at schoul will be helpful in my everyday life

Item 7 – School science has increased my curiosity about things we cannot yet explain.

Item 8 – School science has increased my appreciation of nature

Item 9 – School science has shown me the importace of science for our way of living.

In the **pre-test**, **boys** are **more positive** than girls:

Item 1 – School science is a difficult subject

Item 13 – I would like to get a job in technology

Girls agree less in the post-test (than in the pre-test) with the item 5 ***I think everybody should learn science at school***.

Students' attitudes towards science - About science and technology

Students agree with Science and technology being important and interesting for society (items 1, 2, 3, 4).

Students disagree with Science and technology are helping the poor (items 7). The other statements evaluated average (between 3 and 2).

There is one statistically significant difference between pre- and post-test: Students agree more in the post-test (than in the pre-test) with the item 7 *Science and technology are helping the poor.*

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score in the pre-test 65 % and 66 % in the post-test.

Dimension **Nature of knowing and learning** – score in the pre-test 66 % and 69 % in the post-test.

Dimension **Evolving knowledge** – score in the pre-test 53 % and 62 % in the post-test.

There is one **statistically significant difference** between pre- and post-test in **Evolving knowledge.**

Poland (approx. 40 students, aged mostly 12 to 15)

Students' attitudes towards science in school - My science classes

In the **pre-test**, **boys agree more** than girls with the item 13 ***I would like to get job in technology***.

There are no **statistically significant differences** between **pre- and post-test**.

Students' attitudes towards science - About science and technology

There is **one statistically significant difference** between **pre- and post-test**: Students **agree less in the post-test** (than in the pre-test) with the item 9 ***A country needs science and technology to become developed****, however, both values (3,58 and 3,05) mean a strong agreement.

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score in the pre-test 49 % and 56 % in the post-test.

Dimension **Nature of knowing and learning** – score in the pre-test 73 % and 63 % in the post-test.

Dimension **Evolving knowledge** – score in the pre-test 43 % and 56 % in the post-test.

There are **no statistically significant differences** between girls / boys or pre- / post-test.

Slovakia (approx. 50 students, aged mostly 11 to 14)

Students' attitudes towards science in school - My science classes

In the **pre-test**, there is **no statistically significant difference** between **girls and boys**.

There are two statistically significant differences between pre- and post-test: Students agree more in the post-test (than in the pre-test) with the item 2 *School science is interesting* and the item 13 *I would like to get job in technology*.

Students' attitudes towards science - About science and technology

In the **pre-test**, there is **no statistically significant difference** between **girls and boys**.

There is **one statistically significant difference** between **pre- and post-test**: Students **agree less in the post-test** (than in the pre-test) with the item 1 ***Science and technology are important for society***, however, both values (3,58 and 3,30) mean a strong agreement (especially girls).

Students' epistemological beliefs

Dimension **Structure of scientific knowledge** – score in the pre-test 55 % and 58 % in the post-test.

Dimension **Nature of knowing and learning** – score in the pre-test 67 % and 68 % in the post-test.

Dimension **Evolving knowledge** – score in the pre-test 58 % and 58 % in the post-test.

There are **no statistically significant differences** between girls / boys or pre- / post-test.

4.6 Main results and their interpretation

This section deals with main results obtained from the analysis of the above presented data. The most reliable data was chosen.

Results concerning motivation and communication during lessons (Task 2)

Within the dimension *Interest/Enjoyment,* students obtained score between 69% and 83%, where 100% would mean that they perceived the lessons the most interesting and the most enjoyable. So that, the general evaluation is positive (approx.5 to 6 on 7-point scale for direct items). There is no statistically significant difference between gender or girls are more positive than boys and in the case, they assess learning units as more interesting.

In the dimension *Perceived Choice*, students obtained relative between 60 % and 69 %. In the case, the general evaluation is average or slightly positive (approx. 4 to 5 on a 7-point scale for direct items).

Dimension *Value/Usefulness* obtained from students score between 64 % and 78 %. As for the dimension Interest/Enjoyment, we can find the general evaluation as positive (approx. 4 and 6 on a 7-point scale).

The communication is assessed mostly as average or positive (approx. 3 to 4 on a 5-point scale).

Results concerning attitudes toward science and cognitive skills (Task 1, 3 and 4)

In the before and after whole teaching (series of activities) questionnaire several aspects were examined. The results were compared using appropriate statistical testing. There was a set of questions assessing students' opinion about **science lessons and their attitude towards taking up career in science or technology**. Statistically significant differences between the pre- and post-test are rare. However, there is one exception verified in two countries (in three groups of students):

- Polish girls from upper secondary and Slovak students (both from lower and upper secondary) agree more in the post- than in the pre-test with the statement „*I would like to get a job in technology."*

A set of 16 questions were used to assess how students perceive **the role of science and technology in society**. Statistically significant differences between the pre- and post-test are rare as well. Again, there are two exceptions verified in two countries:

- Italian students from lower secondary and Slovak students from upper secondary agree more in the post- than in the pre-test with the statement *"Science and technology are helping the poor".*
- Polish students from lower secondary and Slovak students from upper secondary agree less in the post- than in the pre-test with the statement *"A country needs science and technology to become developed".*

The part of the questionnaire focused on students' epistemological beliefs contained items involved into three dimensions (according to the authors of the original questionnaire):

1. Structure of scientific knowledge. Is physics and chemistry knowledge a bunch of weakly connected pieces without much structure and consisting mainly of facts and formulas? Or is it a coherent, conceptual, highly-structured, unified whole?

2. Nature of knowing and learning. Does learning science consist mainly of absorbing information? Or, does it rely crucially on constructing one's own understanding by working through the material actively, by relating new material to prior experiences, intuitions, and knowledge, and by reflecting upon and monitoring one's understanding?

3. Evolving knowledge. This dimension probes the extent to which students navigate between the twin perils of absolutism (thinking all scientific knowledge is set in stone) and extreme relativism (making no distinctions between evidence-based reasoning and mere opinion).

Obtained relative scores for each dimension is shown in the list below. Relative score 100 % would mean

1. Students believe that science knowledge is coherent, conceptual unified whole (dimension 1).
2. Students believe that learning science rely on constructing one's own understanding (dimension 2).
3. Students are between the twin perils of absolutism (thinking all scientific knowledge is set in stone) and extreme relativism (making no distinctions between evidence-based reasoning and mere opinion) (dimension 3).

Dimension Structure of scientific knowledge – score in the pre-test 49 % to 65 %, in the post-test 52 % to 66 %.

Dimension Nature of knowing and learning – score in the pre-test 54 % to 73 %, in the post-test 53 % to 69 %.

Dimension Evolving knowledge – score in the pre-test 43 % to 58 %, in the post-test 50 % to 62 %.

Statistically significant differences between the pre- and post-test are rare. However, there are a few exceptions: There is a statistically significant increase in Evolving knowledge (Italian lower secondary and Slovak upper secondary) and a statistically significant decrease in Nature of knowing and learning (Slovak upper secondary).

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6. Appendix I – The ESTABLISH instruments

Design of ESTABLISH instruments to determine the impact of IBSE on students' learning

Questionnaire 1A: Feedback after a learning unit

for older pupils from upper secondary schools (about 16 – 19 years)

Questionnaire 1B: Feedback after a learning unit

for younger pupils from lower secondary schools (about 12 – 15 years)

Questionnaire 2A: Feedback before and after a series of several learning units

(pre- and post-test for older pupils from upper secondary schools, about 16 – 19 years)

Questionnaire 2B: Feedback before and after a series of several learning units

(pre- and post-test for younger pupils from lower secondary schools, about 12 – 15 years)

1A Feedback after a learning unit for upper secondary schools

Hello,

The following items concern your experience with the activities in the learning unit. Please answer all items. We are very much interested in your answers!

Establish team

Code

A	B	C		D		E		F	G		H				I	

About you

I am  ❑ or  ❑ , and I am ___ years old.

Part 1

For each of the following items, please indicate how true the statement is for you.

Use the following scales as a guide.

1 2 3 4 5 6 7
Not at all true - - - → Somewhat true - - - → Very true

		1	2	3	4	5	6	7
1	I believe that doing activities in the learning unit could be of some value for me.							
2	I believe I had some choice about doing activities in the learning unit.							
3	While I was doing activities in the learning unit, I was thinking about how much I enjoyed it.							
4	I believe that doing activities in the learning unit is useful for improved concentration.							
5	Activities in the learning unit were fun to do.							

6	I think activities in the learning unit are important for my improvement.							
7	I enjoyed doing activities in the learning unit very much.							
8	I really did not have a choice about doing activities in the learning unit.							
9	I did activities in the learning unit because I wanted to.							
10	I think this is an important learning unit.							
11	I felt like I was enjoying activities while I was doing them.							
12	I thought these were very boring activities.							
13	It is possible that activities in the learning unit could improve my studying habits.							
14	I felt like I had no choice but to do activities in the learning unit.							
15	I thought this was a very interesting learning unit.							
16	I am willing to do activities in the learning unit again because I think it is somewhat useful.							
		1	2	3	**4**	5	6	7
17	I would describe activities in the learning unit as very enjoyable.							
18	I felt like I had to do activities in the learning unit.							
19	I believe doing activities in the learning unit could be somewhat beneficial for me.							
20	I did activities in the learning unit because I had to.							
21	I believe doing activities in the learning unit could help me do better in school.							
22	While doing activities in the learning unit I felt like I had a choice.							
23	I would describe activities in the learning unit as very fun.							
24	I felt like it was not my own choice to do activities in the learning unit.							

25	I would be willing to do activities in the learning unit again because it has some value for me.							
		1	**2**	**3**	**4**	**5**	**6**	**7**

Part 2

For each of the following items, please indicate how often the activity happened during the learning unit.

Use the following scales as a guide.

1	**2**	**3**	**4**	**5**
Almost never	**Seldom never**	**Sometimes**	**Often**	**Almost always**

In this class during the learning unit …		1	2	**3**	4	5
1	I got the chance to talk to other students.					
2	I talked with other students about how to solve problems.					
3	I explained my ideas to other students.					
4	I asked other students to explain their ideas.					
5	Other students asked me to explain my ideas.					
6	Other students explained their ideas to me.					

1B Feedback after a learning unit for lower secondary schools

Hello,

the following items concern your experience with the activities in the learning unit. Please answer all items. We are very much interested in your answers!

Code

A	B	C		D		E		F	G		H				I	

About you

I am  ❑ or  ❑ , and I am ___ years old.

Part 1

For each of the following items, please indicate how true the statement is for you.

Use the following scales as a guide.

1 2 3 4 5 6 7

Not at all true - - - → Somewhat true - - - → Very true

		1	2	3	4	5	6	7
1	I believe that doing activities in the learning unit could be of some value for me.							
2	While I was doing activities in the learning unit, I was thinking about how much I enjoyed it.							
3	I believe that doing activities in the learning unit is useful for improved concentration.							
4	Activities in the learning unit were fun to do.							
5	I think activities in the learning unit are important for my improvement.							
6	I enjoyed doing activities in the learning unit very							

	much.							
7	I think this is an important learning unit.							
8	I felt like I was enjoying activities while I was doing them.							
9	I thought these were very boring activities.							
10	It is possible that activities in the learning unit could improve my studying habits.							
11	I thought these were very interesting activities.							
12	I am willing to do activities in the learning unit again because I think it is somewhat useful.							
13	I would describe activities in the learning unit as very enjoyable.							
14	I believe doing activities in the learning unit could be somewhat beneficial for me.							
15	I believe doing activities in the learning unit could help me do better in school.							
16	I would describe activities in the learning unit as very fun.							
17	I would be willing to do activities in the learning unit again because it has some value for me.							

Part 2

For each of the following items, please indicate how often the activity happened during the learning unit.

Use the following scales as a guide.

1	2	3	4	5
Almost never	**Seldom never**	**Sometimes**	**Often**	**Almost always**

	In this class during the learning unit …	1	2	**3**	4	5
1	I got the chance to talk to other students.					
2	I talked with other students about how to solve problems.					
3	I explained my ideas to other students.					
4	I asked other students to explain their ideas.					
5	Other students asked me to explain my ideas.					
6	Other students explained their ideas to me.					

2A Feedback before and after a series of several learning unit for upper secondary schools

Hello,

the following items concern your experience with the activities in the learning unit. Please answer all items. We are very much interested in your answers!

Establish team

Code

A	B	C		D		E		F	G		H				I		J		K	

About you

I am ❑ or ❑ , and I am ___ years old.

Part 1 *My science classes*

To what extent do you agree with the following statements about the science that you may have had at school? Give your answer with a tick on each row. If you do not understand, leave the row blank.

1 Disagree **2** **3** **4 Agree**

		1	2	3	4
1	School science is a difficult subject.				
2	School science is interesting.				
3	School science is rather easy for me to learn.				
4	School science has opened my eyes to new and exciting jobs.				

5	I like school science better than most other subjects.				
6	I think everybody should learn science at school.				
7	The things that I learn in science at school will be helpful in my everyday life.				
8	I think that the science I learn at school will improve my career chances.				
9	School science has made me more critical and sceptical.				
10	School science has increased my curiosity about things we cannot yet explain.				
11	School science has increased my appreciation of nature.				
12	School science has shown me the importance of science for our way of living.				
13	School science has taught me how to take better care of my health.				
14	I would like to become a scientist.				
15	I would like to have as much science as possible at school.				
16	I would like to get a job in technology.				

Part 2 *My opinions about learning and understanding science*

For each of the following items, please read the statement, and indicate the answer that describes how A B C D E **strongly you agree or disagree.**

A: **Strongly disagree** B: **Somewhat disagree** C: **Neutral** D: **Somewhat agree** E: **Strongly agree**

1. Tamara just read something in her science textbook that seems to disagree with her own experiences. But to learn science well, Tamara shouldn't think about her own experiences; she should just focus on what the book says.

A B C D E

2. When it comes to understanding physics or chemistry, remembering facts isn't very important.

A B C D E

3. When it comes to controversial topics such as which foods cause cancer, there's no way for scientists to evaluate which scientific studies are the best. Everything's up in the air!

A B C D E

4. When handing in a physics, biology or chemistry test, you can generally have a sense of how well you did even before talking about it with other students.

A B C D E

5. When learning science, people can understand the material better if they relate it to their own ideas.

A B C D E

6. If biology, physics or chemistry teachers gave *really clear* lectures, with plenty of real-life examples and sample problems, then most good students could learn those subjects without doing lots of sample questions and practice problems on their own.

A B C D E

7. To understand chemistry and physics, the formulas (equations) are really the main thing; the other material is mostly to help you decide which equations to use in which situations.

A B C D E

Part 3 *What do I think about the following situations?*

Fill in the answer that best fits your view.

1. Scientists are having trouble predicting and explaining the behavior of thunder storms. This could be because thunder storms behave according to a very complicated or hard-to-apply set of rules. Or, that could be because some thunder storms don't behave consistently according to any set of rules, no matter how complicated and complete that set of rules is.

In general, why do scientists sometimes have trouble explaining things? Please read all options before choosing one.

(a)	Although things behave in accordance with rules, those rules are often complicated, hard to apply, or not fully known.
(b)	Some things just don't behave according to a consistent set of rules.
(c)	Usually it's because the rules are complicated, hard to apply, or unknown; but sometimes it's because the thing doesn't follow rules.
(d)	About half the time, it's because the rules are complicated, hard to apply, or unknown; and half the time, it's because the thing doesn't follow rules.
(e)	Usually it's because the thing doesn't follow rules; but sometimes it's because the rules are complicated, hard to apply, or unknown.

2. In physics and chemistry, how do the most important formulas relate to the most important concepts? Please read all choices before picking one.

(a)	The major formulas summarize the main concepts; they're not really separate from the concepts. In addition, those formulas are helpful for solving problems.
(b)	The major formulas are kind of "separate" from the main concepts, since concepts are *ideas*, not equations. Formulas are better characterized as problem-solving tools, without much conceptual meaning.
(c)	Mostly (a), but a little (b).
(d)	About half (a) and half (b).
(e)	Mostly (b), but a little (a).

Part 4 *What do I think about the following discussions?*

In each of the following items, you will read a short discussion between two students who disagree about some issue. Then you'll indicate whether you agree with one student or the other.

1. Brandon & Jamal

Brandon: A good science textbook should show how the material in one chapter relates to the material in other chapters. It shouldn't treat each topic as a separate "unit," because they're not really separate.

Jamal: But most of the time, each chapter is about a different topic, and those different topics don't always have much to do with each other. The textbook should keep everything separate, instead of blending it all together.

With whom do you agree? Read all the choices before circling one.

(a)	I agree almost entirely with Brandon.
(b)	Although I agree more with Brandon, I think Jamal makes some good points.
(c)	I agree (or disagree) equally with Jamal and Brandon.
(d)	Although I agree more with Jamal, I think Brandon makes some good points.
(e)	I agree almost entirely with Jamal.

2. Justin & Dave

Justin: When I'm learning science concepts for a test, I like to put things in my own words, so that they make sense to me.

Dave: But putting things in your own words doesn't help you learn. The textbook was written by people who know science really well. You should learn things the way the textbook presents them.

(a)	I agree almost entirely with Justin.
(b)	Although I agree more with Justin, I think Dave makes some good points.
(c)	I agree (or disagree) equally with Justin and Dave.
(d)	Although I agree more with Dave, I think Justin makes some good points.
(e)	I agree almost entirely with Dave.

3. Leticia & Maria

Leticia: Some scientists think the dinosaurs died out because of volcanic eruptions, and others think they died out because an asteroid hit the Earth. Why can't the scientists agree?

Maria: Maybe the evidence supports both theories. There's often more than one way to interpret the facts. So we have to figure out what the facts mean.

Leticia: I'm not so sure. In stuff like personal relationships or poetry, things can be ambiguous. But in science, the facts speak for themselves.

(a)	I agree almost entirely with Leticia.
(b)	I agree more with Leticia, but I think Maria makes some good points.
(c)	I agree (or disagree) equally with Maria and Leticia.
(d)	I agree more with Maria, but I think Leticia makes some good points.
(e)	I agree almost entirely with Maria.

4. Jose & Miguel

Jose: In my opinion, science is a little like fashion; something that's "in" one year can be "out" the next. Scientists regularly change their theories back and forth.

Miguel: I have a different opinion. Once experiments have been done and a theory has been made to explain those experiments, the matter is pretty much settled. There's little room for argument.

(a)	I agree almost entirely with Jose.
(b)	Although I agree more with Jose, I think Miguel makes some good points.
(c)	I agree (or disagree) equally with Miguel and Jose.
(d)	Although I agree more with Miguel, I think Jose makes some good points.
(e)	I agree almost entirely with Miguel.

5. Jessica & Mia

Jessica and Mia are working on a homework assignment together...

Jessica: O.K., we just got problem #1. I think we should go on to problem #2.

Mia: No, wait. I think we should try to figure out why the thing takes so long to reach the ground.

Jessica: Mia, we know it's the right answer from the back of the book, so what are you worried about? If we didn't understand it, we wouldn't have gotten the right answer.

Mia: No, I think it's possible to get the right answer without really understanding what it means.

(a)	I agree almost entirely with Jessica.
(b)	I agree more with Jessica, but I think Mia makes some good points.
(c)	I agree (or disagree) equally with Mia and Jessica.
(d)	I agree more with Mia, but I think Jessica makes some good points.
(e)	I agree almost entirely with Mia.

Part 5 *My opinions about science and technology*

To what extent do you agree with the following statements? Give your answer with a tick on each row. If you do not understand, leave the row blank.

1 2 3 4
Disagree Agree

		1	2	3	4
1	Science and technology are important for society.				
2	Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.				
3	Thanks to science and technology, there will be greater opportunities for future generations.				
4	Science and technology make our lives healthier, easier and more comfortable.				
5	New technologies will make work more interesting.				
6	The benefits of science are greater than the harmful effects it could have.				
7	Science and technology will help to eradicate poverty and famine in the world.				
8	Science and technology can solve nearly all problems.				
9	Science and technology are helping the poor.				
10	Science and technology are the cause of the environmental problems.				
11	A country needs science and technology to become developed.				
12	Science and technology benefit mainly the developed countries.				
13	Scientists follow the scientific method that always leads them to correct answers.				
14	We should always trust what scientists have to say.				
15	Scientists are neutral and objective.				
16	Scientific theories develop and change all the time.				

2B Feedback before and after a series of several learning unit for lower secondary schools

Hello,

the following items concern your experience with the activities in the learning unit. Please answer all items. We are very much interested in your answers!

Establish team

Code

A	B	C		D		E		F	G		H				I		J		K	

About you

I am ❑ or ❑ , and I am ___ years old.

Part 1 *My science classes*

To what extent do you agree with the following statements about the science that you may have had at school? Give your answer with a tick on each row. If you do not understand, leave the row blank.

1 Disagree **2** **3** **4 Agree**

		1	2	3	4
1	School science is a difficult subject.				
2	School science is interesting.				

3	School science is rather easy for me to learn.				
4	I like school science better than most other subjects.				
5	I think everybody should learn science at school.				
6	The things that I learn in science at school will be helpful in my everyday life.				
7	School science has increased my curiosity about things we cannot yet explain.				
8	School science has increased my appreciation of nature.				
9	School science has shown me the importance of science for our way of living.				
10	School science has taught me how to take better care of my health.				
11	I would like to become a scientist.				
12	I would like to have as much science as possible at school.				
13	I would like to get a job in technology.				

Part 2 *What do I think about the following discussions?*

In each of the following items, you will read a short discussion between two students who disagree about some issue. Then you'll indicate whether you agree with one student or the other.

1. Brandon & Jamal

Brandon: A good science textbook should show how the material in one chapter relates to the material in other chapters. It shouldn't treat each topic as a separate "unit," because they're not really separate.

Jamal: But most of the time, each chapter is about a different topic, and those different topics don't always have much to do with each other. The textbook should keep everything separate, instead of blending it all together.

With whom do you agree? Read all the choices before circling one.

(a)	I agree almost entirely with Brandon.
(b)	Although I agree more with Brandon, I think Jamal makes some good points.
(c)	I agree (or disagree) equally with Jamal and Brandon.
(d)	Although I agree more with Jamal, I think Brandon makes some good points.
(e)	I agree almost entirely with Jamal.

2. Justin & Dave

Justin: When I'm learning science concepts for a test, I like to put things in my own words, so that they make sense to me.

Dave: But putting things in your own words doesn't help you learn. The textbook was written by people who know science really well. You should learn things the way the textbook presents them.

(a)	I agree almost entirely with Justin.
(b)	Although I agree more with Justin, I think Dave makes some good points.
(c)	I agree (or disagree) equally with Justin and Dave.
(d)	Although I agree more with Dave, I think Justin makes some good points.
(e)	I agree almost entirely with Dave.

3. Leticia & Maria

Leticia: Some scientists think the dinosaurs died out because of volcanic eruptions, and others think they died out because an asteroid hit the Earth. Why can't the scientists agree?

Maria: Maybe the evidence supports both theories. There's often more than one way to interpret the facts. So we have to figure out what the facts mean.

Leticia: I'm not so sure. In stuff like personal relationships or poetry, things can be ambiguous. But in science, the facts speak for themselves.

(a)	I agree almost entirely with Leticia.
(b)	I agree more with Leticia, but I think Maria makes some good points.
(c)	I agree (or disagree) equally with Maria and Leticia.
(d)	I agree more with Maria, but I think Leticia makes some good points.
(e)	I agree almost entirely with Maria.

4. Jessica & Mia

Jessica and Mia are working on a homework assignment together...

Jessica: O.K., we just got problem #1. I think we should go on to problem #2.

Mia: No, wait. I think we should try to figure out why the thing takes so long to reach the ground.

Jessica: Mia, we know it's the right answer from the back of the book, so what are you worried about? If we didn't understand it, we wouldn't have gotten the right answer.

Mia: No, I think it's possible to get the right answer without really understanding what it means.

(a)	I agree almost entirely with Jessica.
(b)	I agree more with Jessica, but I think Mia makes some good points.
(c)	I agree (or disagree) equally with Mia and Jessica.
(d)	I agree more with Mia, but I think Jessica makes some good points.
(e)	I agree almost entirely with Mia.

Part 3 *My opinions about science and technology*

To what extent do you agree with the following statements? Give your answer with a tick on each row. If you do not understand, leave the row blank.

1 2 3 4
Disagree Agree

		1	2	3	4
1	Science and technology are important for society.				
2	Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.				
3	Science and technology make our lives healthier, easier and more comfortable.				
4	New technologies will make work more interesting.				
5	Science and technology will help to eradicate poverty and famine in the world.				
6	Science and technology can solve nearly all problems.				
7	Science and technology are helping the poor.				
8	Science and technology are the cause of the environmental problems.				
9	A country needs science and technology to become developed.				
10	Science and technology benefit mainly the developed countries.				
11	We should always trust what scientists have to say.				
12	Scientists are neutral and objective.				

7. Appendix II – Instructions for administration of questionnaires

Instructions for administration of questionnaires to assess the implementation of ESTABLISH on student learning

- **for local co-ordinators**
- **for persons distributing questionnaires**
- **for persons filling the database**

1 Introduction

The questionnaires need to be translated into students' native language, and it is necessary to make sure that students understand both instructions and individual items of the questionnaire. The English-language originals are available on web: http://www.establish-fp7.eu , section WP 6.

Phases:

- Translation of questionnaires into national languages.
- Distribution to respondents (students).
- Recording of data into electronic form (filling the database), and their sending to the e-mail address impact.establish@gmail.com

There are 4 types of questionnaires available, each with clearly defined applications:

Questionnaire 1A

- The questionnaire is used to obtain "fast" feedback after each learning unit completed by upper secondary school students (about 16 to 19 years old, ISCED 3).
- It needs to be assigned immediately after the unit (at the end of the lesson), and students must be explained which unit the questions are related to (in the event that they also attended other units).
- We estimate that respondents will need about 15 minutes to complete this questionnaire. We recommend, however, that all respondents have enough time to complete it.

Questionnaire 1B

- The questionnaire is used to obtain "fast" feedback after each learning unit completed by lower secondary school students (about 12 to 15 years old, ISCED 2).
- It needs to be assigned immediately after the unit (at the end of the lesson), and students must be explained which unit the questions are related to (in the event that they also attended other units).
- We estimate that respondents will need about 10 minutes to complete this questionnaire. We recommend, however, that all respondents have enough time to complete it.

Questionnaire 2A

- The questionnaire is used to assess the impact of more learning units on students. We assign it to students expected to participate in more learning units of the ESTABLISH project. As a minimum, we recommend three units, however, it is possible to assign it after two units or one unit as well.
- It is assigned both before and after a series of more learning units completed by upper secondary school students (about 16 to 19 years old, ISCED 3). Therefore, it is distributed twice to these respondents. As a "pre-test", it needs to be assigned within two weeks before the first learning unit of the series. As a "post-test", it needs to be assigned within two weeks after the end of the last unit. (The impact of each unit is assessed using the questionnaire 1A; therefore, both questionnaires are combined.)
- We estimate that respondents will need about 35 minutes to complete this questionnaire. We recommend, however, that all respondents have enough time to complete it.

Questionnaire 2B

- The questionnaire is used to assess the impact of more learning units on students. We assign it to students expected to participate in more learning units of the ESTABLISH project. As a minimum, we recommend three units, however, it is possible to assign it after two units or one unit as well.
- It is assigned both before and after a series of more learning units completed by lower secondary school students (about 12 to 15 years old, ISCED 2). Therefore, it is distributed twice to these respondents. As a "pre-test", it needs to be assigned within two weeks before the first learning unit of the series. As a "post-test", it needs to be assigned within two weeks after the end of the last unit. (The impact of each unit is assessed using the questionnaire 1B; therefore, both questionnaires are combined.)
- We estimate that respondents will need about 25 minutes to complete this questionnaire. We recommend, however, that all respondents have enough time to complete it.

2. An example illustrating the distribution of questionnaires (time sequence)

Situation: Students aged 13 are to complete three learning units.

Questionnaires and units should follow in this order:

Order	Questionnaires and learning units
1	**Quest. 2B** (as a "pre-test", within two weeks before the beginning of the first unit)
2	**Unit 1**
3	**Quest. 1B** (immediately after the Unit 1)
4	**Unit 2**
5	**Quest. 1B** (immediately after the Unit 2)
6	**Unit 3**
7	**Quest. 1B** (immediately after the Unit 3)
8	**Quest. 2B** (as a "post-test", within two weeks after the end of Unit 3)

3. Filling in the questionnaire header

Particular attention should be paid to the code in the header of each questionnaire. This code must be filled by each respondent in his/her printed (paper) questionnaire at the beginning of the survey. **Without the complete code filled in, the obtained data has no value, and cannot be included in processing.** The code is filled in together with the students, based on the following instructions:

A	B	C		D		E		F	G		H					

Fields

- **A …** type of questionnaire
  - 1A … 1
  - 1B … 2
  - 2A … 3
  - 2B … 4

- **B** … pre-test / post-test
  - In types 1A and 1B, fill in … 0 (zero)
  - In case of a "pre-test" of the questionnaire 2A and 2B, fill in … 1
  - In case of a "post-test" of the questionnaire 2A and 2B, fill in … 2
- **C …** two-letter code of the location (mostly of the state) of the department assigning the questionnaires. We assume that the questionnaires are assigned in the same state as the distributors´ workplace. Individual states (or cities, as the case may be) have been assigned the following codes:

Ireland – IR

The Netherlands – NL

Cyprus – CY

Sweden, Umea – SU

Sweden, Malmo – SM

Poland – PL

Czech Republic – CZ

Malta – MA

Slovakia – SK

Estonia – ES

Italy – IT

Germany, Halle – DH

Germany, Kiel – DK

- **D** ... number of the school in the particular country (2 digits).
  This number will be determined by the national co-ordinator.
- **E** … number of the class (study group) in the particular country (2 digits). This number will be determined by the national co-ordinator, after consultation with the persons who assign the questionnaires.
- **F** … gender of a respondent
  girl … 1

  boy … 2
- **G** … age (rounded down to whole years, 2 digits)

- **H** ... six-digit number composed of the date of the student´s birth (day, month, and year (without "19" or "20"). It serves for identifying the student in the "pre-test" and "post-test".

Example 1 – the field H for a student who was born on the 3rd August 1997:

H					
0	3	0	8	9	7

Example 2 - fields A to H of the code

A	B	C		D		E		F	G		H					
2	0	D	O	0	6	1	3	1	1	5	0	3	0	8	9	7

In questionnaires of the type 1A and 1B, we add field I:

I … two-digit number of the learning unit completed by the student. The numbers of learning units are available available on web: http://www.establish-fp7.eu/index.php?option=com_content&view=article&id=106&Itemid=178

and http://www.establish-fp7.eu/index.php?option=com_content&view=article&id=138 .

Example 3 - fields A to I of the code

A	B	C		D		E		F	G		H						I	
2	0	D	O	0	6	1	3	0	0	6	0	3	0	8	9	7	0	6

In questionnaires of the type "2A post-test" and "2B post-test", we add fields I, J, K, … :

I, J, K and so on … two-digit numbers of the learning units completed by the student (regardless of the order). The numbers of learning units are available on web: http://www.establish-fp7.eu .

In questionnaires of the type "2A pre-test" and "2B pre-test", we add no fields (see Example 2).